Hapres | Journal of Sustainability Research
sustainability.hapres.com

Article

Implications of Corporate Sustainability Reporting Directive (CSRD) to Company Network Collaboration

Leena Jokinen [1,*], Noora Harju [2], Kalle Kinnunen [2], Saara Hänninen [2]

[1] Finland Futures Research Centre, University of Turku, Turku 20500, Finland
[2] VTT Technical Research Centre of Finland Ltd, Espoo 02044, Finland; noora.harju@vtt.fi (NH); kalle.kinnunen@vtt.fi (KK); saara.hanninen@vtt.fi (SH)
* Correspondence: Leena Jokinen, Email: leena.jokinen@utu.fi.

ABSTRACT

This paper examines the collaborative dynamics within a European cruise shipbuilding company network, with a particular focus on sustainable development (SD) initiatives and compliance with the Corporate Sustainability Reporting Directive (CSRD). Shipbuilding is characterized by highly complex supplier networks, posing challenges for CSRD implementation, particularly in reporting indirect (Scope 3) greenhouse gas emissions (GHG) across the value chain. The mandatory inclusion of Scope 3 emissions requires companies to account for previously overlooked activities, posing significant resource demands due to the complexity of global supply chains. The findings highlight challenges in the preparedness of case companies for CSRD-compliant Scope 3 emissions reporting, particularly regarding necessary operational and collaborative changes. Network analysis reveals that the case company network is loosely connected, with limited interorganizational SD initiatives. While the lead company occupies a central position in advancing sustainability efforts, the overall network structure exhibits weak coordination. Despite a social framework that facilitates information exchange, the network demonstrates limited capacity to leverage collective resources for integrated reporting, development, and innovation. The findings suggest that a more open and balanced network structure, coupled with coordinated collaboration, is essential for effectively addressing CSRD requirements. Strengthening transparency, fostering commitment, and enhancing joint SD initiatives may provide strategic advantages and contribute to long-term business sustainability and renewal.

KEYWORDS: CSRD; sustainability reporting; social network analysis; marine industry

Received: 17 February 2025
Accepted: 24 March 2025
Published: 28 March 2025

INTRODUCTION

In light of the current climate and environmental crises, measures to reduce emissions and promote sustainability are urgently required. The

European Union wants to set an example and be the first climate-neutral continent in the world [1]. To tackle the crises, the European Green Deal was designed with the goal of reducing emissions by 55% by 2030. The Corporate Sustainability Reporting Directive (CSRD) [2] is part of the Green Deal. The CSRD replaces the previous Non-Financial Reporting Directive (NFRD) and requires a wider range of companies to report on sustainability while simultaneously tightening reporting requirements. The requirements will initially apply only to companies subject to the NFDR; subsequently, they will be phased in for large and small to medium-sized enterprises [2]. Notably, for the first time, companies are required to report their indirect greenhouse gas (GHG) emissions, i.e., Scope 3 emissions, while companies have reported their Scope 1 and 2 emissions already before [2].

Scope 1 emissions are direct emissions from sources owned or controlled by the company, such as those arising from combustion processes. Scope 2 emissions consist of indirect emissions resulting from the production of the purchased energy used by the company. Scope 3, on the other hand, encompasses all other indirect emissions occurring in the value chain of the reporting company, like emissions related to production of raw materials and treatment of waste treatment. Due to the complex and global nature of scope 3 GHG emissions and other sustainability-related topics, collaboration between companies in terms of sharing data is greatly needed [3]. Recent research on supply chain networks has highlighted the interdependence between companies and other actors within the network. In today's business environment, this interdependence is growing, impacting collaboration expectations across various domains, including sustainable development (SD) [4,5].

The growing flow of sustainability information throughout the network would enable improved business intelligence and more advanced decision-making based on sustainability information. In the context of CSRD reporting, being transparent and open to exchanging information can be beneficial. If everyone within a specified network would share data about their emissions, their partners could easily get information about their scope 3 emissions, which would make the reporting less time-consuming and more effortless for all companies involved [3,6].

Moreover, an increased amount of sustainability data is valuable for researchers to better understand and be able to help small and medium-sized companies transition to more sustainable practices [7]. Therefore, the importance of partnerships and collaboration within company networks is crucial from a sustainability point of view. Nonetheless, [8] recently concluded that the main challenges for the sustainability information flow between companies are complex value chains, lack of quality data and motivation, cost of creating and operating environmental data, and lack of common systems for automated information flow. There is a growing number of researches, especially, in supply chain management literature see e.g., [9,10], which highlights to importance of

linking SD collaboration to business performance. We emphasize the role of social network structure as an enabler to improve interorganizational collaboration effectiveness e.g., such as fulfilling reporting standards and reinforcing readiness to face environmental challenges. To tackle these challenges, more research is needed regarding how networked collaboration can be further developed in order to improve its effectiveness, competitiveness, and readiness to face environmental challenges.

