sustainability

MDPI

Systematic Review

Are Sustainable Supply Chains Managing Scope 3 Emissions? A Systematic Literature Review

Miriam Borchardt [1,*], Giancarlo Pereira [2], Gabriel Milan [1], Elisabeth Pereira [3], Leandro Lima [1], Renata Bianchi [1] and Annibal Scavarda do Carmo [4]

[1] Department of Production Engineering, Polytechnic School, Vale do Rio dos Sinos University (UNISINOS), São Leopoldo 93022-750, Brazil; gsmilan@unisinos.br (G.M.); limaleandro@edu.unisinos.br (L.L.); bianchirenata@edu.unisinos.br (R.B.)
[2] Department of Production Engineering, Paulista University (UNIP), São Paulo 04026-002, Brazil; giancarlo.pereira@docente.unip.br
[3] Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, 3810-193 Aveiro, Portugal; melisa@ua.pt
[4] Department of Production Engineering, Fluminense Federal University, Niterói 24210-201, Brazil; annibal.scavarda@unirio.br
* Correspondence: miriamb@unisinos.br or mborchardt100@gmail.com; Tel.: +55-51984667669

Abstract

The sustainable supply chain management (SSCM) literature does not directly address Scope 3 emissions despite their role as primary drivers of greenhouse gas emissions. This study aims to provide an overview of the main themes through which the SSCM literature has considered Scope 3 emissions and identify further avenues for research. A systematic literature review (SLR) was conducted. Scopus and Web of Science were the databases considered. Sixty-one papers were included in the analysis. Most papers focus on assessing and estimating Scope 3 emissions, followed by papers that discuss the reporting of Scope 3 emissions. These papers shed light on how firms may not report Scope 3 emissions if the information is negative to improve investors' perception of the firm. The last group of papers discusses practices and strategies to manage Scope 3 emissions. The main challenge identified in establishing strategies to manage Scope 3 emissions is engagement with stakeholders, as, generally, only one or two tiers of the value chain cooperate. This study is the first to organize the literature on Scope 3 emissions under the lens of SSCM. If supply chains are to become more sustainable, focal enterprise coordination must be effective and leverage practices such as Scope 3 emissions metrics and measurement, data sharing, and green product development for all stakeholders.

Keywords: Scope 3 emissions; sustainable supply chain; sustainable supply chain management; ESG; ESG report; GHG protocol; climate change; carbon emissions

check for updates

Academic Editor: Giada La Scalia

Received: 19 May 2025
Revised: 29 June 2025
Accepted: 30 June 2025
Published: 2 July 2025

Citation: Borchardt, M.; Pereira, G.; Milan, G.; Pereira, E.; Lima, L.; Bianchi, R.; Scavarda do Carmo, A. Are Sustainable Supply Chains Managing Scope 3 Emissions? A Systematic Literature Review. *Sustainability* **2025**, *17*, 6066. https://doi.org/10.3390/su17136066

Copyright: © 2025 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

It is imperative to deal with climate change and its impacts. Both international organizations like the United Nations and academic studies have highlighted the importance of corporate commitment and actions to reduce carbon emissions [1]. Protocols that offer guidance and standards for measuring greenhouse gas (GHG) emissions have emerged over the years to deal with climate-warming emissions. The GHG Protocol has been widely used in the corporate world for this purpose [2]. Most protocols define the following three different types of GHG emissions: Scope 1 refers to direct emissions from sources owned

or controlled by the organization itself; Scope 2 includes indirect emissions from energy sources consumed by the organization; and Scope 3 emissions are indirect emissions from sources that are not owned or controlled by the organization, such as suppliers [1,3].

Scope 3 emissions have been considered a responsibility of all supply-chain actors, and focal enterprises should be the leading actors in coordinating integrated actions and the flow of data and information [4]. Measuring, reporting, and taking actions to reduce the impacts of Scope 3 emissions require engagement among supply-chain partners [5] to exchange data, develop green products, and adopt green practices [4]. For many corporations, Scope 3 carbon emissions account for more than 75% of their total carbon emissions profile, primarily driven by emissions generated by the firm's suppliers and the transportation of associated goods [6]. A review of corporate environmental, social, and governance (ESG) reports reveals that Scope 3 emissions represent 99.26% of the total emissions at Nike [7], 97% at JBS—a slaughterhouse and meat producer [8]—and 75% at Google [9]. Despite the large proportion of Scope 3 emissions in the food and beverage industry (approximately 88%), reporting in ESG reports has often been incomplete and inconsistent [6]. Land-use change emissions, for example, are key to the food system but are only explicitly covered by approximately 10% of companies. In addition, more than one third of companies do not include Scope 3 emissions in their emissions reduction target [10].

The majority of the current Scope 3 emissions literature focuses on analyzing corporations' emissions reports [11,12] and proposing methods for measuring emissions [13,14]. There is no unified regulatory canvas imposing a detailed framework for measuring and reporting Scope 3 emissions beyond the regular financial and accounting requirements [15]. As a result, reporting is highly fragmented, which risks missing the bigger picture of supply-chain decarbonization [6]. Reporting corporate Scope 3 emissions is a critical step toward decarbonization, but it is not yet a common practice for most firms, as it remains voluntary under all global regulatory frameworks [4]. While some firms may be transparent about their carbon footprint, others may hesitate to measure and disclose GHG emissions because investors may penalize them for high emissions levels [16]. Thus, in some cases, where the firms' focus is only on showing a beautiful picture to investors, they are strongly incentivized to publish favorable numbers that do not make them look like heavy polluters [15].

Scope 3 emissions are significantly more complex and challenging to quantify than Scopes 1 and 2. Barriers to the determination of Scope 3 emissions are related to the complexity of supply-chain networks; the need to involve a variety of stakeholders, including politicians, corporations, and consumers; a lack of transparency, trust, and accurate measurements among supply-chain stakeholders; and the high costs associated with Scope 3 emissions management [17–19]. Consequently, decarbonizing an entire supply chain is a remarkably complex challenge [6]. Transparency and accurate measurement of carbon emissions throughout the supply chain (i.e., Scope 3 emissions) are needed before actions to reduce carbon emissions can be implemented [20]. Due to the interconnectedness of firms within a supply chain [21], a holistic perspective that considers Scope 2 and Scope 3 emissions is paramount to reducing the carbon footprint of both individual firms and the supply chain as a whole [19].

Sustainable supply chain management (SSCM) explicitly integrates the social and environmental dimensions with economic considerations of the triple bottom line (TBL), focusing on forward and reverse supply chains [22,23]. Additionally, SSCM refers to managing information, equity, and raw materials in collaboration with supply-chain partners to implement the economic, social, and environmental dimensions of sustainable development initiatives [18]. Sustainable development initiatives encompass Scope 3 emissions management. Due to the relevancy and power of focal enterprises in a supply chain, they

are expected to coordinate and integrate actions focused on Scope 3 emissions management among the stakeholders [4]. In part, sustainable supply chains are complex because they require systemic coordination of key inter-organizational business processes to improve the long-term economic performance of an individual company and its value network [24]. Businesses need to seek effective ways to address multiple sustainable challenges at both upstream and downstream levels. Such challenges are related to systems integration, information sharing, data availability, traceability, data security, and the priorities of each stakeholder. The needs of each individual business must be met while simultaneously making improvements that increase the overall sustainability of the supply chain [21]. However, the structure of a value chain is not always stable, and its boundaries can change frequently, making it difficult to understand clearly. This dynamic nature of the chain increases the difficulty of determining Scope 3 emissions, especially for global companies with extensive and geographically dispersed chains [25].

Additionally, the SSCM literature has discussed supply-chain decarbonization factors. For example, the power balance among supply-chain actors influences the adoption of carbon emissions reduction practices [26]. Using carbon labels affects consumers' decisions and leverages companies to adopt decarbonization practices to obtain such labels [27]. Regulations establishing parameters for producers and avoiding greenwashing are also mentioned as factors that promote decarbonization in supply chains [28]. Financial analysts' force mitigates opportunistic behavior by reducing information asymmetry and greenwashing practices [29]. Although the SSCM literature has discussed supply-chain decarbonization, the management of Scope 3 emissions and actions to reduce such emissions in the entire value chain are not directly addressed [30]. Such an aspect is relevant despite the necessity of their inclusion in Scope 3 emissions when considering how the value chain should be assessed and reconfigured to reduce GHG emissions [17–19].

Considering such an academic gap, we utilize a systematic literature review (SLR) to provide an overview of the extent to which the scattered SSCM literature has addressed Scope 3 emissions, the main themes and subjects uncovered, and further avenues for research and managerial practices. This study considers Scope 3 emissions from the perspective of SSCM.

We address the following two research questions:

RQ1—What are the themes and respective subjects related to Scope 3 emissions according to the systematic literature review on sustainable supply chain management?

RQ2—What further research avenues are identified for each theme according to the systematic literature review of the sustainable supply chain management literature?

Understanding the main themes and respective subjects contributes to the SSCM literature by indicating which topics are more prominent and which ones need a deeper future analysis. Also, managerial contributions are expected to reveal some directions and practices to improve the management of Scope 3 emissions on the entire value chain.

