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Corporate Reporting of Scope 3 Greenhouse Gas Emissions and the Future of Artificial Intelligence: Current Situation, Issues, and Prospects

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Abstract:

The current state of corporate greenhouse gas (GHG) emissions reporting has undergone a massive transformation over the last several years as the Scope 3 emissions are the most challenging and enormous part of organizational carbon footprints that often comprises more than 70 percent of overall emissions by industry. Although these regulatory and stakeholder pressures to incorporate full emissions disclosure in their reporting have positively impacted their reporting, there are still gaps in their standardization, data quality of Scope 3 reporting frameworks and methodological consistency. The paper provides a summary of the current standards and gaps in the research field, a new analysis of the Scope 3 greenhouse gas emissions reporting problem and technologies, which can transform the practice of GHG emission reporting. The studies include the findings of more than 15 other peer-reviewed articles and industry reports published in the last 5 years and investigates the extent of current reporting systems, industry-specific variations in emissions reporting, and the major ambiguities that could impede effective Scope 3 reporting, relying on the holistic dataset of more than 100 companies across industries. It presents a novel AI-based emissions estimation regression model, which shows high predictive accuracy, especially of S3 Category 1 emissions, and network analysis shows new importance of investment-related Scope 3 emissions groups. Such outcomes positively respond to the necessity to develop standardised strategies, enhance the quality control of the information, and instill technologies of artificial intelligence into the Scope 3 reporting system that would serve plausible policy suggestions which can be followed by policy-makers, sustainability specialists, and business decision-makers in their practice of introducing more transparency and accountability of emissions to the system.

Keywords:

Corporate Sustainability Reporting, Scope 3 Emissions, Greenhouse Gas (GHG) Reporting, Supply Chain Decarbonization, Artificial Intelligence (AI) in Sustainability

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Introduction

There has never been a stronger urgency to respond to climate change, supported by a rapidly accumulating body of scientific evidence and international policy platforms that highlight the urgency to respond near and far-reaching decreases in greenhouse gases. With the world moving towards decarbonization, businesses have become participants in the process, and their operations, products and supply chains comprise a significant portion of global emissions. Appropriate quantification and reporting of GHG emissions have therefore become part of corporate sustainability practices, risk management, and stakeholder relations (Herbohn et al., 2019; Dahlmann and Rohrich, 2019; Isil and Sebastianelli, 2020).

The reporting of corporate GHG has changed significantly in the last 20 years, with an early emphasis on direct emissions (Scope 1) and purchased energy (Scope 2) that are comparatively easy to measure within organizational confines. But these scopes are usually a minute percentage of a company actual climate impact. The largest corporate carbon footprints are Scope 3 emissions, which happen all over the value chain, and the reporting company does not have direct control over them. Scope 3 emissions constitute over three-quarters of the total carbon footprint of an average company, and even larger proportions of some industries (Carbon Disclosure Project, 2023; Blanco et al., 2016).

Although they are important, Scope 3 emissions are the most difficult to quantify, manage, and reduce. Lifecycle emission tracking is very challenging due to the complexity of modern supply chains that may extend across multiple continents and have thousands of suppliers. The availability of data is also an issue, with numerous suppliers, especially in leading to markets or in the lower provision chain, do not have the means or ability to collect accurate emissions data. Furthermore, a lack of internationally recognized reporting frameworks and subjective interpretation of the current standards also leads to ambiguities in reporting, which leads to inconsistency and thus hinders comparability among companies and industries (Downie and Stubbs, 2013; Huang et al., 2009; Depoers et al., 2016).

The regulatory framework regarding Scope 3 reporting is quickly changing and is not uniform. Whilst in certain jurisdictions greater disclosures of climate are mandated, in the majority of areas, Scope 3 reporting is voluntary, motivated less by law than by investor interests, customer insurance and reputational issues. As of now, Scope 3 emissions are reported by 70 percent of European companies, 45 percent of North American and 31 percent of East Asian companies, and by larger companies more than smaller ones. Out of all relevant emission sources, not many reporting companies include them in all of their areas and have reduction targets approved by the Science Based Targets initiative (Blanco, 2021; Linares-Rodriguez et al., 2022).

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Scope 3 reporting is further complicated by methodological issues with no consensus on how to compute it, what emission factors to include, or what to report. The lack of supplier data leads to the need to use secondary sources of supplier information, such as industry averages or generic emission factors, which cause a great amount of uncertainty and reduce the validity of estimations. The fact that there is currently a wide range of variation in the interpretation and application of the available standards, such as the GHG Protocol Corporate Value Chain (Scope 3) Standard, discourages performance benchmarking and aggregation at sectoral levels (Greenhouse Gas Protocol, 2013; Busch et al., 2022).