The cruise shipbuilding industry is an impactful actor both economically and environmentally for coastal nations and globally. Shipyards are complex ecosystems in which the product, a cruise ship, is produced in partnership with a wide range of suppliers operating in the same yard. Cruise ships require a variety of work, including cabins and other interior installations, piping, heating, ventilation, air conditioning, state-of-the-art machinery, and services. These features make the maritime industry a good object for analyzing the corporate network and collaboration between the companies at a shipyard. The case network examined in this paper is a shipbuilding network that includes 11 companies located in Europe and is anchored directly or indirectly by a cruise shipbuilder that employs over 9500 employees.

Transparency through shared sustainability information also has an interest among cruise passengers who are increasingly aware of environmental aspects [11,12]. Improving sustainability in cruise shipbuilding requires a long-term perspective, as vessels have been built to be used for decades. There is a great desire for sustainability innovations that have a positive impact on efficient products and processes by reducing the use of raw materials, energy, and resources, as well as emissions during the operational phase. Modern SD emphasizes the importance of collaboration between companies, broad perspectives, and diverse ideas for improvement [13,14].

The aim of this study is (1) to demonstrate a case corporate network structure in multicompany collaborations seeking to collaborate and innovate on SD. In this paper, SD is examined particularly from the perspective of GHG emissions, but in terms of network analysis, the results can be expanded to cover other aspects of sustainability. The study also aims (2) to illuminate how scope 3 GHG reporting sets demands on collaboration and (3) to discuss possible hindrances or bottlenecks in the collaborative enhancement of SD.

LITERATURE REVIEW

CSRD and Scope 3 GHG Emissions

Scope 3 GHG emissions can form a major part of companies' total GHG emissions, which is problematic since, so far, they have mostly been neglected from GHG emission calculations [3]. The main reason for this exclusion is the complex nature of supply chains, which means that

companies do not have control of or access to the needed data [3,15]. Along with the CSRD, there is, for the first time, a clear need for companies to report their scope 3 emissions, which ultimately will require closer and more organized collaboration between companies [3].

The CSRD includes a variety of laws and actions to help tackle climate and environmental crises [1]. It became effective in January 2023, and the first companies are obliged to publish their sustainability reports for the financial year 2024 in 2025. The scope of the companies required to report will gradually expand. The NFRD was the first step toward obligatory sustainability, but it allowed choosing any reporting standard without the obligation of external assurance, which made reporting was very flexible, and companies could exclude any aspects they did not want to mention by justifying it [16,17]. The mandatory nature and stricter requirements of the CSRD are expected to accelerate the change toward more sustainable business-as-usual activities if companies manage to see the reporting requirements as an opportunity rather than a liability [18].

The aim of the CSRD is to facilitate and unify sustainability reporting while improving the comparability, quality, and reliability of the information. Furthermore, at the core of the CSRD are limited assurance of the sustainability data by an independent third party, availability of the information in a digital format, as well as the double materiality assessment. Double materiality means that the impacts of the company on the environment, economy, and society need to be reported, but how these create financial risks or opportunities for the company must also be assessed [2].

The CSRD is tightly linked with the European Sustainability Reporting Standards (ESRS) [19]. In short, the CSRD obliges companies to report according to certain requirements, whereas the ESRS sets out the framework and methodology for reporting. The ESRS defines a set of sustainability and societal standards that each company needs to go through and assess which ones are relevant to be included and reported under the CSRD [19]. Moreover, the goal of the ESRS is to tie sustainability closer to financial matters, for example, by connecting the use of natural resources or changes in supply chain to financial effects but also by requiring companies to use the same reporting year for sustainability reporting as for financial reporting [19]. Overall, the combination of the CSRD and the ESRS aims to achieve more transparent and sustainable growth for financial and economic activities.

Reporting scope 3 GHG emissions has been voluntary before, and reporting them has rarely been included in GHG emission calculations, as it is difficult to quantify scope 3 emissions due to a lack of information [18]. The CSRD, however, now requires all relevant scope 3 GHG emissions to be reported. Furthermore, the disclosure requirements for Climate Change (E1) by the ESRS determine more detailed requirements for quantifying scope 3 GHG emissions; for example, scope 3 inventory needs to be updated every three years or if major changes take place. These

emissions need to be reported according to the guidelines of the GHG Protocol—A Corporate Accounting and Reporting Standard for all significant scope 3 categories [19].

