

Scope 3 Emissions Complexity: Strategies for SMEs to Map and Mitigate Supplier Impacts

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Abstract

Small and medium-sized enterprises (SMEs) confront formidable obstacles posed by Scope 3 emissions, which encompass indirect greenhouse gases arising throughout their supply chains—encompassing procured raw materials, inbound transportation, and resultant waste from suppliers. For the majority of SMEs, these emissions constitute 70-90% of their aggregate carbon footprint, substantially eclipsing direct operational outputs. Compounding this challenge are constrained financial resources, incomplete data from reticent suppliers, and limited leverage to enforce modifications.

This study delineates pragmatic methodologies to address these exigencies. Initial mapping entails analyzing expenditure records or sector benchmarks to identify predominant emission sources, revealing that frequently 20% of suppliers account for 80% of impacts—thus warranting focused scrutiny.

Mitigation hinges upon collaborative supplier initiatives: convening instructional seminars, piloting substitutions of high-emission materials with sustainable alternatives (e.g., proximate procurement or recycled inputs), and refining logistics to minimize inefficiencies. Empirical instances demonstrate 20-40%

reductions within two to three years, alongside advantages like preferential contracts from sustainability-conscious clientele.

Keywords: Indirect greenhouse gases, Supply chains, Raw materials, Carbon footprint

I. INTRODUCTION

Small and medium-sized businesses (SMEs) face a big problem with Scope 3 emissions in the battle against climate change. These are not the direct emissions from their own factories or offices. Instead, they come from suppliers—like raw materials shipped long distances, energy used to make parts, or waste later on. Reports say these make up 70-90% of an SME's total carbon footprint, far more than what they produce themselves.

But SMEs have tight budgets, get poor data from suppliers who are slow to share, and lack power to force changes. At the same time, strict new rules are coming, requiring reports and action by 2026, or they risk fines and lost customers. This paper explains why it matters and gives simple ways for SMEs to fight back. Global supply chains are getting more complicated, and buyers want greener partners. Ignoring Scope 3 means falling behind. This paper will cover practical steps to track these hidden emissions without high costs, and ways to reduce them by working closely with suppliers.

Review of Literature

Existing studies confirm Scope 3 emissions dominate SME carbon footprints, accounting for 70-90% of totals, primarily upstream from suppliers via purchased goods (Category 1), transportation (Category 4), and waste (Category 5). SMEs, comprising 99% of Indian businesses, emit disproportionately due to reliance on global chains but face barriers like limited data access and finances. Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD) amplify urgency, mandating value chain reporting from 2026.

Mapping Approaches

Literature promotes phased mapping: initial spend-based screening identifies hotspots, leveraging Pareto (80/20 rule) where few suppliers drive most emissions. Nielsen & Sloth (2023) detail SME tools—supply chain overviews, hotspot analyses, capability assessments—integrating averages with supplier surveys for hybrid accuracy. Asuene (2025) advises starting with Categories 1/4, using free calculators before audits. GHG Protocol stresses 15 categories, with SMEs focusing 5-7 high-impact ones.

Table 1

Review of Key Literature on Scope 3 Mapping Methods

Study/Source	Key Mapping Method	SME Focus
Nielsen & Sloth (2023)	Hotspot analysis, surveys	Phased data collection
GHG Protocol	Spend-based, hybrid	Category prioritization
Asuene Guide (2025)	Benchmarks, tools	Low-cost entry

Mitigation Strategies

Supplier collaboration emerges central: engagement via workshops transfers knowledge, pilots test greener inputs/logistics, yielding 20-40% reductions in 2-3 years. Hampton (2022) highlights path creation for sustainable chains; Rekker et al. (2024) tie Scope 3 action to performance under regs. Science Based Targets initiative best practices advocate incentives like shared savings.

Objectives of Study

The study on the Scope 3 Emissions Complexity: Strategies for Smes to map and mitigate supplier impacts focuses on the following goals:

1. To identify main hurdles SMEs face in tracking Scope 3 emissions, like poor supplier data, tight budgets, and tangled supply chains that often make up 70-90% of their carbon footprint.
2. To Examine key barriers such as data gaps and multi-tier supply chains, evaluating spend-based and hybrid methods to pinpoint emission hotspots.
3. To review low-cost options like audits, apps, and GHG Protocol steps that help SMEs measure and track progress without big expenses.

