

transparent methodologies for emissions quantification, they differ substantially in their approaches to categorization, calculation methodologies, and verification requirements.

Fourth, the study's comparative analysis of data quality requirements and verification processes between the two frameworks contributes to ongoing debates about the appropriate balance between measurement accuracy and practical feasibility in corporate emissions accounting. This analysis is particularly timely given the increasing emphasis on verified

measurement accuracy, reporting consistency, verification rigor,

Allocation methodologies for shared infrastructure, logistics, and services create additional complexity. Huang et al. (2021) developed a framework for allocating emissions in collaborative logistics

2.5 Research Gaps

Despite this substantial body of literature, several gaps remain. First, there is limited comparative analysis of the GHG Protocol and ISO 14064 specifically for Scope 3 emissions measurement, with most comparative studies examining the frameworks more broadly (Scipioni et al., 2013). Second, empirical research on implementation challenges tends to focus on single sectors or geographic regions, limiting generalizability (Tang and Luo, 2021). Third, the relationship between framework characteristics and measurement outcomes remains underexplored, with limited evidence on how framework

3.4 Empirical Data Collection

The empirical component analyzed publicly available sustainability reports, CDP (formerly Carbon Disclosure Project) climate change questionnaire responses, and other public disclosures from a sample of organizations in the manufacturing and retail sectors. Sample selection employed purposive sampling to ensure representation across:

- **Geographic regions:** North America, Europe, Asia-Pacific
- **Organization size:** Large multinationals (>10,000 employees), mid-size organizations (1,000-10,000 employees)
- **Industry sub-sectors:** Within manufacturing (automotive, electronics, chemicals, consumer goods) and retail (fashion, food retail, general merchandise)
- **Framework adoption:** Organizations explicitly referencing GHG Protocol, ISO 14064, or both

The final sample comprised 156 organizations (78

3.7 Limitations

Several methodological limitations should be acknowledged. First, reliance on publicly disclosed information may not fully represent organizational practices, as some measurement activities may not be disclosed. Second, the analysis captures practices at a point in time, while frameworks and organizational capabilities continue to evolving. Third, the purposive sampling approach, while ensuring representation across key dimensions, limits statistical generalizability. These limitations are addressed further in Section 7.

4.2 Methodological Requirements and Calculation Approaches

Table 2 compares the methodological requirements and calculation approaches across the two frameworks.