The GHG Protocol [20] is a framework developed by the World Resources Institute and the World Business Council for Sustainable Development to ensure consistent emission calculations across all companies. The GHG Protocol itself is not a binding or regulative standard but defines how companies should calculate and report the carbon footprint resulting directly or indirectly from their activities. It categorizes carbon emissions into three different scopes, of which Scope 3 is the broadest, covering all indirect emissions resulting from a company's activities, except for purchased energy. For example, emissions from the acquisition of raw materials or manufacturing processes used by the company's suppliers are categorized as scope 3 emissions [20]. There is also a separate guidance, [21], for quantifying scope 3 GHG emissions. It divides scope 3 GHG emissions into 15 subcategories, such as purchased goods and services, employee commuting, and investments; it defines the minimum boundaries for reporting the emissions for each category.

Networked Sustainable Development

Networks in an industrial business context have been studied for decades, and the topic has remained interesting both theoretically and practically, as networks evolve constantly and new perspectives, such as sustainability reporting, have emerged [22]. The network perspective on SD has gained prominence due to the increasing interdependencies among companies and the central role of information flow in overall reporting. Within business environments such as shipbuilding, collaboration is essential for addressing sustainability challenges, as companies often collaborate and are intertwined to solve sustainability challenges [23]. Company networks serve as a mechanism for collaborative agency, enabling the capture and transmission of information relevant to sustainability outcomes, including reporting [24]. Concrete collaborative actions in SD encompass supplier relationships, innovation partnerships, and knowledge transfer. These action categories are commonly discussed in the collaborative network literature, reflecting the complex reality of interaction, interdependence, embeddedness, connectedness, and business relationships within a networked business context [25,26].

Traditionally, the academic literature on SD in company networks has primarily focused on organizational collaborations within the supply chain, particularly upstream activities, which refer to the production and transportation of goods and services that a company purchases or uses. However, recent developments emphasize the need for a broader approach that integrates customers and other stakeholder groups into sustainability efforts [27]. Viewing SD as a comprehensive, systems-level phenomenon has prompted efforts to enhance the understanding of sustainability and its impacts within networks and their operational

dynamics [13]. However, business partner relationships in SD and interdependent reporting are emerging areas where new understanding can contribute to both operational tasks and strategic partnership relations.

Research on social relationships within sustainability partner networks highlights the pivotal role of lead partners in the chain [28,29]. These lead partners wield influence on selecting suppliers whose sustainability performance aligns with their policies and meets the criteria set by standard frameworks. Notably, the CRSD expands the responsibilities within company networks, as traditionally, lead partners have played a decisive role in defining sustainability and choosing evaluation methods [30]. Contemporary research on collaborative SD highlights equal dialog among stakeholders and stresses the central role of suppliers' independent, self-directed development [31]. The role of partner companies in corporate networks underlies systematic change, such as changed sustainability reporting requirements, and partner networks are seen as a relevant structure for SD, as they are the sources and means of enhancing knowledge flow and communication [32].

Research Questions and Methodology

Interorganizational collaboration, in the form of horizontal networks, plays a significant role in SD in networked business environments and consequently processes the optimization of information flow [14]. Innovative development activities are distributed widely within networks involving multiple network dimensions, such as structure and connections between nodes, the direction of ties, and the content/topic that is shared [33]. We have focused on the transmission of knowledge and information connected to organizational or technological collaboration, which facilitates innovative and novel perspectives on SD. In practice, these types of actions involve deliberate networking and the formation of professional ties that extend beyond organizations' borders, as well as interact across disciplines [34].

Our claim is that improvements in calculations and reporting of scope 3 GHG emissions cannot and will not contribute to any significant degree to improving and enhancing SD progress as long as the performance measures remain disconnected from collaboration actions. Therefore, we have analyzed collaboration ties and cooperative tasks, such as supplier roles and innovation partnerships on SD across organizational boundaries. Connections and interdependence among actors are the focus of this study to see how connections are established and how possible hindrances are described in practice.

Research Questions

1. What are the biggest challenges in fulfilling the reporting requirements regarding scope 3 GHG emissions?

2. Does the CSRD encourage collaboration between companies to fulfill the reporting requirements, and if so, in what form?
3. What kinds of collaboration ties do the case companies have on sustainability development and innovation?

(a) What is the overall structure and size of the case network on SD?

(b) Which case companies have central positions in the case network on SD?

(c) Do the case companies collaborate on sustainability topics?

(d) If any, what are the obstacles/hindrances companies face regarding collaboration with their SD partnerships?

