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Impact pathways: the hidden challenges of Scope 3 emissions measurement and management

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Abstract

Purpose – This pathway discusses the need for further research into how focal companies measure and manage indirect Scope 3 emissions in their value chains.

Design/methodology/approach – This pathway relies on the authors' qualitative research on European companies' decarbonisation strategies. We analysed self-reported and tertiary data from 33 manufacturing European companies considered leaders in climate action. Additionally, interviews were conducted with four experts who work to elaborate decarbonisation strategies in large companies that are part of global value chains.

Findings – The limited visibility of focal firms over their value chains and data collection capacity raises questions on the reliability of indirect emissions inventories and companies' ability to manage indirect emissions.

Research limitations/implications – Investigation of the emerging empirical phenomena of indirect emissions may lead to valuable insights for the measurement and management of sustainability issues.

Practical implications – Our piece explores the process of constructing indirect emissions inventories, assists in ensuring accurate interpretation of the data and provokes discussion on focal companies' role in managing Scope 3 emissions.

Social implications – Many stakeholders refer to companies' Scope 3 inventories. This piece exposes inconsistencies in these inventories and what companies' responsibilities are in managing emissions.

Originality/value – Research on managing sustainability issues in supply and value chains is increasing, and indirect emissions are central in this space. This impact pathway seeks to stimulate research in underdeveloped areas by discussing the limitations of this data and highlighting practical limitations present in its management.

Keywords Indirect emissions, Value networks, Greenhouse gas protocol,
Sustainable supply chain management, Scope 3 emissions

Paper type Impact pathways

1. Introduction

Many companies have most of its greenhouse gas emissions (GHGs) classified as indirect Scope 3 emissions (Dooley *et al.*, 2019). These emissions result from various activities that are part of companies' value chains, such as the purchase of materials, employee commuting, waste disposal and product usage. Although companies are not legally obliged to manage Scope 3 emissions, including them in their decarbonisation strategies can significantly increase their contribution to climate change mitigation (Lintukangas *et al.*, 2022). Therefore, there is growing pressure from markets and civil society for companies to broaden the scope of their sustainability practices to address indirect emissions associated with their value chains (De Stefano and Montes-Sancho, 2023). As a result, many companies have established Scope 3 targets, and external stakeholders often rely on associated Scope 3 inventories as precise and representative figures (Callery and Perkins, 2021). Scope 3 inventories comprise indirect greenhouse gas emissions associated with an organisation's activities that occur from sources not owned or controlled by the organisation. Scope 3 emissions data are also a variable in

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studies that analyse and theorise company performance in mitigation (Dahlmann *et al*., 2023; De Stefano and Montes-Sancho, 2023).

Our deep engagement with companies' decarbonisation strategies has presented us with significant issues related to Scope 3 emissions measurement and management that are taken for granted by the literature. Our impact pathway will elaborate on these issues and seek to stimulate further research to improve the measurement and management of indirect emissions and maximise companies' contribution to climate change mitigation.

The insights presented in this impact pathway derive from our research on European companies' decarbonisation strategies. Firstly, we analysed the 33 European manufacturing companies considered leaders (top score – A) in climate action by the CDP in 2021. Those companies have net-zero targets verified by the Science Based Targets Initiative (SBTi) and have included Scope 3 emissions in their strategies. We consider those companies as focal firms of their value chains. We engaged with a broad range of different data sources that described companies' decarbonisation strategies: CDP questionnaires, sustainability reports from 2021, news, the SBTi database and any other associated documents linked to companies' climate strategies (e.g. TCFD reports and net-zero roadmaps). Overall, 381 documents comprising more than 13,000 pages were collected. We then developed a content analysis on these data sources to clearly understand their decarbonisation strategies, which revealed inconsistencies in the Scope 3 emissions measurement process. Secondly, to dig deeper into this issue, we collected data through interviews with four experts who work first-hand with assembling data on carbon emissions and decarbonisation strategies in large companies' part of global value chains from the sectors of finished goods, insurance and manufacturing. A separate content analysis was carried out on the interviews using predefined dimensions relevant to deepening our inquiry.

This impact piece will explore three main research topics relevant to the IJOPM community to advance knowledge on challenges related to companies' measurement and management of Scope 3 emissions from their value chains. We explore (1) How value chain knowledge affects Scope 3 emissions measurement; (2) The quality of the available Scope 3 data and (3) How companies manage Scope 3 emissions.