Scope 3 reporting is severely limited by resource and organizational factors. Extensive inventories involve significant investments in information systems, training of employees, involvement of suppliers and third-party verification. These costs are prohibitive to many firms, especially to small and medium enterprises (SMEs). Another set of deterrents is transaction costs related to the task of coordinating data collection on complex networks of suppliers (Ritz, 2022; Robinson et al., 2015).

Behavioral and strategic elements become even more complicated. Other companies sometimes choose not to report in detail on the Scope 3 to safeguard their competitive positioning or reputation. According to the so-called organizing-performing paradox, the improved reporting functions can make previously undiscussed sources of emissions visible, which will temporarily push the reported levels of emissions higher, deterring full disclosure. Moreover, the lack of interrelation between executive compensation and climate performance undermines reporting incentives, allowing businesses to exploit the flexibilities of reporting standards and selectively disclose information, which can amount to greenwashing (Apergis et al., 2022; Popescu et al., 2021).

Nevertheless, quality Scope 3 reporting is emerging as a valuable strategic management driver, as it allows firms to find opportunities related to reduction of emissions, address risks within their supply chain, and create specific strategies to decarbonize. It helps to increase the transparency of the stakeholders and helps to compete advantageously. With more stringent regulatory requirements and higher expectations on stakeholders, the best placed companies to succeed in the low-carbon economy will be those that are ahead in reporting on Scope 3 (Villena & Dhanorkar, 2020; Shrimali, 2022).

The technological development, especially artificial intelligence (AI), may provide some means to address significant Scope 3 reporting challenges. Applications of machine learning have the potential to automate the data collection process, combine various data sources, fill-in gaps, and identify anomalies, thus enhancing the quality of data and minimizing the load on the corporate sustainability team. These technologies make possible sophisticated analyses, such as network-based emission allocation schemes of complex supply chains and investment networks. The role AI plays in the accurate, timely, and actionable disclosure of Scope 3 is becoming more critical as the volume and complexity of sustainability data keep growing (Nguyen et al., 2022; Goldhammer et al., 2017).

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The paper gives an in-depth analysis of existing Scope 3 GHG emissions reporting problems and opportunities, with a particular emphasis on AI-based solutions to address limitations in data and processes. Based on the examination of 100 plus company disclosures, systematic literature reviews, and network-based investment emission analysis, the following sections discuss the current coverage and limitations of frameworks, variations in emissions reporting sectors, and uncertainties that are critical to an effective Scope 3 disclosure, as well as suggest methodological innovations and organizational solutions to achieve greater reporting effectiveness and help support global decarbonization goals.

Literature Review

The Role of Scope 3 Reporting in Supply Chain Decarbonization

Scope 3 reporting has grown beyond compliance requirements and has become one of the strategic pillars of supply chain decarbonization initiatives. Firms that engage in robust Scope 3 reporting should explore their respective value chains, starting at the source of raw materials, and going all the way to waste disposal, exposing unreported points of emission hotspots such as carbon-intensive suppliers, logistic bottlenecks, and product utilization stages. This overall mapping allows organizations to devote themselves to interventions that have the greatest decarbonizing effect, either by switching their suppliers or by redesigning the product or streamlining the logistics. It is also useful to understand the supply chain structures, dependencies, and vulnerabilities that are significant in responding to environmental and operational risks (Garcia Alaminos et al., 2022; Graf-Vlachy and Hettler, 2024; Villena and Dhanorkar, 2020).

Maximizing transparency and gaining stakeholder trust (especially investors, customers and regulators) occurs through scope 3 reporting. As sustainable finance expands and as ESG factors take a central role in investment decision-making, investors are urging financial institutions to adopt extensive Scope 3 reporting to ensure precise evaluation of climate risks in a portfolio. The necessity of supplier emissions data to ensure disclosure compliance by B2B customers generates value chain spillover effect where unilateral reporting practices by single firm enhance upstream and downstream practices. With rules such as the Corporate Sustainability Reporting Directive (CSRD) of the EU establishing regulatory standards for Scope 3 disclosure, companies that already have established reporting infrastructures have advantages in compliance and in their operating licenses (Blanco, 2021; Herbohn et al., 2019; European Commission, 2023).

In spite of this, existing Scope 3 reporting cannot help achieve supply chain decarbonization. The absence of supplier primary data is making many companies use secondary data and generic emission factors which is giving a lot of uncertainty and making reported figures questionable. Cross-firm and cross-sector comparability is weakened by methodological variations such as non-standard boundaries,

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allocation factors and emission factors. Most jurisdictions interpret Voluntary Scope 3 disclosure as implying that few businesses report all their sources of emissions, and even fewer of them set targets in the alignment with the Paris Agreement (CDP, 2023; Downie and Stubbs, 2013).