2. Methodology

This study utilized a comprehensive literature review to explore the interconnection between Scope 3 emissions and SSCM. An SLR provides a well-defined process for identifying, evaluating, and interpreting all available academic documents [31]. Additionally, an SLR articulates the state of the art of a field or addresses precise research questions [28], which is an appropriate approach for achieving the research purpose of this study.

The following five steps drove our research: (1) formulating explicit research questions (presented in the Section 1); (2) developing inclusion and exclusion criteria, (presented in Table 1); (3) locating and identifying studies that meet those criteria; (4) data extraction and coding; and (5) data synthesis/analysis and reporting of the results [31,32]. Such

steps are in line with the ones proposed by the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) [33]. PRISMA 2020 is a reporting guideline designed to address the reporting of a systematic literature review [33]. It has been widely endorsed and adopted in multiple journals, including the *Sustainability* journal (MDPI). Figure 1 presents the extraction results. The PRISMA 2020 [34] checklist is provided as Supplementary Materials.

Table 1. Inclusion and exclusion criteria.

Item	Inclusion Criteria	Observation/Exclusion Criteria
Limited date to search	Until 6 March 2024 (i.e., the final date of the database search).	Excluded papers published after 6 March 2024.
Database definition	Scopus and Web of Science.	Web of Science and Scopus are the most recognized and important international scientific databases [35]. Papers from other databases were not considered.
Search strings definition	"SUSTAINABLE SUPPLY CHAIN" AND "SCOPE 3", "SUPPLY CHAIN" AND "SCOPE 3", and "SCOPE 3" AND "DISCLOSURE"	Based on research questions focusing on how the sustainable supply-chain literature has discussed Scope 3 emissions. Publications that addressed only Scope 1 and Scope 2 emissions without mentioning Scope 3 were excluded.
Search filter	Within Title, Abstract, Keywords.	
Language	Only records in English.	Other languages were not considered.
Type of records	Only articles and reviews.	Other types of records were not considered.
Type of publication	Only peer-reviewed journals.	Other types of publications were not considered.
Categories within the database	In Scopus: fields included are environmental science; engineering; business, management, and accounting; energy; social science; economics, econometrics, and finance; decision science; earth and planetary sciences; and computer science. In Web of Science: fields included environmental science; green sustainable science technology; management; business finance; environmental studies; business; engineering environmental; computer science and information systems; engineering manufacturing; operations research management; engineering biomedical; engineering electrical and electronic; engineering industrial; food science technology; information science; and materials science and biomaterials.	Other categories were not considered.

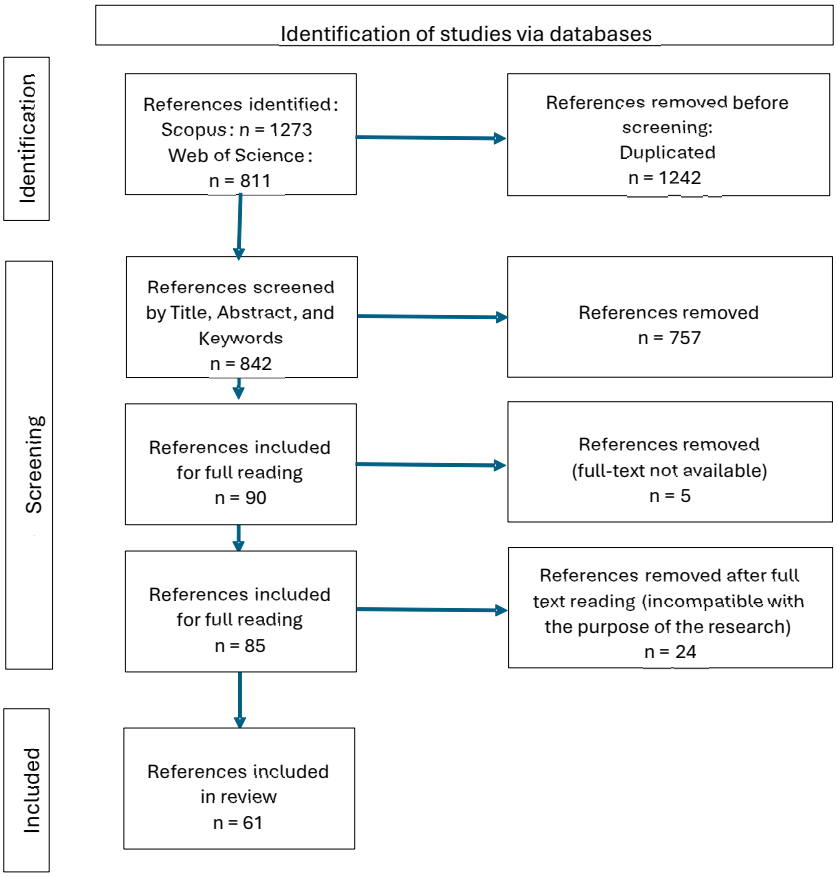


Figure 1. Identification of studies via databases.

Two researchers performed the identification and screening processes. Mendeley software (version 2.109.0.148) was used to make the selected articles available to all researchers. The last step in the paper selection consisted of carefully reading each paper, coding it, and extracting the data. One researcher performed the coding manually and inductively after reading the papers. Then, the other two checked them later. An Excel (version 2505) spreadsheet was used to organize the codes, initially indicated by different colors.

Finally, after reading the papers and based on the established codes, we observed three prevalent themes into which the papers could be classified. The first theme, "Assessing Scope 3 Emissions", encompassed 38 papers that either propose or evaluate and compare methods for assessing Scope 3 emissions. The codes related to this theme encompass measuring, evaluating, accounting, assessing, monitoring, and controlling Scope 3 emissions. The second theme, "Disclosing Scope 3 Emissions", included 15 studies that analyze whether and/or how Scope 3 emissions have been presented in sustainability companies' reports. This theme groups papers that present disclosure, reporting, and communicating codes. The last theme, "SSCM Practices Related to Scope 3 Emissions", included 12 papers that explicitly identify strategies and practices in supply chain management related to Scope 3 emissions. The codes in this theme are related to relationship and engagement, circular economy and certification, transparency and information flow, and emissions management. Four papers were classified into two themes.

3. Results

3.1. General Context

The analysis of the selected papers (as seen in Table 2) indicates a prevalence of the theme "Assessing Scope 3 Emissions". Prior to 2019, papers on the two other themes were

relatively scarce. Articles on the reporting of Scope 3 emissions became more abundant after 2020, reflecting a growing organizational commitment to making ESG strategies and practices known to investors and the market. The third theme, "SSCM Practices Related to Scope 3 Emissions", became more evident after 2023. The relative scarcity and newness of the literature reinforce the novelty of the subject and highlight how challenging the path to building an integrated view of Scope 3 emissions is.

Only three papers of the identified papers were from journals related to supply chains or logistics, as follows: Supply Chain Management, International Journal of Logistics Management, and Journal of Business Logistics. Most of the papers included in this SLR were published in the Journal of Cleaner Production (12 papers), followed by Business Strategy and the Environment (four papers), Sustainability (two papers), and Resources, Conservation and Recycling (two papers).

Table 2. Theme of the papers and journal.

Reference	Prevalent Theme in the Paper			Journal
	Accounting or Assessing Scope 3 Emissions	Disclosing or Reporting Scope 3 Emissions	SSCM: Strategies and Practices Related to Scope 3 Emissions	
[36]	✓			Environmental Engineering Research
[1]	✓			Journal of Manufacturing Technology Management
[37]			✓	Supply Chain Management
[6]		✓		Business Strategy and the Environment
[38]	✓			Journal of Cleaner Production
[3]	✓			Sustainability Science
[39]	✓			Environment, Development and Sustainability
[40]	✓			Environmental Pollution
[41]			✓	International Journal of Operations and Production Management
[10]		✓		Journal of Cleaner Production
[42]	✓			Sustainability
[43]			✓	Journal of Financial Stability
[44]		✓		International Journal of Energy Economics and Policy
[45]			✓	Society and Business Review
[14]	✓			Ecological Economics
[46]		✓		Journal of Cleaner Production
[47]	✓			Environmental Science and Pollution Research
[48]	✓			Journal of Cleaner Production
[13]	✓			Circular Economy
[49]	✓			Oxford Open Climate Change
[50]			✓	Financial Analysts Journal
[51]	✓			Environmental Science and Policy
[12]	✓			International Journal of Sustainability in Higher Education
[52]			✓	Journal of Sustainable Finance and Investment