2. The challenges of mapping a company's value chain

A company's measurement and management of its Scope 3 emissions inevitably requires a comprehensive knowledge of the value chain those emissions derive from. However, the vast number of independent businesses involved recurrently in the value creation of global companies makes delimitating a value chain a problematic task (Acquier *et al*., 2017). There is still debate among authors regarding whether a value chain can be considered a stable entity with clear boundaries or better understood as a "fast-moving amorphous target" (Fabbe-Costes *et al*., 2020). Carter *et al*. (2015) have pointed out that the inability to determine the structure of the value chain and its boundaries is a limitation for elaborating on any related parameter. Scope 3 emissions inventories are closely linked to this issue as they require mapping all upstream and downstream activities of a company's value chain (Zhang *et al*., 2024). The GHG Protocol was a pioneering initiative that provided guidelines that characterise value chains' activities and assist in measuring their associated emissions (WRI, 2011). However, the seemingly straightforward practical guidelines are somewhat incompatible with the theoretical difficulty of conceptualising a company's value chain. Considering all the limitations that surround the topic, limited research attention has been given to the practical feasibility of assessing indirect Scope 3 emissions (Downie and Stubbs, 2012; Schmidt, 2009).

Our content analysis indicates that companies have limited knowledge of their value chains. All focal firms are still making significant efforts to map and assess the impact of their first-tier suppliers or customers, and only 15% of companies engage with further tiers of their value chains. Our interviewees also emphasise that some value chain relationships are stable, but there is still a high level of variability. This dynamicity in the value chain structure

increases the complexity of a carbon inventory. As the conceptualisation of value chains remains fluid, all companies often make arbitrary decisions on inventory boundaries regarding tiers and which emissions categories to include. Opinions of external consultants or industry guidelines often guide this process, demonstrating a common reliance on tacit knowledge and susceptibility to bias rather than a thorough understanding of a focal company's value chain carbon impact: "We have discussed the categories [leased assets and investments] with an external consultant, and it is our understanding given the size of other scope 3 categories, that the potential size of these categories will be insignificant compared with other Scope 3 activities" (Novo Nordisk, CDP questionnaire, 2021).

3. The measurement of Scope 3 emissions

The first issue that the measurement of indirect carbon emissions faces is the lack of clarity on the boundaries of value chains and quality issues in the collected data are an additional challenge. The Scope 3 inventories of companies are mainly based on estimations, which produce results with varying levels of accuracy. Our analysis revealed that the quantity of primary or secondary data used varies significantly (refer to Table 1). Considering upstream activities, only one-third of the 33 companies we assessed mention primary data collection when considering suppliers' emissions. However, on average, primary data are collected only from 40% of suppliers. Focusing on downstream activities, to estimate emissions from product usage, companies often consider the number of products sold multiplied by life cycle assessment (LCA) coefficients and assumptions about consumer behaviour. Sanofi, for example, mentions that several assumptions were made in its calculation of product usage emissions that used emission factors from the database Ecoinvent. The company itself recognises that the data quality is medium due to the combination of assumptions. Additionally, our interviews with practitioners confirmed that Scope 3 inventories are rarely based on primary data and rely mostly on estimates.

The excessive reliance on estimations and secondary data leads to inventories that do not adhere to the basic measurement principles of reliability and validity. The poor quality of these data requires them to be accompanied by margins of error, a practice adopted only by Diageo among companies analysed. One interviewee pointed out that the lack of primary data makes it difficult to measure progress towards achieving emission reduction targets. The estimations involve many coefficients, assumptions and modelling factors, which have limited capacity to reflect improvements obtained due to real-world practices. It may be unrealistic to expect primary data to be collected from all suppliers, given the extensive value chains of large manufacturing companies: "any supply chain today is extremely varied and to characterize the thousands of product codes that we buy, for example, we rely on the reliability of existing LCA models to get this information" (Interviewee, manufacturing sector). As such, the measurement of indirect emissions as a performance indicator becomes impractical due to the large amount of data required and the need for continuous monitoring.