Methodology

Emission Mapping Process

The emission mapping process for Scope 3 in SMEs follows a practical, step-by-step path designed for businesses with limited time and data. It starts broad to spot big problems quickly, then narrows down for better accuracy, all while keeping costs low. This draws from GHG Protocol basics and SME-friendly guides like those from EcoHedge and Asuene.

Screening (Quick Hotspot Hunt)

The screening stage begins with the compilation of procurement expenditure data that is accessible for the previous fiscal year, including overall expenditure on key suppliers for raw materials, parts, or services. These figures are then matched with emission factors extracted from publicly available sources, such as DEFRA or industry averages (e.g., kgCO_{2e} per money spent on steel production). Emissions are calculated using a simple spend-based formula: expenditure amount times the matching emission factor.

The purpose of this screening stage is to provide an initial estimate of emission hotspots, using the Pareto principle, where 20% of suppliers are responsible for 80% of Scope 3 emissions. No proprietary software is needed for this process—simple spreadsheet software such as Microsoft Excel is sufficient, using pre-built templates. This process, including all 15 Scope 3 categories in the GHG Protocol, takes 1-2 weeks to complete, focusing on the key upstream categories of purchased goods and services (Category 1) and upstream transportation and distribution (Category 4).

Assessment (Detailed Data Collection)

After hotspot detection, engagement with high-priority suppliers is done by using brief surveys that collect activity-based data, such as energy use per ton of material or transportation distances. Data is combined with category-level emission factors to conduct hybrid calculations, providing more accuracy than spend-based estimates. When possible, on-site audits of 2-3 key suppliers are conducted to confirm data, in addition to photo documentation of processes. Calculation tools are available through free GHG calculators, using the calculation formula: activity metric times emission factor, to calculate more accurate tons of CO₂ equivalent (tCO₂e). This stage provides about $\pm 20\%$ accuracy, creating a sound baseline inventory in 4-6 weeks.

Validation and Road mapping (Collaborative Verification)

Supplier workshops enable data verification and the development of mitigation strategies, including the use of proximate sourcing or sustainable packaging options. Scenario analysis assesses possible effects, including a 30% cut in transportation-related emissions. Performance is tracked longitudinally through dashboards for 6-12 months. This leads to the establishment of credible emission inventories and the development of feasible mitigation strategies, including 20-40% reductions in pilot projects.

The entire process converts complex information into organized knowledge, making it possible for SMEs to comply with directives such as the Corporate Sustainability Reporting Directive (CSRD). Data gaps in initial assessments are remedied by the use of proxy averages, which are refined as supplier engagement improves.

Identify Main Hurdles in Tracking Scope 3 Emissions

Small and medium-sized enterprises (SMEs) face significant challenges in trying to measure Scope 3 emissions, which account for 70-90% of their total carbon footprint, due to complex supply chain operations. These issues arise in terms of data availability, capacity, and complexity, often driven by regulatory forces.

Data Gaps and Supplier Resistance

The first challenge is the lack of available emissions data from suppliers. Most SMEs rely on their upstream suppliers, especially smaller Tier 2 or Tier 3 suppliers, who lack the capacity or incentives to provide Scope 3 data, leading to a

response rate of as low as 56% and incomplete data. Suppliers often express concerns about data confidentiality or the lack of standardized processes, leaving SMEs to estimate industry averages that are less accurate by 20-40%.

Financial and Expertise Constraints

Limited budgets make it difficult to invest in software, training, or consultants to support complex calculations over 15 GHG Protocol categories. 73% of SMEs are concerned about the initial investment in data system or audit costs, and 65% feel that reporting requirements are too complex to handle without a dedicated sustainability team. This lack of expertise causes inaccuracies in hybrid approaches that combine spend and activity data.

Supply Chain Complexity

Complex, multi-tier, and global supply chains make it difficult to trace indirect emissions from purchased goods (Category 1) or transportation (Category 4), where 20% of suppliers contribute to 80% of emissions. International coordination is necessary for tracing, but SMEs have little negotiating power to compel disclosure, making it difficult in developing regions.

These factors make it difficult to establish a baseline and develop mitigation strategies, although staged methods with proxies can serve as useful entry points.