Artificial Intelligence: Transforming Scope 3 Emissions Reporting

Artificial intelligence is already quickly changing the reporting of Scope 3 GHG emissions, but it is solving the problems of data collection, quality assurance, and strategic utility that have always presented a significant challenge. The automation, transparency, and actionable insight of AI-based systems provide organizations with opportunities to work with large volumes of value chain data (Australian Climate Leaders Coalition, 2025; Nguyen et al., 2022; Jahnukainen, 2024).

The greatest effect of AI is an automated data collection on emissions and mapping. Conventional Scope 3 reporting involved intensive data compilation by hand of the various suppliers and stakeholders, and the final inventories were not complete. Now machine learning and natural language processing can be used to bring together data in various formats with different types of suppliers and invoices all of suppliers and contracts, along with unstructured documents and normalize and harmonize data to be analyzed. This type of automation can save time, human resource used in data collection, reduce human error, and use resources available in other value-add activities (Australian Climate Leaders Coalition, 2025; Jahnukainen, 2024; Goldhammer et al., 2017).

AI improves the quality and consistency of Scope 3 data with machine learning algorithms that enable detection of anomalies, outliers, and filling data gaps based on historical trends and industry standards. Where supplier-reported emissions data is not available (or inconsistent) AI models use similar suppliers, product types, or regional means to formulate likely values, leading to increased inventory accuracy and completeness. With these systems, conflicting data points are resolved to capture defensible reporting figures that satisfy increasing stakeholder requirements of clear, credible emissions reporting (Australian Climate Leaders Coalition, 2025; Jahnukainen, 2024; Busch et al., 2022).

Emission prediction and emission related analysis can be based on the use of AI in business prediction analytics and can place companies in a more proactive than reactive reporting field. AI models decarbonization choices, supplier switching, product redress, logistics changes to distinguish the most efficient modifications, and find the scope 3 footprints of a company. Predictive analytics help companies set targets in a more science-based manner that incorporates the requirements of regulations (Jahnukainen, 2024; Nguyen et al., 2022; Wiedmann et al., 2021).

AI-Driven Platforms and Digital Innovation in Scope 3 Emissions Reporting

The next generation AI-driven Scope 3 software applications have the ability to quantify, monitor, and manage value chain emissions using hybridized calculation methods that incorporate spend-based

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estimates, proxy activities, and emissions factor databases produced by EPA and DEFRA. These sites also have full audit trails easily identifying estimated data which can be substituted by real supplier data as the data matures. The intelligent gap-filling feature enables the creation of all-inclusive and standards-compliant emissions inventories even when the data is flawed (Pulsora, 2025; Standard Carbon Inc., 2025; Wolters Kluwer, 2024).

Leading Scope 3 platforms are defined by standards alignment and audit-readiness, and are designed to conform to numerous frameworks such as GHG Protocol, CSRD, SBTi, CDP, and any regulations still developing such as California SB 253. By their templates, they are not only user friendly, but also in terms of customization on reporting to produce disclosure packages in various regulatory and voluntary programmes, they must meet its requirements at this day and at the future (Pulsora, 2025; Standard Carbon Inc., 2025; European Commission, 2023).

Underdeveloped platforms provide scenario analysis of decarbonization, hotspots of emissions and non-compliant reduction planning based on SBTi. It allows users to simulate supplier variation, substitution of materials or regional suppliers and monitor progress. Internal carbon pricing models, marginal abatement cost curves, and AI-based recommendations can be considered systems as they help organizations finance cost-efficient interventions in value chains (EY, 2025; Pulsora, 2025; Shrimali, 2022).

The Emerging Importance of Investment-Related Scope 3 Emissions

Category 15 of the GHG Protocol framework (investment-related Scope 3 emissions) is a large but underrepresented component of company carbon footprint, especially by financial institutions and firms with diversified investment holdings. Approximately half of financial sector firms only report emissions associated with investments even though they may make up three quarters of their carbon footprint. It is a reporting gap that arises due to discretionary materiality thresholds, methodology differences and lack of regulatory mandates (GHG Protocol, 2013; Hettler and Graf-Vlachy, 2024; Mejia and Kajikawa, 2024).

Traditional investment-related emissions quantification uses the first-tier methods which assigns the share of emission to direct holdings of the investee companies but they do not examine the effects of the multi-tiered investment network systems. The ripple effect of environmental liabilities in linear hierarchical financial relationship can not be measured using this linear methodology, as it can omit 70% of the attributable emissions in linked shareholder networks (Popescu et al., 2021; Apergis et al., 2022).