Table 2. *Cont.*

Reference	Prevalent Theme in the Paper			Journal
	Accounting or Assessing Scope 3 Emissions	Disclosing or Reporting Scope 3 Emissions	SSCM: Strategies and Practices Related to Scope 3 Emissions	
[53]		✓		Cogent Business and Management
[18]			✓	International Journal of Logistics Management
[54]	✓	✓		Journal of Industrial Ecology
[55]	✓	✓		Environmental Impact Assessment Review
[56]	✓			Journal of Cleaner Production
[57]	✓			Chemical Engineering & Technology
[58]	✓			Frontiers in Sustainable Food Systems
[30]	✓			Corporate Social Responsibility and Environmental Management
[59]	✓			Environmental Research Letters
[60]	✓			Environmental Science and Technology
[61]			✓	Journal of Business Logistics
[62]	✓			Journal of Sustainable Tourism
[63]		✓		Cleaner Production Letters
[16]		✓		Production and Operations Management
[19]	✓			International Journal of Production Economics
[64]		✓		Sustainability
[65]		✓		Journal of Cleaner Production
[66]			✓	Resources, Conservation and Recycling
[67]	✓	✓		Journal of Industrial Ecology
[68]	✓	✓		Journal of Cleaner Production
[20]			✓	Business Strategy and the Environment
[4]			✓	Business Strategy and the Environment
[69]	✓			Resources, Conservation & Recycling
[70]	✓			Building and Environment
[71]	✓			Renewable and Sustainable Energy Reviews
[72]	✓			Environmental Research Letters
[17]			✓	Journal of Cleaner Production
[73]	✓			Journal of Cleaner Production
[74]		✓		Journal of Cleaner Production
[75]	✓			Building and Environment
[76]	✓			Carbon Management
[77]	✓			Sustainable Production and Consumption
[78]	✓			Building and Environment
[79]	✓			Journal of Cleaner Production
[80]		✓		Business Strategy and the Environment
[81]	✓			Journal of Cleaner Production
[82]	✓			Environmental Science and Technology

3.2. Assessing Scope 3 Emissions

According to our review, measuring, accounting, assessing, monitoring, and controlling Scope 3 emissions are the most studied topics within the literature, likely due to the myriad methods available for quantifying Scope 3 emissions and the challenges inherent in gathering accurate data. The GHG Protocol is widely accepted as the foundation for determining organizational carbon footprint, while other methods, such as life cycle assessment (LCA), describe the carbon footprint of individual products. Because supplier-specific data are generally limited across global supply chains [48], the GHG Protocol guidance allows for modeling using industry-average data or generic LCAs to complete a full Scope 3 emissions footprint [49]. Input–output analysis and multi-regional input–output analysis are also frequently used in the literature [54].

Studies evaluating the carbon footprint of nations, regions, or sectors are the most abundant in the studied literature. The pioneering paper on this theme was written in 2009 and studied Scope 3 emissions in the U.S. economic sector [82]. The results showed that enterprises can successfully quantify a large portion of their total upstream carbon footprint by collecting full emissions information from only a handful of direct suppliers. The second oldest study estimated the Scope 3 emissions from the Australian ambulance service [81]. Other areas of study include, for example, the Turkish industrial sector [77], Korean automobile industry [36], textile sectors in Brazil [39] and Bangladesh [40], European equity funds [14], and stadium construction and operation in Qatar [13]. Most studies confirmed that Scope 3 emissions account for around 75% to 90% of the total carbon footprint declared by the firms in their sustainability reports [49].

Several studies mapped the primary sources of Scope 3 emissions. For European telecommunication companies, these sources include purchasing goods, using solid products, commuting employees, and capital goods [71]. In a Chinese municipality, food, water, steel, cement, and fuel are critical sources of Scope 3 emissions [73].

The studied literature seems to agree that measuring Scope 3 emissions is influenced by the flow of information among supply-chain partners. This implies that accurate, timely, trusted, and valuable information should be available to the firm that is measuring its emissions, which demands supply chain integration [1,36].

3.3. Disclosing Scope 3 Emissions

A pioneering publication analyzing the Carbon Disclosure Project (CDP) firms' responses from 2003 to 2010 revealed that the quality of Scope 3 emissions reporting did not improve over that period [80]. While Japanese and European Union firms increased transparency during the period, American firms decreased transparency. Another study, nine years later, also emphasized a lack of transparency, incompleteness, and inconsistency in reporting Scope 3 emissions [54]. Inconsistency and lack of transparency were also evidenced in a study of global food and beverage manufacturers [10,63]. Data quality—including availability, comparability, and consistency—remains problematic to this day [6,54].

As long as the reporting of Scope 3 emissions is voluntary, firms will only participate if they anticipate a tangible financial benefit. Using information gathered from the annual reports of 81 early adopters committed to the Paris Agreement Initiative, [64] revealed that 48% of companies were behind target concerning Scope 3 emissions. In addition, Scope 3 reporting is often used for greenwashing—purposely spinning information disclosure to lead to a better image or perception of a firm than the actual behavior of the firm would justify [54]. In other words, firms may purposely disclose positive climate-related information while withholding negative information to avoid sending negative signals about their environmental behaviors to stakeholders [16].

Several factors can lead to high-quality Scope 3 reporting. A systematic literature review on corporate Scope 3 emissions reporting found that regulation and measurement standards are the main factors influencing the reporting of Scope 3 emissions [6]. Investor pressure, customer requirements, governance, and leadership commitment also play a role [54]. While perceived financial gains may also induce firms to report Scope 3 emissions [44], there is no evidence that the disclosure of Scope 3 emissions impacts earnings management for U.K. firms [53].

Low levels of executive and manager experience with required corporate processes for Scope 3 reporting make current policy making ineffective [6]. The high transaction costs of engaging stakeholders to measure and manage emissions are another barrier inhibiting detailed and accurate disclosure of Scope 3 emissions [17,54]. The country where a firm is headquartered also significantly influences the level of detail in Scope 3 reports [63]. Some countries have stricter regulations concerning GHG emissions than others; however, firms might engage in different reporting behaviors in various countries rather than follow the most rigorous reporting standards across all countries. Country-level carbon accounting should be connected to firms' emissions assessments [63].

Supplier engagement can also hinder the reporting of Scope 3 emissions due to how firms manage information (e.g., sometimes without transparency or trustworthiness), different perceptions of the rules and purposes for managing emissions, and fear of interference from the focal enterprise [4]. As a result, some corporations' sustainability reports only covered part of the value chain, considering the first and second tiers of suppliers within the supply chain [10]. Carbon footprint data are typically available only for large companies and may be nonexistent for small- and medium-sized enterprises, further inhibiting an accurate assessment of Scope 3 emissions [45,54].

To overcome the challenges and barriers related to the disclosure of Scope 3 emissions, the literature recommends developing frameworks for integrating financial accounts within the regional, national, and global economies [65]. Harmonizing emissions accounting methodologies through appropriate metrics and standards is also critical [63]. Smaller businesses beginning their sustainability journey may need additional technology and educational resources for accounting and carbon emissions reporting [63]. Despite comprising the most significant percentage of Scope 3 emissions, service sectors (e.g., public administration, defense, education, and health) have largely been ignored in GHG inventories [67]. Several studies have also raised concerns as to whether it is even feasible for companies to account for their indirect emissions from the whole value chain [10]. In agricultural production, for example, where a focal firm has many suppliers, for some small-sized companies and those located in different geographic regions, it may be challenging to collect accurate Scope 3 emissions data.

3.4. SSCM Strategies Related to Scope 3 Emissions

SSCM requires collaboration among supply-chain partners to implement the economic, social, and environmental dimensions of sustainable development initiatives [18]. A bibliometric analysis suggests redesigning focal firms' business models considering circular economy, reverse logistics, digitalization of logistics, and supply chain practices to leverage sustainable supply chains [18]. Although they did not directly consider Scope 3 emissions in their analysis, the authors reinforced the substantial pressure faced by companies to adopt such practices and coordinate actions through the entire supply chain.

Engagement among focal enterprises and stakeholder groups is essential to obtain, process, and transfer relevant climate-change-related information and account for Scope 3 emissions [83]. Climate change information that partners should share includes emissions and environmental performance data from supplier plants, transportation and distribution

data, and investment plans for climate change initiatives. However, in 1191 of 2877 cases surveyed from 2014 to 2017, firms explicitly declared that they did not engage with any of their supply-chain partners on climate change actions. Among the firms that declared engagement with supply-chain partners, 28% of firms engaged with customers only, while 24% engaged with both suppliers and customers, and 21% with suppliers only. Few firms engage with both customers and suppliers, as well as other stakeholders, such as universities and industry associations.

Three types of climate change engagement with supply-chain partners [83] are presented in the literature. The first is basic engagement in which information gathering primarily consists of firms' preliminary efforts to address information uncertainty by obtaining an initial or revised assessment of their Scope 3 emissions. It is principally driven by a concern for establishing baseline data on Scope 3 emissions rather than considering its effect on process and product improvements within the focal firm. The second type of engagement, transactional engagement, entails a more proactive attitude toward processing and utilizing GHG emissions data—calculating carbon footprints and identifying performance improvement opportunities. Transactional engagement exemplifies firms' efforts to go beyond initial information uncertainties stemming from a lack of Scope 3 emissions data and integrate climate change concerns into supplier engagement. The last type, collaborative engagement, results when firms include both upstream and downstream partners in their engagement practices and strategies. It includes informal and ad hoc communication through personal letters, phone calls, meetings, discussion groups, web-based communication platforms, and sustainability events.