4. The management of Scope 3 emissions

Recent studies focusing on the management of sustainability issues in supply chains can help to develop assumptions on how the management of indirect emissions can function (Jia *et al.*, 2021; Marttinen and Kähkönen, 2022; Soundararajan and Brammer, 2018). Shared values and goals among actors seem crucial for achieving improvements; on the other hand, practices that resemble private regulation may not necessarily provide mutual benefits and can exacerbate power imbalances. However, studies have focused only on engagement with suppliers and managing Scope 3 emissions requires engagement with other actors (e.g. clients or final customers), which increases the challenges already faced in sustainable supply chain management. Large global companies with established Scope 3 targets must manage actors and issues beyond their legal boundaries and from different geographical locations.

Table 1. Sources of indirect emissions data according with the different categories – European manufacturing companies

Scope 3 categories	Characteristics of the data obtained
Purchased goods and services	• Estimated using LCA analysis • Estimated based on data from purchases and coefficients • 40% of companies use primary data from 1-tier suppliers on estimations
Capital goods	• Estimated based on data from purchases and coefficients
Fuel-and-energy-related activities (not included in Scope 1 or 2)	• Calculated using primary data related to fuel and energy consumption • Estimated based on the amount of Scope 1 emissions • Estimated using LCA analysis
Upstream transportation and distribution	• Estimated using data from the logistics department and coefficients
Waste generated in operations	• Estimated based on types of waste, treatment methods, and emissions coefficients associated • Estimated based on expenditure on waste treatments
Business travel	• Estimated based on data related only to air travel • Estimated based on rail, air, and road travel • Provided by travel or car rental agencies • Some companies include emissions related to hotel stays
Employee commuting	• Estimated using models • Estimated based on primary data collected through employees' survey • Some companies include in business travel
Upstream leased assets	• Considered as not relevant for most companies, and estimated using coefficients by those who included it
Downstream transportation and distribution	• Estimated using data from the logistics department, logistic providers, or standard coefficients linked to different modes of transport • Some companies also included emissions linked to retailing activities
Processing of sold products	• Considered as not relevant for most companies, and estimated using coefficients by those who included it
Use of sold products	• Estimated using LCA analysis • Estimated based on products sold and average emission level • Estimated using scenarios of consumers behavior
End of life treatment of sold products	• Estimated using LCA • Estimated considering only packaging emissions • Estimated by multiplying the mass of finished goods with the product carbon content and the treatment-specific emission factors
Downstream leased assets	• Considered as not relevant for most companies • Estimated using primary data of emissions
Franchises	• Considered as not relevant for most companies • Estimated using primary data of energy consumption
Investments	• Considered as not relevant for most companies

Note(s): Estimated data is highlighted in grey
Source(s): Created by the authors

Insights from our sample show that companies with the highest emissions related to upstream activities of materials and services providers adopt different postures depending on the type of relationship and the actor's familiarity with climate mitigation. When dealing with critical suppliers, the mutual dependence between the two actors inclines companies to adopt a more collaborative approach that might result in shared benefits. When smaller material

suppliers are considered, their higher dependency on the focal firm creates an unbalanced power relationship, making them more susceptible to accepting prescribed targets or actions: "after 2025, only zero carbon [material] suppliers can be in the value chain of [company name]. It is a trigger together with the other aspects, to be or not be a supplier for [company name]" (Interviewee, finished goods). Smaller suppliers' lack of leverage can result in a predominant transactional approach that may lead to unexpected negative consequences, such as a lack of transparency in emissions data to mask negative performances. The third type of relationship involves independent suppliers with a large pool of clients, such as providers of technologies, services and finished goods. According to our interviewees, monitoring whether these companies have established Scope 1 targets or are reducing emissions is the most common practice, as these companies often have decarbonisation strategies in place: "in some cases you already know that some of your suppliers will reduce their emissions because they have set a target, therefore, they reduce [their scope 1 emissions] and you reach your target [scope 3], it is a chain" (Interviewee, insurance sector). Thus, there is an understanding that these companies will inevitably contribute to the Scope 3 targets of other companies.

Companies whose emissions are primarily linked to downstream activities mention product development, training for correct usage and increasing the circularity of their products as the main opportunities to reduce emissions in their strategies. However, the visibility that companies have of downstream actors can be limited. This lack of knowledge of their value chain makes it difficult to develop solutions to reduce downstream emissions and monitor their results. Furthermore, companies' decarbonisation strategies assume that circular practices are compatible with indirect emissions reductions. However, operations management research has only marginally explored possible environmental implications of circular practices such as extending product usage (Agrawal *et al*., 2019).