Network analysis is an innovative approach, in that complete webs of equity investments are traced in order to more accurately distribute the responsibility of emissions. This approach assigns emissions with reference to the investment ecosystem influence of firms (as calculated with centrality measures such

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as PageRank) using publicly-traded firm shareholder data. In terms of the network influence net, financial services and industrial sectors held the number one position in the analysis of the Tokyo Stock Exchange as the largest contributors of Scope 3 emissions, with financial institutions being those with the most emission increase attributed to them regardless of their operational footprint (Hettler and Graf-Vlachy, 2024; Mejia and Kajikawa, 2024; Popescu et al., 2023).

This is a networked method that re-locates the meaning of climate responsibility, exposing financial institutions, asset managers, and industrial holding companies as the key points of contact in the carbon economy. Depending on the network centrality measures used, some financial and industrial firms indicate larger scopes of emitting than the large steel manufacturers. This redistribution of responsibilities questions the traditional approaches to decarbonization that prioritize upstream producers but fail to consider the facilitators of high carbon activities, which in turn implies that capital allocation decisions are as important as operational ones with net-zero objectives (Greenhouse Gas Protocol, 2013; Apergis et al., 2022; Popescu et al., 2021).

Methodology

A mixed-methods research methodology was used to investigate the challenges of Scope 3 greenhouse gas (GHG) emissions reporting and determine the usefulness of artificial intelligence (AI) technologies in improving reporting accuracy and consistency. The interdisciplinary approach covered the simple data processing, systematic search of the literature, and the complex mathematical model.

The first qualitative phase was to conduct an in-depth study of the current Scope 3 emissions reporting standards and frameworks. This covered the analysis of the greenhouse gas protocol Corporate Value Chain (Scope 3) standard, Carbon Disclosure Project (CDP) questionnaires, Science Based Targets initiative (SBTi), Task Force on Climate-related Financial Disclosures (TCFD) standards, ISO 14064-1:2018, and Global Reporting Initiative (GRI) standards. The analysis was conducted to determine the variations in the definitions of boundaries, the classification of emissions, and guidance on calculation between the frameworks, with special emphasis being drawn to the points of convergence, points of divergence, and some sector-specific guidance. It was a required qualitative assessment in the process of identifying sources of ambiguity and inconsistency in industry-wide practices on Scope 3 reporting (Task Force on Climate-related Financial Disclosures, 2023; CDP, 2023).

A representative sample of 100 companies (varying in type: manufacturing, chemicals, technology, and consumer goods) was picked using the availability of recent (2022-2023) Scope 3 emissions disclosures. Sampling criteria allowed inclusion of firms which had different supply chain complexities, geographic footprints and levels of reporting maturity. Publicly available sustainability reports and CDP disclosures and regulatory submissions served as sources of data, allowing for cross-sectional and

longitudinal analysis and representing heterogeneous reporting practices across sectors (Blanco et al., 2016; Isil and Sebastianelli, 2020; Liu et al., 2021).

A thorough qualitative analysis of sustainability reports prepared by each company was conducted in depth, looking at the standards and methodologies applied to reporting, scope and completeness of data reported, and its alignment with accepted standards such as the GHG Protocol. Common difficulties identified in the company during the review were data availability, engagement with suppliers, and methodological uncertainty. Relevant academic and business publications were identified through parallel internet-based literature searches using the keywords: Scope 3 emissions, Corporate Carbon Disclosure, and Scope 3 quantification. This method of triangulation enhanced qualitative analysis by connecting the findings found in company reports with the general knowledge of the literature (Herbohn et al., 2019; Depoers et al., 2016).

The quantitative segment reflected structured data gathering through various public sources, such as specific internet searches, annual ESG reports of companies, and CDP questionnaire and reports. The multi-source method allowed developing a complete set of data to examine more than 100 businesses using specific Scope 3 emissions data, revenue data, and industry categories. The openness and reliability of publicly disclosed sustainability reports on corporations and the reports provided by the CDP developed a list of standardized ratings of the emission reporting schemes to help compare the data across the industries (Swinkels and Markwat, 2023).

Preprocessing of data included cleaning and normalization of data and then subjecting the data to machine learning methods. Any missing data were either deleted or imputed with averages of each sector and the statistical indicators of deviation were used to highlight the outliers that were checked manually. This was performed during the preprocessing step, to ensure the integrity of the data and to bestow some assurance that the prediction bias of the model would not be a byproduct of a statistical artifact (Busch et al., 2022).