Numerous factors inhibit gathering information, establishing sustainability commitments, and managing Scope 3 emissions throughout the value chain, such as transaction costs, power, responsibility allocation, uncertainty and competition, location contingency, and economic performance [17]. Scope 3 emissions management extends the responsibilities of the focal firm upstream and downstream in the value chain, amplifying governance costs due to the multiple transaction partners at each stage. The GHG Protocol has paid attention to Scope 3 emissions. The ambition is to use the power of MNCs in their supply chains to drive emissions measurements and management throughout the value chain. Power must be discussed because the presumption that MNCs can leverage GHG governance through the value chain is the understated premise of the GHG proposal. In that sense, power is more than an influence on transaction costs; possession or lack of power will certainly influence a firm's strategies to extract information from a transaction partner. Responsibility allocation refers to the legitimacy and coherence with which accountability is distributed and accepted through the value chain, influencing both transaction costs and the acceptance of power. Responsibility allocation is a premise of the GHG proposal and, to a certain extent, a premise within the SSCM's structure. Risks such as climate-change effects, regulation changes, supply-chain partners with perceived financial or technological or ethical risks, and scarcity of resources can increase uncertainty. Also, competition could be affected by the development of new technologies and new product designs, which require adjusting the supply chain. Location contingency acknowledges that significant proportions of emissions are not within the direct control of firms within the value chain but instead depend on the shared energy provision, transport infrastructure, and waste recycling systems of the location in which they operate. Economic performance is associated with the cost of sustainable initiatives, and the ambiguity of their relation to economic performance requirements remains a powerful barrier to interfirm cooperation [17].

The literature also reinforces the tensions among firms within the same supply chain in managing Scope 3 emissions [41]. Transparency, a critical first step toward proactively improving carbon performance, often lies at the center of such tensions. Because supply-

chain partners have strong incentives to share only positive performance data with their partners, firms tend to adopt selective disclosure approaches. The lack of transparency that arises from publicizing only the information that is convenient for the firm to do so disrupts coordination and collaboration processes. In contrast, long-term supply chain transparency efforts and increased SSCM practices are associated with relative reductions in Scope 3 emissions [41]. However, only firms focused on transparency for six or more years are likely to have improved their performance concerning Scope 3 emissions year-on-year [41].

Despite the need to coordinate Scope 3 emissions actions across the entire supply chain, awareness and integration are much higher in upstream rather than downstream activities [20]. Assessing the Scope 3 emissions of the downstream partners, especially accounting for GHG during product use and end-of-life stages, requires sophisticated life-cycle analysis specific to each product, which may bias data and information about Scope 3 emissions and affect the report quality.

One study on Scope 3 emissions in freight transportation suggested that a green network or partnership focused on reducing freight emissions, fuel consumption, and the associated costs could support the industry's strategies and actions to reduce emissions [61]. Despite such relevance, the authors reiterated that a lack of reporting and goals related to transportation emissions proves that most firms do not view disclosure and reduction in freight emissions as essential to their legitimacy within their network of stakeholders.

We uncovered several mitigation strategies related to supply chain management and the role of the focal enterprise. Encouraging suppliers to adopt ISO 14001 (Environmental management systems—Requirements with guidance for use) certification, developing new technologies, using renewable energy, transforming business models, and changing managerial practices were proposed [36]. Additionally, the country where a firm is headquartered and the type of company are relevant to mitigation strategies [1]. Competition, regulatory factors, public policies, and limited experience with Scope 3 targets impact the role of the focal enterprise in setting sustainable purchasing goals [6].

Climate-related risks have become a major concern for financial regulators and can significantly threaten financial stability [43]. Climate risks can be grouped into the following three categories: transition (related to changes in policy and regulations, business practices, and consumer preferences), physical (due to the impact of extreme climate conditions, such as floods and hurricanes), and liability (related to non-ethical actions of stakeholders or not fulfilling the contracts) [51]. Despite material climate transition risks for stock prices, limited disclosure concerning Scope 3 emissions and low carbon prices mean these risks are not likely to be fully priced into stock values [52]. European financial institutions that publish Scope 3 emissions data showed that transition risk significantly negatively impacts financial stability at the institutional and financial system levels [43]. Given the low proportion of companies and banks that disclose Scope 3 emissions, the transition risks are most likely underestimated [43].

3.5. Synthesis of the Findings

Next, Table 3 presents a synthesis, as well as the challenges, of the literature review regarding each identified theme. The main difficulties are SSCM strategies and establishing practices throughout the value chain to assess, monitor, and reduce Scope 3 emissions. Such a scenario is a consequence of the research evolution on the subject: first, the literature began to study how to assess Scope 3 emissions; second, the focus was on reporting these emissions to investors and the market; and then, the focus was on how to improve strategies and practices throughout the entire value chain. This last issue is the newest one and requires a deep understanding.

Table 3. Literature synthesis and main challenges.

Synthesis	Challenges
"Assessing Scope 3 Emissions"	
38 papers in this theme; Scope 3 emissions represent 75% to 90% of a firm's total carbon footprint [49]; Several quantification methods are mentioned, as follows: - The GHG Protocol is widely accepted for determining organizational footprints, and an LCA addresses individual products [49]; - Modeling emissions with industry-average data or a generic LCA when supplier-specific data are limited [48,49] - Input–out and multi-regional input–output analyses are presented [54]. Applications: - Evaluating Scope 3 emissions at national, regional, and sectoral levels [13,14,36,39,40,77,81,82]; - Mapping primary sources of emissions for various industries [71,73].	Transparency and timely flow of information among supply-chain partners [1,3,36]; Data accuracy and availability [48]; Lack of evaluation standards [48].
"Disclosing Scope 3 Emissions"	
15 papers in this theme; Scope 3 emissions reporting did not improve significantly over a decade (2003–2010) [6,10,54,63,80]; Possibly due to the voluntary nature of reporting, firms engage only if they anticipate financial benefits, selectively disclose positive information, and/or lead to greenwashing [16,54]; Recommendations: integrating financial accounts [65] and harmonizing methodologies and reporting standards; Feasibility concerns for a complex value chain [10].	Poor data quality and inconsistency in reporting [6,10,41,54,63]; Avoiding greenwashing [16,54]; Lack of executive experience [6]; High transaction costs to engage stakeholders [17,54]; Difficulty in engaging suppliers [4,10]; Country-specific discrepancies and regulations [1,63]; Data scarcity for small- and medium-sized enterprises [44,54].

Table 3. *Cont.*

Synthesis	Challenges
"SSCM Strategies Related to Scope 3 Emissions"	
12 papers in this theme; Effective SSCM hinges on robust collaboration and stakeholder engagement [18,83], and long-term transparency efforts [41]; Relevant role of focal firms in leveraging actions and strategies to asses and monitor Scope 3 emissions [83]; Focal firms should redesign their business models to incorporate concepts like circular economy, reverse logistics, and digitalization to foster sustainable supply chains [18]; Specific Mitigation Strategies: - Encouraging suppliers to adopt ISO 14001 certification, developing new technologies, using renewable energy, transforming business models, and changing managerial practices [36]; - The country of headquarters and company type are also relevant to mitigation strategies [1]. Competition, regulatory factors, public policies, and limited experience with Scope 3 targets impact the role of the focal enterprise in setting sustainable purchasing goals [6]; - Climate-Related Financial Risks: Increasing concern among financial regulators regarding climate risks [43] (transition, physical, and liability [52]) and their potential impact on financial stability [43]. These risks are likely underestimated due to limited Scope 3 emissions disclosure by companies and banks [43]; - Location Contingency: acknowledging that significant proportions of emissions are not within the direct control of firms but depend on shared local infrastructure (energy, transport, and waste recycling) [17].	Upstream versus Downstream Focus: assessment and integration of Scope 3 emissions are much higher in upstream than downstream [20]; Transparency: tensions among firms within the same supply chain in managing Scope 3 emissions [41]; Engagement gaps: many firms do not engage with supply-chain partners on climate change actions; engagement is often limited to only one or two tiers [83]; Transaction Costs: Scope 3 emissions management extends focal firm responsibilities, amplifying governance costs due to multiple transaction partners. Power influences a firm's strategies to extract information from transaction partners [17]; Using new digital technologies and product designs, requiring supply chain adjustments [17]; Lack of goals and reporting in specific areas (e.g., transportation emissions): most firms do not view their disclosure and reduction as essential for legitimacy [61]; External Factors and Limited Experience: competition, regulatory factors, public policies, and limited experience with Scope 3 targets impact the focal enterprise's role in setting sustainable purchasing goals [6]; Underestimation of Climate Risks: limited disclosure concerning Scope 3 emissions and low carbon prices mean that material climate transition risks are not likely to be fully priced into stock values [52], and these risks are most likely underestimated [43].

4. Discussion, Implications, and Avenues for Future Research

This section discusses the main findings from the academic and managerial perspectives and suggests avenues for future research.