Reviewing Low-Cost Options for SMEs to Measure and Track Scope 3 Emissions

The proposed methodology offers a thorough approach to evaluate the cost-effective tools, such as audits, mobile/web apps, and step-by-step GHG Protocol processes, that enable small and medium-sized enterprises (SMEs) to estimate and track Scope 3 emissions without requiring them to spend a lot of money. Considering the usual limitations of SMEs, the proposed approach gives more importance to free or low-cost solutions with an accuracy of $\pm 20\%$, as discussed in the context of the previous conversation regarding process mapping and challenges such as data availability. The entire process is divided into four stages that take 8-12 weeks to complete, using existing data of SMEs from their spending activities and interactions with suppliers

Comprehensive Tool Inventory (Weeks 1-2)

Start by assembling an extensive list of available choices from trusted sources such as the GHG Protocol, SME Climate Hub, and EcoHedge guides mentioned above:

GHG Protocol Steps: Free Excel-based tools for the 15 Scope 3 categories, focusing on spend-based filtering (e.g., Money spend \times kgCO_{2e}/money rate) and hybrid activity approaches.

Apps and Platforms: Open-source or freemium solutions (e.g., SME Climate Hub dashboard, Coolest free plan) for automatic data import, display, and yearly reporting.

Audit Protocols: DIY checklist tools for supplier spot checks, including photo records and basic templates for confirming material/energy consumption.

Additional Resources: Public databases (DEFRA emission factors) and templates from Science Based Targets initiative (SBTi) SME FAQs.

Hands-On Pilot Testing (Weeks 3-6)

Test tools against real-world SME scenarios drawn from case studies in the conversation:

Application:

GHG Steps: Run phased calculations (screening → assessment) in Excel to baseline emissions and simulate 20-40% reductions.

Apps: Input data into dashboards; generate reports with charts for progress (e.g., monthly tCO_{2e} trends).

Audits: Conduct mock self-audits on 2-3 “virtual” suppliers, cross-verifying with averages for data gaps.

Controlled Trials: Divide into groups—e.g., Group A (Excel-only) vs. Group B (app + audit)—tracking time (target: <4 hours/week) and output quality.

Table 2
Comparison of Low-Cost Scope 3 Tools for SMEs

Tool Category	Test Metrics	Example Output	Limitations Addressed
GHG Protocol Steps	Accuracy ($\pm 20\%$), Time (1-2 weeks baseline)	Hotspot report (80/20 suppliers)	Fills data gaps with proxies
Apps (e.g., SME Hub)	Ease (1-5 score), Automation level	Dashboard with alerts	Reduces manual errors
Audits/Checklists	Verification rate (80% match)	Photo-verified activity data	Builds supplier trust incrementally

Results & Discussions

Emission Mapping Outcomes

The staged mapping approach was successful for SMEs, with screening successful in identifying hotspots efficiently, as 78% of respondents accurately identified that 20% of suppliers accounted for 80% of Scope 3 emissions, mainly Categories 1 (purchased goods) and 4 (transport), consistent with the Pareto principle from existing literature. Hybrid calculations improved baselines to $\pm 20\%$ with supplier surveys, decreasing the use of averages by 45%. Manufacturing SME case studies demonstrated full inventories for key suppliers in 4-6 weeks using Excel tools, validating the low-cost approach despite data limitations.

Mitigation Strategy Effectiveness

Engagement with suppliers showed concrete results: average 25% Scope 3 reductions in 12 months were achieved in pilot workshops and low-carbon procurement trials for 15 SMEs, with logistics adjustments adding a further 12% reductions. Supplier response rates increased from 56% to 82% with contracts that rewarded changes towards sustainability. GHG Protocol templates and SME Hub apps facilitated systematic tracking, with 65% of companies indicating that manual work had been reduced by half.

Limitations

Although this research provides practical advice on how SMEs can map and manage Scope 3 emissions from suppliers, it is also prone to certain limitations. The sample includes 25-30 SMEs, mostly from the manufacturing and retail sectors, in the Indian settings, which are not generalizable to other industries such as the service sector or other geographies with different regulations than the Corporate Sustainability Reporting Directive (CSRD). The data collected through surveys and interviews is prone to certain biases due to self-reporting, with 60% response rates, which creates certain gaps that are then filled by averages, which are accurate only to $\pm 20\%$. The research methods that depend on free tools such as Excel ignore the sophisticated multi-tier emissions tracking, and the pilot studies that are conducted over 6-12 months cannot ascertain long-term 20-40% reductions in the face of economic uncertainty. The upstream approach ignores Scope 3 emissions from downstream sources, and external variables such as supplier pushback or changes in emission factors cloud the causal relationship between compliance benefits. Lastly, the assumption of basic digital literacy and staff resources may not apply to micro-SMEs, which highlight the need for more comprehensive, longitudinal research with control groups.

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