Preliminary analytical steps identified and assessed the relationship between revenue and Scope 3 emissions by category, and the category of Purchased Goods and Services (unaffiliated scope of company 3) presented the largest positive correlation with company revenue (correlation coefficient of 0.76). This knowledge was used to design the predictive algorithm with revenue as the most important predictive variable of C1 emissions (Huang et al., 2009).

To avoid overfitting, the development of AI models was presented with an 80:20 training-testing split, and cross-validation with k-folds. The multiple linear regression and random forest regression models were used due to their interpretability, as well as, their ability to both learn non-linear relationships and their ability to display transparency in their feature importance. Systematic grid search was used to

optimize model hyperparameters and maximize predictive performance on each category and the total Scope 3 outputs (Goldhammer et al., 2017).

The Standard predictive measures used in the model performance evaluation were; Root Mean Squared error (RMSE), Mean Absolute error (MAE) and coefficient of determination (R2). Analysis of the estimated and actual emissions revealed some categories with better model performance and those with greater variability in actual emissions. It has also been shown using the sensitivity analysis that the S3 C1 emissions were primarily revenue sensitive, with other types necessarily being multi-variable to allow the analysis to be more accurate (Nguyen et al., 2022).

CliMax, a web-based application, was DEVELOPED to operationalize the predictive model and deployed at the following URL: https://scope3-emission-calculator.netlify.app/. Users can use this pilot tool to enter company revenue and C1 emissions percentage to forecast the combined Scope 3 footprint and intensity of emission, and now predicts sectoral average C1 emissions intensity based on training data (101.23 tCO2e/MUSD manufacturing). The future generation will deploy dynamic AI representations through API networks where predetermined sector means will be replaced with multi-factor search that is more correct and can be applied within the sector (Australian Climate Leaders Coalition, 2025).

The Scope 3 emissions analysis associated with investments also involved analyzing data related to the financial success of specific companies, which were selected to utilize shareholder information and create financial databases. Financial indicators were matched with emissions to gauge the systemic effects in investment chains, providing a comprehensive measure of carbon content in financial flows and disclosing the often-neglected role of investors in creating macroeconomic-level emissions.

Systematic literature review procedures, involving location, screening, and synthesis of more than 100 peer-reviewed articles and industry reports, based on empirical studies, methodological innovations, and policy analyses of Scope 3 emissions reporting, were used as the concluding methodology. The combination of qualitative analysis and quantitative modeling as well as AI applications allowed the authors to study current Scope 3 reporting practices and the revolutionary potential of AI technologies in this key area of sustainability in a comprehensive way (Wiedmann et al., 2021; Popescu et al., 2023; Rietbergen et al., 2015).

Results and Discussion

The quantitative section of the research demonstrated several essential findings regarding the relationship between the revenues of organizations and Scope 3 emissions of the manufacturing industry. During the first analysis stage, revenue against Scope 3 emissions were identified as having strong and positive correlation values within 0.51 to 0.76 with the highest correlation coefficient of 0.76

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in Category 1 (Purchased Goods and Services). Descriptive statistics demonstrated that C1 had the largest number of contribution to the total Scope 3 emissions found in the manufacturing industry, and C2 (capital goods) and C4 (upstream transportation and distributed) had the highest number of contributions to C1 emissions, which was the most critical predictive factor.

The resulting pilot machine learning model was trained on divided 80-20 train / -test and k-fold cross-validation to prevent overfitting. The reason behind the utilization of linear multiple regression models and random forest regression models is that they are easy to understand and also capable of identifying the non-linear relationships at the same time without compromising the transparency of features importance. The use of model performance evaluation concerning RMSE, MAE and R2 indicated relatively high predictability of output accuracy relative to other chosen categories in predicting and reporting emission at the category level than other categories considered. The sensitivity analysis confirmed that C1 emission was mostly defined by revenue but the other categories required multi-variable inputs to have a more accurate prediction.

The results of the study were applied by developing CliMAX, an online predictor tool which is hosted on a web-based platform aviliable at: scope3-emission-calculator.netlify.app. This pilot application will allow users to input company revenue and percent of S3 C1 category emissions to predict total Scope 3 footprints and emission intensities that will operate deterministically with manufacturing sector averages of 101.23 tCO2e/MUSD. The strong association between revenue and C1 emissions is a good contribution to the area of corporate sustainability design and law compliance, where the success of the implementation of the pilot CliMAX tool is an important step forward in the process of democratizing the Scope 3 emissions prediction process among industry stakeholders, which will in the future be developed and improved with the dynamism of AI models and the coverage of industries.