5. Future research avenues

This impact pathway explored practical issues that challenge Scope 3 emissions measurement and management and require further research. Table 2 summarises the issues presented in this piece grouped in three macro-topics: value chain knowledge, indirect emissions measurement and indirect emissions management. It also presents potential research questions and how they can contribute to theory. We will expand on those avenues in the sequence.

Our first block of proposals regards the need to extend knowledge on the composition of focal companies' value chains. Authors have sought to increase the transparency of global supply chains by exploring the number of direct ties a company has, the number of levels in the chain and the geographical distribution of those actors (Choi and Hong, 2002; De Stefano and Montes-Sancho, 2023). The role of supply chain transparency has been explored when managing risks and efficiency; however, it is also relevant for extending sustainability performance measurement and management from focal firm operations to their whole value chains. Considering the issue of indirect emissions specifically, linking emissions to the structure of value chains, going beyond estimates, would clarify better to what extent unregulated emissions are currently prevalent in focal firms' value chains. Clarity on the magnitude of unregulated emissions can better justify the need for focal companies managing Scope 3 emissions. Knowledge on the structure of value chains would also expose the degree to which actors are interconnected, potentially creating indirect links among companies.

Indirect emissions measurement is our second macro-topic that requires further research. First, critical evaluation of the employment of Scope 3 emissions as a performance indicator is necessary. The equivocality present in estimated inventories does not seem marginal, and further research should focus on debating the function of such metric. Our findings indicate that violation of basic measurement principles is present in Scope 3 data, and caution should be exercised when using inventories presented in CDP questionnaires and sustainability reports as a proxy of performance improvement. Second, regarding primary data collection for Scope 3 inventories, attention must be paid to data reliability and to what degree sharing

Table 2. Avenues for future research

Macro-topic	Issues	Research questions	Contributions to theory
Value chain knowledge	- There is no clarity on the boundaries of value chains - Need for more conceptual definition of value chain activities - Companies often do not consider downstream activities when assessing their carbon impact	- What is the role that value chain stability can play in indirect emissions management? - To what extent carbon emissions part of a value chain are not regulated? - How are emissions distributed among the different activities and actors of a company's value chain?	- Network theory: Further characterisation of archetypes that compose value chains and its dynamics (Carter *et al*., 2015; Fabbe-Costes *et al*., 2020) - Network theory: Increase knowledge on the relationship between complexity of supply chains and environmental performance (De Stefano and Montes-Sancho, 2023; Feng *et al*., 2024)
Indirect carbon emissions measurement	- Inventories are largely estimated - Boundaries adopted for each category vary - Not clear how progress will be measured when using estimated figures	- What is the gap between Scope 3 emissions estimated and actual emissions? - To what extent companies have technical competencies and interest in sharing reliable information on carbon emissions to build Scope 3 inventories? - What is the role that current Scope 3 data should have in climate disclosure and performance measurement? - To what extent companies interact with their value chains to create Scope 3 inventories and can it increase awareness to carbon mitigation? - How companies respond to clients' requirements to provide emission inventories?	- Paradox theory: Explore the organising–performing paradox between the achievement of sustainability goals and Scope 3 emissions transparency (Dahlmann *et al*., 2023) - Organisational impression management: Understand if strategic disclosure is used in Scope 3 inventories and their role in organisational impression management (Callery, 2023)
Indirect carbon emissions management	- No clarity on how power is distributed across value chain actors - The risk that Scope 3 targets become a greenwashing practice	- How do power dynamics present in value chains affect Scope 3 emissions management? - To what extent focal companies that have established Scope 3 targets are free riders in the process of achieving those targets? - What are the current collaborative practices to reduce Scope 3 emissions present in value chains?	- Resource dependence theory: Explore if different value chain structures or availability of resources influence how environmental issues are managed (De Stefano and Montes-Sancho, 2023) - Boundary spanning theory: Investigate if practices adopted by companies can be considered as boundary spanning ones and its impact in terms of shared responsibility (Jia *et al*., 2021; Johnsen *et al*., 2022; Schotter *et al*., 2017) - Institutional theory: to what extent mimetic isomorphism can facilitate indirect emissions management (Daddi *et al.*, 2020; Di Maggio and Powell, 1983; Villena and Dhanorkar, 2020)

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environmental information with their value chains can compete with other companies' interests. It is possible that a paradox exists in requirements to provide accurate emissions information and demonstrate performance improvements. Finally, the lack of reliability of indirect emissions inventories requires a debate on its use as an indicator in climate performance disclosure. Instead of using Scope 3 emissions as a performance indicator, those approximate inventories can be better suited for identifying exclusive opportunities to mitigate climate change. More research is needed to understand the internal role that such metrics and inventories effectively play in decision-making and in delineating decarbonisation strategies.