4.1. Academic Contributions

The first research question is RQ1—"What are the themes and respective subjects concerning Scope 3 emissions according to the systematic literature review of the sustainable supply chain management literature?". This study identifies three main themes within the present literature and their respective subjects. Most papers on "Assessing Scope 3 Emissions" concerned methodologies and techniques for measuring or modeling Scope 3 emissions [71]. We contribute to the literature by indicating that despite multiple proposed approaches for assessing Scope 3 emissions (e.g., input–output analysis, LCA, modeling using industry-average data) [49,54], there is no consensus on which one is the most feasible or applicable for different supply chains. Once Scope 3 emissions are assessed or estimated, organizations report their results to investors and the market. However, the literature related to the theme "Disclosing Scope 3 Emissions" reveals a lack of data quality, transparency, completeness, and consistency [6,54,63]. The main finding indicates that Scope

3 emissions reporting has frequently presented only positive climate-related information. It was observed in the literature that the transaction costs to assess and disclose Scope 3 emissions are not always converted into financial gains, even when presenting positive emissions results [10]. This study contributes to the literature by indicating that such a barrier could limit the efforts to map the entire value chain, especially if the organizational culture is not aligned with sustainability issues or there is no investor pressure. The difficulties related to costs and gathering reliable Scope 3 emissions data and information aligned with regulatory conditions and organizational sustainability commitment, possibly justify why Scope 3 emissions reports tend to only cover part of the value chain.

The literature within the theme "SSCM Strategies Related to Scope 3 Emissions" indicates a need to engage stakeholders in obtaining, processing, and transferring climate-change-related information [83], managing the information flow, and engaging with all supply-chain partners. However, in practice, only one or two supply chain tiers typically engage and cooperate [20]. This collaboration process requires transparency and coordination, as it can promote tensions among partners. The focal firms have a crucial role in leveraging strategies and practices in the value chain. In some cases, the business model needs to be rethought, considering circular economy issues and green and disruptive innovations. Encouraging suppliers to adopt ISO 14000 (Environmental management systems—Requirements with guidance for use) is also indicated to support them in incorporating environmental issues into their management system [1]. Digital transformation, public policies, regulatory factors, and competition could be used to encourage firms to evaluate and reduce Scope 3 emissions. Many companies have focused on investors as a priority for their Scope 3 actions, and, in this case, low carbon prices could limit investments in carbon footprint reduction [52].

4.2. Further Research Avenues

The second research question of this study is RQ2—"What are the further research avenues identified for each theme according to the systematic literature review of the sustainable supply chain management literature?". Table 4 presents the main challenges and inhibitors for Scope 3 emissions management and further research avenues for each theme.

The main challenges for the "Assessing Scope 3 Emissions" theme related to data capture (including quality and accuracy) are a lack of unified standards for measuring Scope 3 emissions, difficulty integrating data from diverse stakeholders, and voluntary participation in assessing and reporting Scope 3 emissions. Digital technologies for automated data sharing beyond organizational boundaries could facilitate the assessment of Scope 3 emissions throughout the value chain [84]. Using a combination of digital technologies can strengthen the exchange of environmental practices within organizations and their supply chain [85] and foster the development of digital supply-chain ecosystems, allowing automated data sharing for a plethora of use cases [84].

Challenges and inhibitors relating to "Disclosing Scope 3 Emissions" can be grouped into three blocks. The first one is associated with the inconsistency [86], lack of transparency, and incompleteness of available data. The second block includes primarily reporting positive results, using non-transparent data for greenwashing [28,29], and only reporting Scope 3 emissions when financial benefits are anticipated. The third block is linked to mobilizing all stakeholders and lack of experience with Scope 3 management.

For the theme "SSCM Strategies Related to Scope 3 Emissions", the challenges are the lack of standards and differing requirements among countries; tensions among firms and the role of the focal firm in leading Scope 3 emissions reductions; lack of effective practices and strategies to reduce Scope 3 emissions; difficulty in measuring the financial

gains from Scope 3 emissions reductions; and challenges faced by small- and medium-sized enterprises in managing emissions.

Table 4. Challenges and inhibitors for Scope 3 emissions management and further research opportunities.

Challenges/Inhibitors	Further Research Opportunities
"Assessing Scope 3 Emissions"	
Lack of accurate data across the supply chain.	Compare and propose methods and metrics to account for Scope 3 emissions, considering each region's specificities, such as consumption habits, energy matrix, logistic infrastructure, and availability of natural resources and their use.
Lack of standard methods and appropriate metrics.	
Scope 3 reporting is voluntary; in some industries, only approximately 50% of global companies measure and report Scope 3.	Analyze whether the data are more accurate in segments or countries where Scope 3 emissions accounting and reporting are mandatory and whether the adopted practices have reduced emissions.
Lack of data sharing and integration among the value chain stakeholders.	Propose and test integrated systems using digital technologies to support the accounting and reporting of Scope 3 emissions.
"Disclosing Scope 3 Emissions"	
Lack of transparency in reporting Scope 3 emissions.	Analyze auditors' role and methods, proposing improvements to identify inconsistencies, lack of transparency, or missing data.
Data inconsistency.	
Lack of data quality.	
Firms only report Scope 3 emissions if they envision a tangible financial benefit.	Analyze the possibility of standardizing reports, pressing the presence of complete data about Scope 3. Study the availability of classifying firms according to their reports' quality and reliability.
Reporting is often used for greenwashing.	
Firms purposely disclose positive climate-related information while withholding negative information.	
Reports cover only part of the value chain.	Studying the consequences and complexity of obliging reports covers all value chains.
Transaction costs to engage with stakeholders to measure and report emissions.	
Low experience level in reporting Scope 3 emissions.	
"SSCM Strategies Related to Scope 3 Emissions"	
Lack of regulation and standards.	Evaluate the availability of a standard considering specific characteristics from regions and countries.
Different requirements among countries.	
Investor pressure or customer requirements.	Understanding the impact of investor pressure or customer requirements contrasting firms' values and vision.
Difficulty determining the role of other players external to the supply chain.	Analyzing the role of each external player in the supply chain and how their policies and procedures have influenced the reduction in Scope 3 emissions.
Difficulty establishing governance and leadership commitment with all stakeholders; tensions among firms.	Study the role of the focal enterprise in coordinating the Scope 3 emissions measurement, disclosure, and reduction.
Difficulty in evaluating financial gains from measuring and reporting Scope 3.	Analyze the long-term perspective considering the risks to the firm from climate change.
Lack of effective practices to measure and reduce Scope 3 emissions.	Analyze the efficiency and efficacy of mitigation strategies, such as ISO 14001, circular economy, reverse logistics, and sustainable purchasing policy goals.
Small- and medium-sized enterprises face financial, technical, and knowledge barriers to accounting for emissions.	
Lack of studies discussing the social pillar of sustainability and how it is impacted by Scope 3 emissions or the actions to reduce such emissions.	Compare the disclosed social results self-declared by firms, related to Scope 3, with the implemented practices and their effects on all value chain stakeholders.

The social dimension of a sustainable supply chain is highly relevant to Scope 3 emissions. However, this issue has barely been explored in the studied literature on SSCM and Scope 3 emissions. Since reports present self-reported results rather than empirically observed activities [4], some firms may attempt to portray a more favorable image than reality. Therefore, an analysis comparing reported results and their practical effects is recommended. Additionally, identifying social practices involving the value chain and their impact on the performance of each stakeholder is recommended. It is crucial to consider the temporal lag between actions and their effects in social practices, as some outcomes may manifest years after implementation and could be influenced by external, uncontrolled factors.

4.3. Managerial Recommendations

In addition to the academic implications, we highlight some managerial practices that could improve Scope 3 emissions management. The focal enterprise must communicate effectively with investors, stakeholders, and customers, clarifying its purpose concerning Scope 3 emissions [87]. Knowing the better method for assessing Scope 3 emissions according to the value chain characteristics is essential to develop a systematic procedure for such assessment. Data-driven technologies that consider data security, privacy, and infrastructure, as well as training in data management, are also recommended to facilitate the data and information exchange between focal firms and partners [21]. This connectivity among firms could facilitate data acquisition and traceability while providing agility in assessing Scope 3 emissions, supporting decision making. We also recommend integrating environmental practices along the supply chain, such as reverse logistics, reusing or recycling material, replacing energy from fossil sources with non-fossil and reinforcing the role of the focal enterprise in qualifying its suppliers through training, support, procedures, and cooperation to implement improvements in the operations, as well as in the emissions management (especially small- and medium-sized ones) [88]. Establishing simplified procedures and methods adapted to each group of stakeholders could facilitate participant engagement, as well as leverage data sharing and actions to monitor and reduce Scope 3 emissions.

Additionally, we recommend that enterprises consider the risks of climate change challenges and social disruption for businesses. Multiple studies show that the economic dimension of the sustainable supply chain is the most critical and tends to be prioritized [21]. A long-term perspective of transaction costs to evaluate and disclose Scope 3 emissions and the respective return in financial terms or risks minimization and visibility to the market and investors should be considered. In some industries, such as the food and beverage sector, Scope 3 emissions could be affected by consumers' decisions if they opt to consume "green products" from other suppliers, for example. Firms ethically committed to sustainable development have a relevant role in informing consumers about their operations and products' environmental and social impacts. Thus, well-informed consumers and the proper product offerings will help consumers choose the least harmful options.