Best Practices and Future Directions for Scope 3 Reporting

The continued evolution of scope 3 greenhouse gas (GHG) emissions reporting remains more driven by the embracement of best practices and the impact of new regulations and the use of modern technologies such as artificial intelligence (AI). As the organizations worldwide struggle to understand value chain emissions and the complexity and magnitude of their emissions, a bunch of reasonable recommendations and proactive measures are quickly emerging to enable organizations that are new in reporting or the experienced ones to deal with the issue.

Establishing a Robust Scope 3 Inventory

Viewing Scope 3 inventorying as a continuous improvement activity, and not a one off exercise, is one of the best practices. According to the US EPA and the GHG Protocol, companies should begin with identifying which of the 15 categories of Scope 3 that applies depending on various factors, such as

size, influence, risk, stakeholder expectations, and sector guidance (Anthesis Group, 2025; GHG Protocol, 2022; US EPA, 2025). Some pertinence can be established even by rough numbers and companies are urged to obtain the data they currently possess and streamline their inventories over time as new data becomes available (Anthesis Group, 2025; US EPA, 2025).

The methodology of calculation must be selected depending on the availability of the data as well as whether it is to be quantified or not. With reference, the upstream transportation emissions can be estimated either through a fuel-based or distance-based approach or through spend-based approach using respective emission factors. These approaches are extremely explicit at the prescriptive step levels (Anthesis Group, 2025; GHG Protocol, 2022; US EPA, 2025) within the GHG Emission Factors Hub by EPA and GHG Protocol calculation instructions. Limits, assumptions, inclusions and exclusions should be obvious and the companies should disclose any limitations, future intentions of their development in their plans (Anthesis Group, 2025; US EPA, 2025).

Supplier Engagement and Data Quality

Another important means of improving quality of Scope 3 data is through the involvement of important suppliers. Organizations have been invited to review how suppliers impact the climate and whether they are a part of the reporting and reducing of emissions. This kind of involvement can be training and technical assistance in addition to incentives to give specific information. The third-party verification of the scope 3 emissions and addition of the supplier GHG management to the business decision-making process are the current best practices as organizations are moving into the future (Anthesis Group, 2025; PricewaterhouseCoopers, 2022; United States Environmental Protection Agency, 2025).

Continuous Improvement and Assurance

The best practice frameworks state that an inventory management plan must be maintained and updated at all times. This will involve regular review of data sources, limiting activity on data estimation and secondary confirmation to increase the plausibility of data reported. As the reporting of emissions intensifies, assurance, even partial or reasonable, is likely to become a requirement, particularly in new regulatory frameworks (the Corporate Sustainability Reporting Directive, or CSRD in the EU and the Sustainability Reporting Standards in Australia), which are now being developed (Anthesis Group, 2025; PwC, 2022; US EPA, 2025).

Leveraging Digital Platforms and AI

AI and digital solutions are now in the process of simplifying Scope 3 reporting. It will be possible to use AI to primarily automate the data collection, mapping, and validation process, removing a majority of the labor resources and increasing the quality and consistency of the data (Australian Climate Leaders Coalition, 2025; Datakinetic, 2025; US EPA, 2025). With the help of such technologies, the organizations

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can deal with unstructured and disorganized sources of data, locate emission hotspots, and anticipate future trends, guided by predictive analytics. AI-based platforms also have real-time dashboards, scenario modelling and benchmarking tools that enable sustainability teams to make business transformations based on data-driven decisions and science-based tracking of targets (Australian Climate Leaders Coalition, 2025; Datakinetic, 2025; US EPA, 2025).

Regulatory Trends and Global Alignment

The scope 3 reporting regulation is evolving rapidly. The CSRD in Europe and the Australian Sustainability Reporting Standards of most companies are required to maintain Scope 3 disclosure (including optional parts Scope 3.1 and Scope 3.1) and have gradually implemented one part, which purportedly ensures that the companies have sufficient time to develop strong inventories (Anthesis Group, 2025; PwC, 2022; US EPA, 2025). It has also led to efforts to align and develop more rules to provide international consistency across jurisdictions (GHG Protocol, 2022; GHG Protocol, 2024). It also means that organizations need to consider the trend of regulatory reporting and align their own reporting with the available alternatives including the GHG Protocol, CDP, and industry guidance (GHG Protocol, 2022; GHG Protocol, 2024).

Transparency and Stakeholder Communication

Effective Scope 3 reporting is premised on transparency. Companies should clearly report the scope, boundaries, mode of computation as well as all of the uncertainties and cutoffs. The stakeholders become convinced of the sincerity of communication and avoid the greenwashing allegations. Information also exists that organizations show their intentions connected with the continuous improvement and external validation that will show that organizations are seeking after accuracy and responsibility (Anthesis Group, 2025; US EPA, 2025).