The third macro-topic concerns focal firms' management of their value chains Scope 3 emissions. The feasibility of indirect emissions management and the opportunities it may bring also require further studies. Combining knowledge of indirect emissions management practices with a deeper understanding of companies' value chains can assist in classifying possible kinds of relationships and the role of power relations. Studying the management of emissions might also increase the knowledge of value chain structures. We have proposed some settings, but more clarity is needed on the impact a focal firm adopting a Scope 3 target can have on its value chain. It is essential to understand if a focal firm can influence value chain members to reduce emissions, in what settings it occurs, and if negative externalities are present. It is unclear whether companies support value chain actors in reducing their Scope 1 emissions, take advantage of improvements achieved by others or act on their mutually exclusive opportunities. Untangling these aspects is crucial to evaluating the impact of Scope 3 management on reducing absolute emissions and the link of Scope 3 targets to greenwashing.

6. Conclusion

This impact pathway explored three main research topics relevant to advancing knowledge on tackling the practical challenges of measuring and managing Scope 3 emissions. We have discussed how the lack of knowledge of the value chain structure can impair the measurement of Scope 3 emissions. Companies have a patchy understanding of their value chains, and assumptions and mental models might be somewhat distant from the current reality of global value chains. The second issue concerns the quality of Scope 3 data, which is insufficient to be used as a performance indicator or subjected to targets. Most Scope 3 data are estimated, and the role of such inventories in climate disclosure and mitigation needs further debate. Finally, a gap remains in understanding the extent to which these shared emissions can be managed and the potential undesirable outcomes associated with current practices.

References

Acquier, A., Valiorgue, B. and Daudigeos, T. (2017), "Sharing the shared value: a transaction cost perspective on strategic CSR policies in global value chains", *Journal of Business Ethics*, Vol. 144 No. 1, pp. 139-152, doi: 10.1007/s10551-015-2820-0.

Agrawal, V.V., Atasu, A. and Van Wassenhove, L.N. (2019), "OM forum—new opportunities for operations management research in sustainability", *Manufacturing and Service Operations Management*, Vol. 21 No. 1, pp. 1-12, doi: 10.1287/msom.2017.0699.

Callery, P.J. (2023), "The influence of strategic disclosure on corporate climate performance ratings", *Business and Society*, Vol. 62 No. 5, pp. 950-988, doi: 10.1177/00076503221115715.

Callery, P.J. and Perkins, J. (2021), "Detecting false accounts in intermediated voluntary disclosure", *Academy of Management Discoveries*, Vol. 7 No. 1, pp. 40-56, doi: 10.5465/amd.2018.0229.

Carter, C.R., Rogers, D.S. and Choi, T.Y. (2015), "Toward the theory of the supply chain", *Journal of Supply Chain Management*, Vol. 51 No. 2, pp. 89-97, doi: 10.1111/jscm.12073.

Choi, T.Y. and Hong, Y. (2002), "Unveiling the structure of supply networks: case studies in Honda, Acura, and DaimlerChrysler", *Journal of Operations Management*, Vol. 20 No. 5, pp. 469-493, doi: 10.1016/s0272-6963(02)00025-6.

Daddi, T., Bleischwitz, R., Todaro, N.M., Gusmerotti, N.M. and De Giacomo, M.R. (2020), "The influence of institutional pressures on climate mitigation and adaptation strategies", *Journal of Cleaner Production*, Vol. 244, 118879, doi: 10.1016/j.jclepro.2019.118879.

Dahlmann, F., Brammer, S. and Roehrich, J.K. (2023), "Navigating the 'performing-organizing' paradox: tensions between supply chain transparency, coordination, and scope 3 GHG emissions performance", *International Journal of Operations and Production Management*, Vol. 43 No. 11, pp. 1757-1780, doi: 10.1108/IJOPM-09-2022-0622.

De Stefano, M.C. and Montes-Sancho, M.J. (2023), "Complex supply chain structures and multi-scope GHG emissions: the moderation effect of reducing equivocality", *International Journal of Operations and Production Management*, Vol. 44 No. 5, pp. 952-986, doi: 10.1108/IJOPM-11-2022-0759.