Shortening the supply chain and reducing the number of suppliers should be considered an option to mitigate logistic emissions and facilitate the integration of stakeholders. As supply chains have a dynamic structure impacted by geopolitical factors, reducing the number of suppliers could make the management of Scope 3 emissions less challenging.

Table 5 synthesizes the main managerial and practical recommendations.

Table 5. Managerial recommendations.

Theme	Managerial Recommendations	Observation
"Assessing Scope 3 Emissions"	Communicating effectively with investors, stakeholders, and customers, clarifying its purpose concerning Scope 3 emissions.	The purpose is to get the commitment of all stakeholders, investors, and customers to invest in Scope 3 emissions management.
	Establishing the proper method for Scope 3 emissions assessment.	Possibly, the focal firm should provide guidelines and training to providers.
	Using digital technologies to gather and exchange data and information among value chain stakeholders.	Establishing a code of ethics for data and information sharing could facilitate firms' adherence.
"Disclosing Scope 3 Emissions"	Using the reports as a tool to guide improvements on Scope 3 emissions, not only to show positive numbers to investors or the market.	
"SSCM Strategies Related to Scope 3 Emissions"	Integrating environmental practices along the supply chain.	Examples: circular economy, reverse logistics, reusing or recycling material, replacing energy from fossil sources with non-fossil, and ISO 14000 adherence.
	Considering the risks of climate change challenges and social disruption for businesses, as well as their impact on business models and the supply chain's resilience.	Recommendation: evaluate the business model and consider restructuring the supply chain reconfiguration (shorter and fewer providers).
	Considering a long-term perspective to transaction costs related to Scope 3 emissions and their impact on the firm's financial issues.	
	Establishing social issues in the value chain and measurement tools for the social results.	
General	Improving the criteria and standards that facilitate the Scope 3 emissions assessment and unify requirements from different regions and countries.	Recommendation to policymakers.
	Establishing a rigorous Scope 3 emissions report analysis to check whether only positive results have been reported or whether some results have been distorted.	Recommendation to investors committed to sustainability.

Next, the conclusion and limitations of this study are presented.

5. Conclusions and Limitations

Scope 3 emissions management requires successfully integrating data, strategies, and practices within the value chain. Despite the urgency of climate change, the role of focal enterprises in reducing Scope 3 emissions, as well as the need for an integrated approach for all value chains, the SSCM literature has barely addressed Scope 3 emissions management and how to reduce such emissions. This study aims to fill this gap by organizing the current literature around this challenging, topical issue.

This study contributes to the academic field by organizing and analyzing the findings into three themes. It also indicates avenues for further studies based on issues barely explored or without significant results. Managerial contributions to policymakers and firms' managers are also presented. There is a long way to go concerning this subject.

A significant concern that arises from this study is whether it is possible to assess, report, and manage Scope 3 emissions throughout the supply chain due to their complexity. New business models and supply chain configurations should be considered to minimize such a challenge. By the voluntary character of reporting Scope 3 emissions, the studied literature indicates that some firms only declare positive results while omitting non-positive ones. Such a finding suggests how relevant regulations and norms are to leverage the Scope 3 emissions management. Digital technologies have been pointed out as facilitators of data integration and sharing among value chain stakeholders. Also, using eco-design, circular economy, renewable raw materials, and rethinking the product life cycle may help minimize Scope 3 emissions. The role of focal firms in conducting strategies and practices along the entire value chain appears essential to managing Scope 3 emissions.

This study, conducted as a systematic literature review (SLR), presents some limitations that warrant acknowledgment to ensure transparency and define the boundaries of our synthesis. Firstly, the selection of our data sources was restricted to Scopus and Web of Science, potentially overlooking relevant contributions from other academic databases or grey literature. Secondly, while comprehensive for their initial scope, the search strings employed did not explicitly consider crucial terms such as "embedded emissions", "supply chain emissions", and "life cycle emissions". These omissions suggest that some papers offering valuable insights into the research could be missing from our review, potentially impacting the breadth of our findings.

Beyond database and keyword coverage, our methodology did not involve a real-world analysis of corporate strategies and practices. We could not provide empirical examples that might inspire others or directly support the simplification of Scope 3 emissions management. Furthermore, our synthesis does not delve into sectoral or geographic distinctions in Scope 3 emissions management, which might offer nuanced insights into specific industry challenges or regional regulatory impacts. Finally, as an SLR, the absence of any form of result validation against empirical data is an inherent limitation, meaning our findings are based solely on the reviewed literature. We reinforce the critical need to continue researching Scope 3 emissions and how to adequately address practices and actions, integrating all partners from the value chain, to build upon the theoretical foundations laid here.

This paper contributes significantly by synthesizing the current academic landscape of Scope 3 emissions management within the SSCM literature, highlighting prevailing challenges, existing strategies, and critical gaps for future research, thereby providing a foundational understanding for both scholars and practitioners aiming for comprehensive emissions accounting and reduction.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su17136066/s1, The PRISMA 2020 checklist is presented as Supplementary Materials.

Author Contributions: Conceptualization, M.B., G.M. and E.P.; methodology, R.B., L.L. and M.B.; search for literature and analysis: R.B., L.L. and M.B.; categorization of the articles: M.B., G.P. and G.M.; writing—original draft preparation, M.B.; writing—review and editing, M.B. and A.S.d.C. All authors have read and agreed to the published version of the manuscript.

Funding: This work was supported by the Research Foundation of the State of Grande do Sul (FAPERGS-Brazil; grant number: 21/2551-0002168-3) and the National Council for Scientific and Technological Development (CNPq-Brazil; grant number: 312395/2022-1).

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

SSCM	Sustainable supply chain management
ESG	Environmental, social, and governance
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analysis
SLR	Systematic literature review
LCA	Life cycle assessment
CDP	Carbon Disclosure Project
MNC	Multinational company

References

1. Alves, M.Y.; Vieira, L.; Partyka, R. Suppliers' GHG mitigation strategies (Scope 3): The case of a steelmaking company. *J. Manuf. Technol. Manag.* **2024**, *35*, 383–402. [CrossRef]
2. WRI; WBCSD. Corporate Value Chain (Scope 3) Accounting and Reporting Standard. Available online: https://ghgprotocol.org/corporate-value-chain-scope-3-standard (accessed on 12 February 2024).
3. Mejia, C.; Kajikawa, Y. Estimating scope 3 greenhouse gas emissions through the shareholder network of publicly traded firms. *Sustain. Sci.* **2024**, *19*, 1409–1425. [CrossRef]
4. Dahlmann, F.; Roehrich, J.K. Sustainable supply chain management and partner engagement to manage climate change information. *Bus. Strateg. Environ.* **2019**, *28*, 1632–1647. [CrossRef]
5. Jurburg, D.; López, A.; Carli, I.; Chong, M.; De Oliveira, L.K.; Dablanc, L.; Tanco, M.; De Sousa, P.R. Understanding the Challenges Facing Decarbonization in the E-Commerce Logistics Sector in Latin America. *Sustainability* **2023**, *15*, 15718. [CrossRef]
6. Hettler, M.; Graf-Vlachy, L. Corporate scope 3 carbon emission reporting as an enabler of supply chain decarbonization: A systematic review and comprehensive research agenda. *Bus. Strateg. Environ.* **2024**, *33*, 263–282. [CrossRef]
7. NIKE. *Moving Together Fy23 Nike, Inc. Impact Report*; NIKE: Eugene, OR, USA, 2023.
8. JBS Sustainability Report 2023. Available online: https://jbsesg.com/docs/JBS_Sustainability_Report_2023.pdf (accessed on 25 October 2024).
9. Google. *Google Environmental Report 2023*; Google: Mountain View, CA, USA, 2023.
10. Hansen, A.D.; Kuramochi, T.; Wicke, B. The status of corporate greenhouse gas emissions reporting in the food sector: An evaluation of food and beverage manufacturers. *J. Clean. Prod.* **2022**, *361*, 132279. [CrossRef]
11. Brander, M.; Bjørn, A. Principles for accurate GHG inventories and options for market-based accounting. *Int. J. Life Cycle Assess.* **2023**, *28*, 1248–1260. [CrossRef]
12. Herth, A.; Blok, K. Quantifying universities' direct and indirect carbon emissions—The case of Delft University of Technology. *Int. J. Sustain. High. Educ.* **2022**, *24*, 21–52. [CrossRef]
13. Al Sholi, H.Y.; Wakjira, T.; Kutty, A.A.; Habib, S.; Alfadhli, M.; Aejas, B.; Kucukvar, M.; Onat, N.C.; Kim, D. How circular economy can reduce scope 3 carbon footprints: Lessons learned from FIFA world cup Qatar 2022. *Circ. Econ.* **2023**, *2*, 100026. [CrossRef]
14. Popescu, I.S.; Gibon, T.; Hitaj, C.; Rubin, M.; Benetto, E. Are SRI funds financing carbon emissions? An input-output life cycle assessment of investment funds. *Ecol. Econ.* **2023**, *212*, 107918. [CrossRef]
15. Anquetin, T.; Coqueret, G.; Tavin, B.; Welgryn, L. Scopes of carbon emissions and their impact on green portfolios. *Econ. Model.* **2022**, *115*, 105951. [CrossRef]
16. Blanco, C.C. Supply Chain Carbon Footprinting and Climate Change Disclosures of Global Firms. *Prod. Oper. Manag.* **2021**, *30*, 3143–3160. [CrossRef]
17. Patchell, J. Can the implications of the GHG Protocol's scope 3 standard be realized? *J. Clean. Prod.* **2018**, *185*, 941–958. [CrossRef]
18. Nikseresht, A.; Golmohammadi, D.; Zandieh, M. Sustainable green logistics and remanufacturing: A bibliometric analysis and future research directions. *Int. J. Logist. Manag.* **2023**, *35*, 755–803. [CrossRef]
19. Mahapatra, S.K.; Schoenherr, T.; Jayaram, J. An assessment of factors contributing to firms' carbon footprint reduction efforts. *Int. J. Prod. Econ.* **2021**, *235*, 108073. [CrossRef]
20. Isil, O.; Sebastianelli, R. Arcs of carbon awareness in the value chain and their antecedents. *Bus. Strateg. Environ.* **2020**, *29*, 503–518. [CrossRef]