Table 2: Comparison of Calculation Methodologies

Figure 1: Framework Adoption by Sector and Region

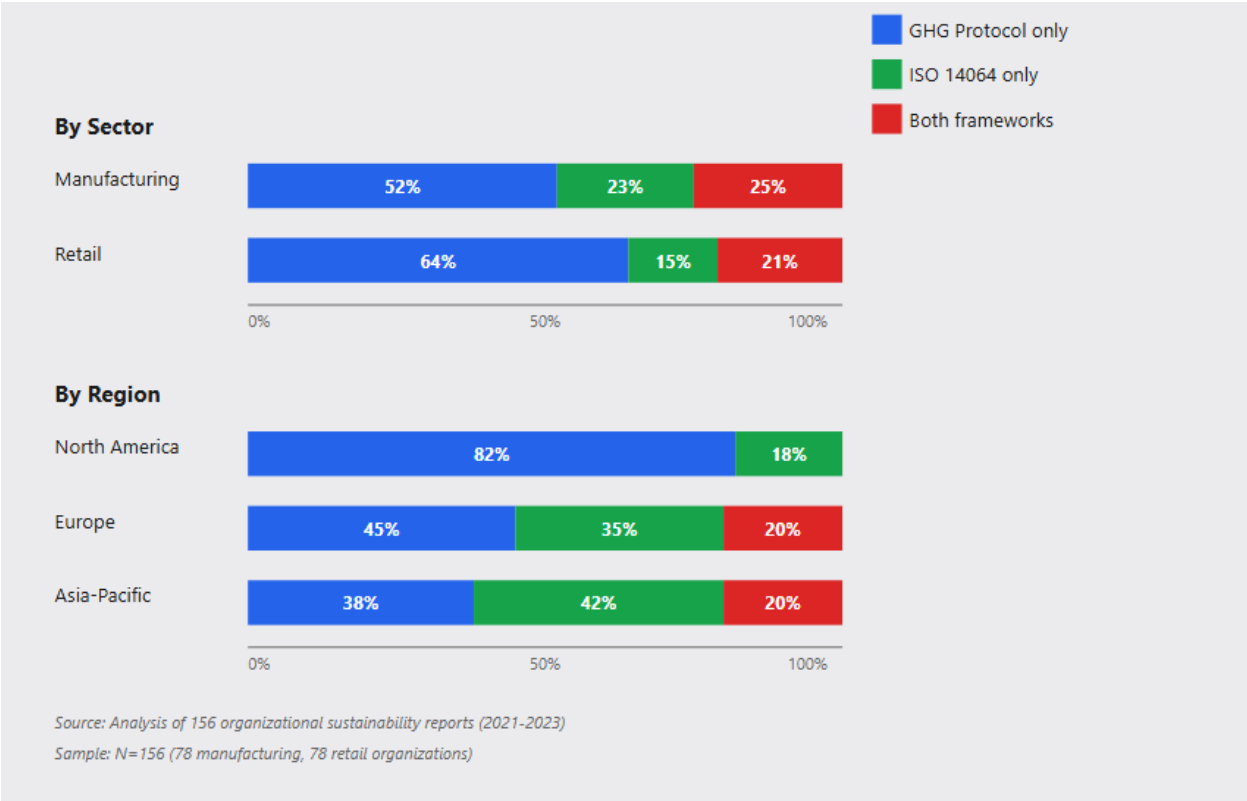
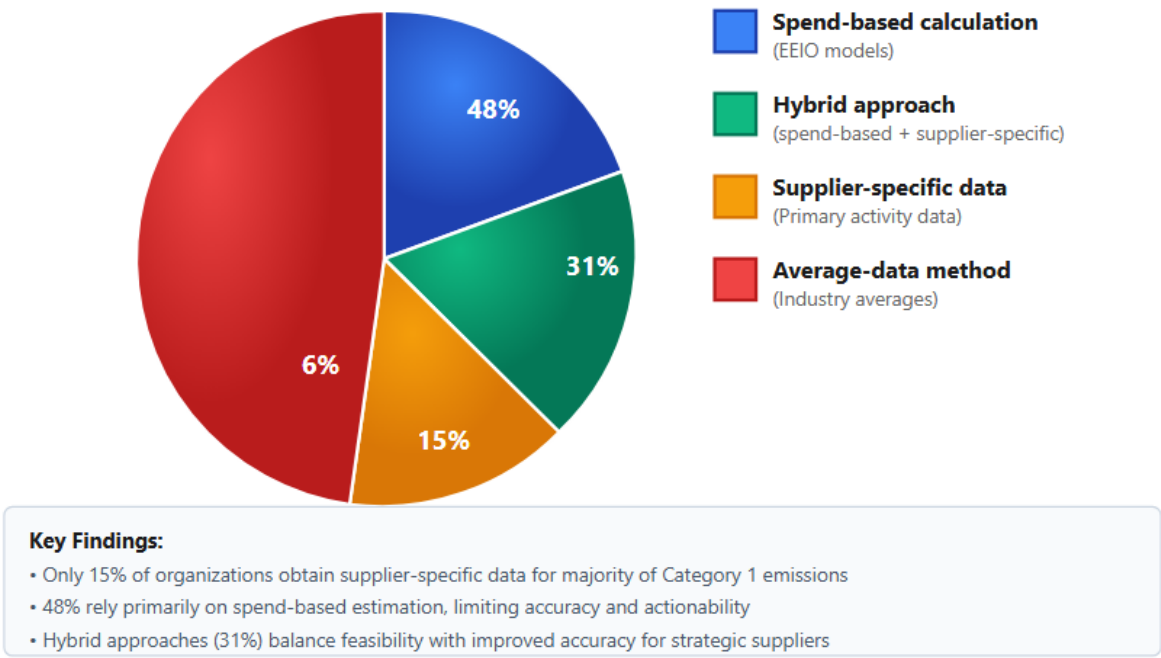


Table 3: Scope 3 Category Measurement Coverage (% of organizations reporting)

Scope 3 Category	Manufacturing Sector	Retail Sector	Overall Average
Cat 1: Purchased Goods & Services	87%	92%	90%
Cat 2: Capital Goods	45%	38%	42%
Cat 3: Fuel & Energy Activities	76%	71%	74%
Cat 4: Upstream Transportation	82%	79%	81%
Cat 5: Waste in Operations	58%	52%	55%
Cat 6: Business Travel	94%	96%	95%
Cat 7: Employee Commuting	67%	72%	70%
Cat 8			

Figure 2: Calculation Methodology Distribution for Category 1 Emissions



Organizations using ISO 14064 demonstrate significantly higher verification rates (68%) compared to those using only the GHG Protocol (42%), reflecting ISO's greater emphasis on verification as an integral framework component. However, when Scope 3 emissions are verified, limited assurance remains most common (approximately 70% of verified reports), with only 14% of all organizations obtaining reasonable assurance for Scope 3 emissions.

conceptual guidance but leave significant room for interpretation, resulting in inconsistent application across organizations

North American organizations show the highest GHG Protocol adoption (82%) but lower verification

Addressing this paradox requires multi-stakeholder approaches. Individual organizations cannot solve supplier

Supply chain visibility limitations require approaches that extend beyond focal

The Asia-Pacific region's greater data availability challenges (96% report