Strategic Integration and Value Creation

Finally, it is recommended to include Scope 3 data in current business strategy, risk management, and value creation. These include: incorporation of emissions in the procurements-related activities, product development and investments as well as development of cross-functional teamwork between sustainability, finance and supply chain departments. But, as far as Scope 3 reporting is concerned, there is an opportunity to unlock innovation, operational efficiency and competitive gains in a global economy that is highly decarbonizing when this potential is managed as a strategic priority instead of a compliance activity (Australian Climate Leaders Coalition, 2025; Datakinetic, 2025; US EPA, 2025).

Concisely, the Scope 3 reporting concept is an idea that is bound to converge in terms of regulations, the use of technology, and a culture of openness and continuous enhancement in the future. This is not only that such best practices will assist a company to live up to the increased demands of their

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stakeholders, but such best practices will also make them a company that is a leader in climate action and sustainable value chain management.

Practical Steps for Scope 3 Reporting

To develop a robust and credible Scope 3 greenhouse gas (GHG) emissions inventory that is both feasible and time bound, a systematic, stepwise approach that adheres to international best practices and is compliant with the changing regulatory environment is required. This begins with relevancy analysis: which of the 15 reporting Scope 3 categories (which number) are material to the reporting organization, as suggested by the US EPA and the GHG Protocol. Some of the factors that can be taken into consideration to give this assessment include size of the source of the emissions, the impact of the organization, risks, expectation of the stakeholders, outsourcing and direction of the sector specific. In some cases, a rough number on the emissions might be necessary to determine relevancy, but the businesses are actually being pushed to estimate anyway in case perfect information is not available in the first place (Anthesis Group, 2025; GHG Protocol, 2024; US EPA, 2025).

Once the appropriate categories have been identified, GHG emissions should then be estimated on a category-by-category basis using the most appropriate calculation process. As an example, the upstream transportation emissions can be computed as either fuel based, distance based or spend based depending on the available information about the activities. The GHG Emission Factors Hub is a tool that provides a full suite of GHG emission factors as per these approaches in order that organizations may select emission factors that better suit their data. This can be explained by the fact that under the conditions that they are not able to utilize primary data, it is possible to use secondary data and industry averages, but the organizations must explicitly show them the boundaries, assumptions, and the weaknesses and strengths of their estimations (Anthesis Group, 2025; GHG Protocol, 2022; US EPA, 2025).

The Scope 3 data collection, calculation, and reporting needs standardization now more than ever to enable digitalization and automation. Data mapping with AI tooling could be automated, resulting in better data quality and the detection of anomalies, which would significantly reduce the effort invested in it manually and enable audits to be made more easily. The Australian Climate Leaders Coalition believes that AI would enable automatization of the process of gathering information about suppliers, making it more consistent, and enable prediction of emissions and contribute to the correct setting of the target and the development of a technical framework and road map to be followed in practice. However, technology should be properly applied as an addition, but not as a substitute to internal expertise and cross-functional collaboration (Australian Climate Leaders Coalition, 2025; Industrial Sustainability Solutions, 2025; Goldhammer et al., 2017).

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Transparency is the basis of efficient Scope 3 reporting. Their calculations should include the numbers of their emissions, approaches, emission factors, limits and exclusions or estimates. Continuous improvement must be essential, the company after inventory has been completed is to update and have an inventory management plan but keep constantly updating data quality and continues to offer opportunities to reconsider estimates as new data are revealed. Third-party verification (as little as is sensible) as a priority will increase over time as regulation focuses on ESG as well as desires of other stakeholders (especially with such frameworks as the EU Corporate Sustainability Reporting Directive CSRD (Anthesi Group, 2025; Industrial Sustainability Solutions, 2025; PwC, 2022).

Suppliers should also be involved in order to improve Scope 3 data quality. Top organizations have best practices in terms of training and providing technical support to suppliers, and incentives to ensure that true emissions data are captured. Over the long term, companies can migrate over time through the stages of utilizing generic emission factors, acquiring more granular, supplier detailed data down to burying the management of emissions into procurement and business decision making. This common process will facilitate not only precise data but will also boost decarbonization of the whole value chain (Australian Climate Leaders Coalition, 2025; GHG Protocol, 2022; Industrial Sustainability Solutions, 2025).

Finally, businesses should incorporate Scope 3 information within the broad business strategy and risk management. By integrating the issues of emissions into the procurement processes, the product development process and the investment process, and by promoting cross-functional communication between the teams of sustainability, financial and supply chain companies will be able to unlock the power of innovation and competitive advantage. Organizations will be in a good position to meet the challenges posed by new regulatory frameworks and stakeholder expectations and become an efficient component of the global climate action effort by viewing Scope 3 reporting as a strategic imperative (as opposed to a compliance burden) (GHG Protocol, 2024; Industrial Sustainability Solutions, 2025; US EPA, 2025).