21. Ozkan-Ozen, Y.D.; Sezer, D.; Ozbiltekin-Pala, M.; Kazancoglu, Y. Risks of data-driven technologies in sustainable supply chain management. *Manag. Environ. Qual.* **2023**, *34*, 926–942. [CrossRef]
22. Roy, V.; Schoenherr, T.; Charan, P. The thematic landscape of literature in sustainable supply chain management (SSCM): A review of the principal facets in SSCM development. *Int. J. Oper. Prod. Manag.* **2018**, *38*, 1091–1124. [CrossRef]
23. Baptista, R.; Thurik, a.R. The relationship between entrepreneurship and unemployment: Is Portugal an outlier? *Technol. Forecast. Soc. Change* **2007**, *74*, 75–89. [CrossRef]
24. Teuteberg, F.; Wittstruck, D. Betriebliches Umwelt- und Nachhaltigkeitsmanagement: A Systematic Review of Sustainable Supply Chain Management. In *Multikonferenz Wirtschaftsinformatik 2010*; Universitätsverlag Göttingen: Göttingen, Germany, 2020; pp. 203–204. [CrossRef]
25. Vieira, L.C.; Longo, M.; Mura, M. Impact pathways: The hidden challenges of Scope 3 emissions measurement and management. *Int. J. Oper. Prod. Manag.* **2024**, *44*, 326–334. [CrossRef]
26. Steiner, B.; Münch, C.; Küffner, C.; Hartmann, E. Mapping the intellectual foundation of low-carbon supply chains: A theory-based literature review on buyer-supplier relationships. *J. Clean. Prod.* **2023**, *425*, 138961. [CrossRef]
27. Yi, W.; Liang, H.; Yang, Z. The Choice of Carbon Labels and the Impact of Ambiguity Under Market Differences Based on a Game Framework. *Sustainability* **2025**, *17*, 3477. [CrossRef]
28. Spaniol, M.J.; Danilova-jensen, E.; Nielsen, M.; Rosdahl, C.G.; Schmidt, C.J. Defining Greenwashing: A Concept Analysis. *Sustainability* **2024**, *16*, 9055. [CrossRef]
29. Gao, Y.; Chen, Y. Watchdogs or Enablers? Analyzing the Role of Analysts in ESG Greenwashing in China. *Sustainability* **2024**, *16*, 4339. [CrossRef]
30. Asif, M.S.; Lau, H.; Nakandala, D.; Fan, Y.; Hurriyet, H. Case study research of green life cycle model for the evaluation and reduction of scope 3 emissions in food supply chains. *Corp. Soc. Responsib. Environ. Manag.* **2022**, *29*, 1050–1066. [CrossRef]
31. Kirst, R.W.; Borchardt, M.; de Carvalho, M.N.M.; Pereira, G.M. Best of the world or better for the world? A systematic literature review on benefit corporations and certified B corporations contribution to sustainable development. *Corp. Soc. Responsib. Environ. Manag.* **2021**, *28*, 1822–1839. [CrossRef]
32. Tranfield, D.; Denyer, D.; Palminder, S. Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *Br. J. Manag.* **2003**, *14*, 207–222. [CrossRef]
33. Prisma. PRISMA 2020. PRISMA for Scoping Reviews (PRISMA-ScR). 2024. Available online: https://www.prisma-statement.org/scoping (accessed on 12 July 2024).
34. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. [CrossRef]
35. Marti, A.; Bastida-Vialcanet, R.; Marimon, F. A systematic literature review: ESG criteria implementation in the insurance industry. *Intang. Cap.* **2024**, *20*, 193–214. [CrossRef]
36. Park, Y.; Putra, A.S.; Park, H.S.; Kim, J. Characterization of the life cycle carbon footprint of the automobile industry in the Republic of Korea by environmentally extended input-output model. *Environ. Eng. Res.* **2024**, *29*, 230583. [CrossRef]
37. Balci, G.; Ali, S.I. The relationship between information processing capabilities, Net-Zero capability and supply chain performance. *Supply Chain Manag.* **2024**, *29*, 351–370. [CrossRef]
38. Tokito, S.; Nagashima, F.; Hanaka, T. Identifying critical transmission sectors by a new approach: Intermediate-based accounting. *J. Clean. Prod.* **2024**, *435*, 140487. [CrossRef]
39. Giacomin, A.M.; Pacca, S.A. Input–output analysis as guidance for the Brazilian textile supply chain. *Environ. Dev. Sustain.* **2024**, *26*, 1–20. [CrossRef]
40. Biswas, M.K.; Azad, A.K.; Datta, A.; Dutta, S.; Roy, S.; Chopra, S.S. Navigating Sustainability through Greenhouse Gas Emission Inventory: ESG Practices and Energy Shift in Bangladesh's Textile and Readymade Garment Industries. *Environ. Pollut.* **2024**, *345*, 123392. [CrossRef]
41. Dahlmann, F.; Brammer, S.; Roehrich, J.K. Navigating the "performing-organizing" paradox: Tensions between supply chain transparency, coordination, and scope 3 GHG emissions performance. *Int. J. Oper. Prod. Manag.* **2023**, *43*, 1757–1780. [CrossRef]
42. Martinuzzi, A.; Hametner, M.; Windsperger, A.; Brunnhuber, N. A Framework for Assessing the Climate Impacts of Research and Innovation Projects and Programmes. *Sustainability* **2023**, *15*, 16600. [CrossRef]
43. Chabot, M.; Bertrand, J.L. Climate risks and financial stability: Evidence from the European financial system. *J. Financ. Stab.* **2023**, *69*, 101190. [CrossRef]
44. Emmanuel, Y.; Adenikinju, O.; Doorasamy, M.; Ayoola, T.; Oladejo, A.; Kwarbai, J.; Otekunrin, A. Carbon Emission Disclosure and Financial Performance of Quoted Nigerian Financial Services Companies. *Int. J. Energy Econ. Policy* **2023**, *13*, 628–635. [CrossRef]
45. Toukabri, M.; Jilani, F. The power of critical mass to make a difference: How gender diversity in board affect US corporate carbon performance. *Soc. Bus. Rev.* **2023**, *18*, 592–617. [CrossRef]