Di Maggio, P.J. and Powell, W.W. (1983), "The iron cage revisited: institutional isomorphism and collective rationality in organizational fields", *American Sociological Review*, Vol. 48 No. 2, pp. 147-160, doi: 10.2307/2095101.

Dooley, K.J., Pathak, S.D., Kull, T.J., Wu, Z., Johnson, J. and Rabinovich, E. (2019), "Process network modularity, commonality, and greenhouse gas emissions", *Journal of Operations Management*, Vol. 65 No. 2, pp. 93-113, doi: 10.1002/joom.1007.

Downie, J. and Stubbs, W. (2012), "Corporate carbon strategies and greenhouse gas emission assessments: the implications of Scope 3 emission factor selection: implications of Scope 3 emission factors", *Business Strategy and the Environment*, Vol. 21 No. 6, pp. 412-422, 6, doi: 10.1002/bse.1734.

Fabbe-Costes, N., Lechaptois, L. and Spring, M. (2020), "'The map is not the territory': a boundary objects perspective on supply chain mapping", *International Journal of Operations and Production Management*, Vol. 40 No. 9, pp. 1475-1497, doi: 10.1108/ijopm-12-2019-0828.

Feng, B., Zheng, M. and Shen, Y. (2024), "The effect of relational embeddedness on transparency in supply chain networks: the moderating role of digitalization", *International Journal of Operations and Production Management*, Vol. ahead-of-print No. ahead-of-print, doi: 10.1108/IJOPM-08-2023-0713.

Jia, M., Stevenson, M. and Hendry, L.C. (2021), "The boundary-spanning role of first-tier suppliers in sustainability-oriented supplier development initiatives", *International Journal of Operations and Production Management*, Vol. 41 No. 11, pp. 1633-1659, doi: 10.1108/IJOPM-12-2020-0856.

Johnsen, T.E., Caniato, F., Meqdadi, O. and Miandar, T. (2022), "Swimming against the tide: supplier bridging roles in diffusing sustainability upstream and downstream in supply networks", *International Journal of Operations and Production Management*, Vol. 42 No. 10, pp. 1605-1629, doi: 10.1108/IJOPM-02-2022-0110.

Lintukangas, K., Arminen, H., Kähkönen, A.-K. and Karttunen, E. (2022), "Determinants of supply chain engagement in carbon management", *Journal of Business Ethics*, Vol. 186 No. 1, pp. 87-104, doi: 10.1007/s10551-022-05199-7.

Marttinen, K. and Kähkönen, A.-K. (2022), "Fostering firms' ability to cascade sustainability through multi-tier supply chains: an investigation of power sources", *International Journal of Operations and Production Management*, Vol. 42 No. 8, pp. 1146-1172, doi: 10.1108/IJOPM-11-2021-0739.

Schmidt, M. (2009), "Carbon accounting and carbon footprint – more than just diced results?", *International Journal of Climate Change Strategies and Management*, Vol. 1 No. 1, pp. 19-30, doi: 10.1108/17568690910934372.

Schotter, A.P.J., Mudambi, R., Doz, Y.L. and Gaur, A. (2017), "Boundary spanning in global organizations: boundary spanning in global organizations", *Journal of Management Studies*, Vol. 54 No. 4, pp. 403-421, doi: 10.1111/joms.12256.

Soundararajan, V. and Brammer, S. (2018), "Developing country sub-supplier responses to social sustainability requirements of intermediaries: exploring the influence of framing on fairness perceptions and reciprocity", *Journal of Operations Management*, Vols 58-59 No. 1, pp. 42-58, doi: 10.1016/j.jom.2018.04.001.

Villena, V.H. and Dhanorkar, S. (2020), "How institutional pressures and managerial incentives elicit carbon transparency in global supply chains", *Journal of Operations Management*, Vol. 66 No. 6, pp. 697-734, doi: 10.1002/joom.1088.

World Resources Institute, WRI (2011), "Corporate value chain (Scope 3) accounting and reporting standard", available at: https://ghgprotocol.org/standards/scope-3-standard

Zhang, Q., Wong, C.W. and Klassen, R. (2024), "Carbon neutrality: operations management research opportunities", *Journal of Operations Management*, Vol. 70 No. 3, pp. 344-354, doi: 10.1002/joom.1303.

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