Conclusion

The Scope 3 greenhouse gas reporting straddles and inhabits enormous challenges and radical opportunities in corporate sustainability and world decarbonization. As the analysis of over 100 companies in this study reveals, despite the growing awareness of companies of the importance of the Scope 3 emissions, which often constitute the largest portion of the carbon footprint of the companies, reporting is still inconsistent, incomplete, and methodologically vague. Even though several initiatives, like the GHG Protocol and CDP, are in place, there are still wide variations in how companies and industries approach the process of data collection, how they compute it, and the coverage of categories (Garcia Alaminos et al., 2022; Hettler and Graf-Vlachy, 2024; Mejia and Kajikawa, 2024).

The analysis demonstrates that effective Scope 3 reporting depends to a large extent on the negative data quality and standardization issues inherent to it. Ongoing use of secondary data, industry standards, and generic emission factors compromises accuracy and comparability, and Scope 3 data should not be used in benchmarking and policy development because of the lack of a universal method and sector-specific guidance. Moreover, voluntary reporting regimes also generated substantial differences in disclosure rates and quality since not every company within the construct will report all sources or emission, or will create science-based reduction targets (Graf-Vlachy and Hettler, 2024).

However, the current paper shows that artificial intelligence and digital innovation has potential opportunities to provide significant technical and organizational changes towards high-quality Scope 3 reporting. The designed and tested AI-based regression model indicates that high-order analytics can enhance the level of accuracy, strength, and timeliness of the emission inventory by gathering data, filling missing data, and detecting abnormalities by using automated data collection, missing data filling, and anomaly detection tools. The artificial intelligence systems help to align the opposing sources of information, allow real-time visualization, and provide more trustworthy modelling of scenarios and objectives (Hettler and Graf-Vlachy, 2024; Mejia and Kajikawa, 2024).

The need to employ the complex measurement approaches to project the environmental responsibility of complex financial constructions is triggered by the development of the Scope 3 emission of investment issues. Analysis of networks has established that financial institutions and industrial holding companies are likely to be key carbon enablers in the sense that investment decisions made by them have a far-reaching influence on the amount of emissions that extend the scope of their operation capabilities. This kind of approach offers a superior insight into the climatic effects of flows in capital and generates systemic drivers of change in the economic aspect of the economy (Mejia and Kajikawa, 2024).

Key Recommendations:

- **For Policymakers:**
  - Establish mandatory, standardized Scope 3 reporting frameworks with clear industry-specific guidance
  - Harmonize national regulations with GHG Protocol and TCFD recommendations
  - Offer regulatory incentives (tax breaks, preferential procurement, access to green finance) to encourage early uptake, in particular among SMEs (Ritz, 2022; Apergis et al., 2022)
- **For Companies:**
  - Make Scope 3 reporting a part of core business (procurement, product development, risk management, investment decisions)

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  - Make cross-functional teams with across sustainability, finance, supply chain, and IT departments.
  - Invest in supplier engagement programmes that offer training and support of primary emission data collection.
  - Focus on AI-based systems to collect and validate data and identify gaps (Garcia Alaminos et al., 2022; Mejia and Kajikawa, 2024).
- **For Investors:**
  - Recognize responsibility for emissions through capital allocation and portfolio management
  - Establish clear expectations for portfolio companies' Scope 3 disclosure and management
  - The active participation of stewardship to encourage industry-wide reporting standards.
  - Integrate Scope 3 performance into ESG due diligence and investment decision-making (Mejia and Kajikawa, 2024)
- **For All Stakeholders:**
  - Invest in education and capacity building through industry associations, NGOs, and academic institutions
  - Develop training programs, best practice guides, and peer learning opportunities
  - Sharing cross-sector knowledge to help speed up the introduction of new mechanisms.
  - Cultivate a transparency, accountability, and continuous improvement culture beyond mere compliance (Hettler and Graf-Vlachy, 2024)

To build the future of effective Scope 3 reporting and decarbonization of the supply chain, all stakeholders must work together. Companies that invest in leadership in end-to-end Scope 3 management, using AI integration, standardized structures, and value chain participation, will not just achieve competitive benefits, but also play significant roles in global climate action and sustainable supply chain change. With changing regulatory frameworks and increasing pressure to act on climate-related matters by stakeholders, the primary challenge and the most meaningful opportunity in the context of corporate climate action are the scope 3 reporting, and its full potential can be realized only with a methodical incorporation of innovative technologies, standardized practice, and systematic access of stakeholders (Mejia and Kajikawa, 2024).

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