46. Linares-Rodríguez, M.C.; Gambetta, N.; García-Benau, M.A. Carbon management strategy effects on the disclosure and efficiency of carbon emissions: A study of Colombian companies' context and inherent characteristics. *J. Clean. Prod.* **2022**, *365*, 132850. [CrossRef]
47. Xia, M.; Cai, H.H. The driving factors of corporate carbon emissions: An application of the LASSO model with survey data. *Environ. Sci. Pollut. Res.* **2023**, *30*, 56484–56512. [CrossRef]
48. Stridsland, T.; Biørnstad, W.; Vigen, K.; Østergaard, K.L.; Sanderson, H. No-one left behind: An open access approach to estimating the carbon footprint of a Danish clothing company. *J. Clean. Prod.* **2023**, *426*, 139126. [CrossRef]
49. Ballentine, R.S. The unusual suspects: Are well-meaning environmental stakeholders and institutions undercutting the contributions that companies can make to fighting climate change? *Oxford Open Clim. Change* **2023**, *3*, kgad009. [CrossRef]
50. Hall, G.; Liu, K.; Pomorski, L.; Serban, L. Supply Chain Climate Exposure. *Financ. Anal. J.* **2023**, *79*, 58–76. [CrossRef]
51. Goodwin, K.; Allen, C.; Teh, S.H.; Li, M.; Fry, J.; Lenzen, M.; Farrelly, S.; Leon, C.; Lewis, S.; Chen, G.; et al. Targeting 1.5 degrees with the global carbon footprint of the Australian Capital Territory. *Environ. Sci. Policy* **2022**, *144*, 137–150. [CrossRef]
52. Kennett, H.; Diaz-Rainey, I.; Biswas, P.K.; Kuruppuarachchi, D. Climate transition risk in New Zealand equities. *J. Sustain. Financ. Invest.* **2023**, *13*, 868–892. [CrossRef]
53. Yasar, A.; Yalçın, N. Voluntary disclosure of scope 3 greenhouse gas emissions and earnings management: Evidence from UK companies. *Cogent Bus. Manag.* **2023**, *10*, 2275849. [CrossRef]
54. Busch, T.; Johnson, M.; Pioch, T. Corporate carbon performance data: Quo vadis? *J. Ind. Ecol.* **2022**, *26*, 350–363. [CrossRef]
55. Hammer, A.J.; Millar, C.; Hennige, S.J. Reducing carbon emissions in aquaculture: Using Carbon Disclosures to identify unbalanced mitigation strategies. *Environ. Impact Assess. Rev.* **2022**, *96*, 106816. [CrossRef]
56. García-Alaminos; Gilles, E.; Monsalve, F.; Zafrilla, J. Measuring a university's environmental performance: A standardized proposal for carbon footprint assessment. *J. Clean. Prod.* **2022**, *357*, 131783. [CrossRef]
57. Schmidt, M.; Nill, M.; Scholz, J. Determining the Scope 3 Emissions of Companies. *Chem. Eng. Technol.* **2022**, *45*, 1218–1230. [CrossRef]
58. Reavis, M.; Ahlen, J.; Rudek, J.; Naithani, K. Evaluating Greenhouse Gas Emissions and Climate Mitigation Goals of the Global Food and Beverage Sector. *Front. Sustain. Food Syst.* **2022**, *5*, 789499. [CrossRef]
59. Cabernard, L.; Pfister, S.; Hellweg, S. Improved sustainability assessment of the G20's supply chains of materials, fuels, and food. *Environ. Res. Lett.* **2022**, *17*, 034027. [CrossRef]
60. Yang, Y.; Park, Y.; Smith, T.M.; Kim, T.; Park, H.S. High-Resolution Environmentally Extended Input-Output Model to Assess the Greenhouse Gas Impact of Electronics in South Korea. *Environ. Sci. Technol.* **2022**, *56*, 2107–2114. [CrossRef]
61. Ellram, L.M.; Tate, W.L.; Saunders, L.W. A legitimacy theory perspective on Scope 3 freight transportation emissions. *J. Bus. Logist.* **2022**, *43*, 472–498. [CrossRef]
62. Demeter, C.; Lin, P.C.; Sun, Y.Y.; Dolnicar, S. Assessing the carbon footprint of tourism businesses using environmentally extended input-output analysis. *J. Sustain. Tour.* **2021**, *30*, 128–144. [CrossRef]
63. Schulman, D.J.; Bateman, A.H.; Greene, S. Supply chains (Scope 3) toward sustainable food systems: An analysis of food & beverage processing corporate greenhouse gas emissions disclosure. *Clean. Prod. Lett.* **2021**, *1*, 100002. [CrossRef]
64. Giesekam, J.; Norman, J.; Garvey, A.; Betts-davies, S. Science-Based Targets: On Target ? *Sustainability* **2021**, *13*, 1657. [CrossRef]
65. Malik, A.; Egan, M.; du Plessis, M.; Lenzen, M. Managing sustainability using financial accounting data: The value of input-output analysis. *J. Clean. Prod.* **2021**, *293*, 126128. [CrossRef]
66. Dou, X.; Deng, Z.; Sun, T.; Ke, P.; Zhu, B.; Shan, Y.; Liu, Z. Global and local carbon footprints of city of Hong Kong and Macao from 2000 to 2015. *Resour. Conserv. Recycl.* **2021**, *164*, 105167. [CrossRef]
67. Wiedmann, T.; Chen, G.; Owen, A.; Lenzen, M.; Doust, M.; Barrett, J.; Steele, K. Three-scope carbon emission inventories of global cities. *J. Ind. Ecol.* **2021**, *25*, 735–750. [CrossRef]
68. Novaes das Virgens, T.A.; Andrade, J.C.S.; Hidalgo, S.L. Carbon footprint of public agencies: The case of Brazilian prosecution service. *J. Clean. Prod.* **2020**, *251*, 119551. [CrossRef]
69. He, K.; Hertwich, E.G. The flow of embodied carbon through the economies of China, the European Union, and the United States. *Resour. Conserv. Recycl.* **2019**, *145*, 190–198. [CrossRef]
70. Martinez, S.; Delgado, M.d.M.; Martinez Marin, R.; Alvarez, S. The Environmental Footprint of the end-of-life phase of a dam through a hybrid-MRIO analysis. *Build. Environ.* **2018**, *146*, 143–151. [CrossRef]
71. Radonjič, G.; Tompa, S. Carbon footprint calculation in telecommunications companies—The importance and relevance of scope 3 greenhouse gases emissions. *Renew. Sustain. Energy Rev.* **2018**, *98*, 361–375. [CrossRef]
72. Hertwich, E.G.; Wood, R. The growing importance of scope 3 greenhouse gas emissions from industry. *Environ. Res. Lett.* **2018**, *13*, 104013. [CrossRef]
73. Meng, F.; Liu, G.; Yang, Z.; Hao, Y.; Zhang, Y.; Su, M.; Ulgiati, S. Structural analysis of embodied greenhouse gas emissions from key urban materials: A case study of Xiamen City, China. *J. Clean. Prod.* **2017**, *163*, 212–223. [CrossRef]

74. Blanco, C.; Caro, F.; Corbett, C.J. The state of supply chain carbon footprinting: Analysis of CDP disclosures by US firms. *J. Clean. Prod.* **2016**, *135*, 1189–1197. [CrossRef]
75. Zhang, X.; Wang, F. Hybrid input-output analysis for life-cycle energy consumption and carbon emissions of China's building sector. *Build. Environ.* **2016**, *104*, 188–197. [CrossRef]
76. Davies, J.C.; Dunk, R.M. Flying along the supply chain: Accounting for emissions from student air travel in the higher education sector. *Carbon Manag.* **2015**, *6*, 233–246. [CrossRef]
77. Kucukvar, M.; Egilmez, G.; Onat, N.C.; Samadi, H. A global, scope-based carbon footprint modeling for effective carbon reduction policies: Lessons from the Turkish manufacturing. *Sustain. Prod. Consum.* **2015**, *1*, 47–66. [CrossRef]
78. Onat, N.C.; Kucukvar, M.; Tatari, O. Scope-based carbon footprint analysis of U.S. residential and commercial buildings: An input-output hybrid life cycle assessment approach. *Build. Environ.* **2014**, *72*, 53–62. [CrossRef]
79. Ozawa-Meida, L.; Brockway, P.; Letten, K.; Davies, J.; Fleming, P. Measuring carbon performance in a UK University through a consumption-based carbon footprint: De Montfort University case study. *J. Clean. Prod.* **2013**, *56*, 185–198. [CrossRef]
80. Matisoff, D.C.; Noonan, D.S.; O'Brien, J.J. Convergence in environmental reporting: Assessing the carbon disclosure project. *Bus. Strateg. Environ.* **2013**, *22*, 285–305. [CrossRef]
81. Brown, L.H.; Buettner, P.G.; Canyon, D.V.; Crawford, J.M.; Judd, J. Estimating the life cycle greenhouse gas emissions of Australian ambulance services. *J. Clean. Prod.* **2012**, *37*, 135–141. [CrossRef]
82. Huang, Y.A.; Weber, C.L.; Matthews, H.S. Categorization of scope 3 emissions for streamlined enterprise carbon footprinting. *Environ. Sci. Technol.* **2009**, *43*, 8509–8515. [CrossRef]
83. Dahlmann, F.; Branicki, L.; Brammer, S. Managing Carbon Aspirations: The Influence of Corporate Climate Change Targets on Environmental Performance. *J. Bus. Ethics* **2019**, *158*, 1–24. [CrossRef]
84. Ströher, T.; Körner, M.F.; Paetzold, F.; Strüker, J. Bridging carbon data's organizational boundaries: Toward automated data sharing in sustainable supply chains. *Electron. Mark.* **2025**, *35*, 33. [CrossRef]
85. Asif, M.; Searcy, C.; Castka, P. ESG and Industry 5.0: The role of technologies in enhancing ESG disclosure. *Technol. Forecast. Soc. Change* **2023**, *195*, 122806. [CrossRef]
86. Gan, K.; Ye, S. Window Dressing in Impression Management: Does Negative Media Coverage Drive Corporate Green Production? *Sustainability* **2024**, *16*, 861. [CrossRef]
87. Pinheiro, A.B.; dos Santos, J.I.A.S.; Cherobim, A.P.M.S.; Segatto, A.P. What drives environmental, social and governance (ESG) performance? The role of institutional quality. *Manag. Environ. Qual.* **2024**, *35*, 427–444. [CrossRef]
88. Tarifa-Fernández, J.; Céspedes-Lorente, J.; de Burgos Jiménez, J. Drivers of environmental sustainability: Environmental capabilities and supply chain integration. *Manag. Environ. Qual.* **2023**, *34*, 843–861. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.