Mixed Methods Approach

The study applied a mixed-method design [35] using complementary quantitative and qualitative data collection and analysis techniques. The study adopted a mixed methods approach in which the CSRD and the GHG Protocol formed a setting to analyze collaboration ties in the case network. The CRSD and GHG Protocol analysis on scope 3 emissions focused on identifying relevant aspects to the context of the study. Key aspects of carbon footprint calculations and emissions across the value chain were analyzed against the relevant factors related to scope 3 emissions in both the CSRD and GHG Protocol. Existing literature on CSRD was reviewed to identify and explain current scope of research and the challenges of the CSRD. A network approach using social network analysis (SNA) was selected to describe the case company's network structure and to identify the central actors in SD and innovation. SNA was enriched with other contextual data to make network data more applicable and accessible.

The SNA was the main quantitative method integrated with the literature review as the qualitative method. In addition to traditional statistical analyzes SNA is appropriate for analysing relational data and quantifying structural patterns and relationships, it is a statistical method to analyze actors, and relationships/interactions. Network metrics such as density, closeness and centrality are quantitative metrics. The small size of the nodes in SNA is appropriate when describing the complete network [36]. The study employed SNA specially to identify key actors of the partner company network revealing network structure and those who have most influence in SD. Using SNA in this study add means to discuss dynamics of network structures, and knowledge flow, see e.g., [37] for SNA use in mixed-method research. A network survey was conducted as part of a multipartner consortium business academia project running from 2023 to 2025. The project involved 11 partner companies. The survey, conducted in 2023, provided the majority of the data needed. The respondents included 12 individuals (one company had two respondents jointly) who were project actors engaged in sustainability issues within their respective organizations. Notably, the response rate for the network survey was 100%.

The survey explored various network dimensions related to SD. These dimensions included connection types (e.g., supplier, innovation partner, or both), connection direction (one-sided or reciprocal), and collaboration types for innovation (such as ongoing cooperation, periodic experiments, seeking collaboration opportunities, general-level discussions, or no collaboration on innovation). Additionally, the respondents were asked about potential obstacles to SD innovation, such as time constraints, personnel limitations, lack of know-how, technology, or tools.

SNA metrics were conducted using KUMU software [38]. We used a whole-network approach to describe the network structure. The overall structure of the network was described by determining the density of connections and relationships between organizations, in addition to actor centrality.

RESULTS

CSRD and Reporting Scope 3 GHG Emissions

According to the reviewed literature (see literature review) reporting scope 1 and scope 2 GHG emissions is relatively well established and straightforward since all the information can be extracted from a company's own operations. However, scope 3 emissions can form a major part of a company's GHG emissions [19], especially in the case of large companies, which makes including them in emission calculations very important for the sake of transparency and understanding of the context.

According to the ESRS E1 Climate Change [19], companies need to identify all the relevant scope 3 categories, defined in the GHG Protocol, where emissions occur in their activities. Both upstream and downstream emissions must be included. GHG emissions are to be reported as carbon dioxide equivalents for each scope 3 emission category separately. Additionally, a plan on how to reduce emissions in each scope should take place with the addition of calculating a reference target value that is aligned with the goal of 1.5 ℃ separately for each scope. Furthermore, it should be noted that the ESRS does not allow any emission removals, carbon credits, or GHG allowances to be included in scope 3 GHG emissions. To ensure transparency, it is also required to report the share of primary data from suppliers and other actors in the value chain used for the scope 3 emission calculations.

The research question 1. What are the biggest challenges in fulfilling the reporting requirements regarding scope 3 GHG emissions, we state that overall, including scope 3 GHG emissions in sustainability reporting increases the workload for companies significantly. Since the CSRD is new and companies are currently preparing to fulfill all of its requirements, it cannot be said yet how well companies will be able to report their scope 3 GHG emissions. Nevertheless, it is clear that working on scope 3 emissions alone is not very feasible since scope 3 emissions cover the whole value chain, meaning activities that are not directly linked to companies' own

operations. Therefore, the main issue for the CSRD reporting regarding scope 3 GHG emissions is data collection and quality of data. It is always desirable to get primary data, as they enable more accurate results, although it is known that for some parts, using secondary data with proxies or industry averages can be necessary. The problem with relying too much on secondary data is that it does not reflect the reality of the desired processes. For instance, if a supplier has invested heavily to make its practices less energy-intensive, the emission calculation with secondary data cannot show this improvement in the emission calculations. On the contrary, using process- or facility-specific data allows for the incorporation of such information, potentially leading to lower GHG emissions in calculations.

The research question 2: Does the CSRD encourage collaboration between companies to fulfil the reporting requirements, and if so, in what form, we state that, using primary data should be desirable and the key to being able to use primary data from suppliers is collaboration. The CSRD itself does not urge or encourage companies to cooperate and share sustainability information, although it is a central issue for companies to be able to report their scope 3 GHG emissions accurately. Most likely the CSRD will silently push companies to work together to get the needed information from their suppliers. Nevertheless, there will probably be differences for the degree of collaboration based on how ambitious companies are to collect primary data, since companies with higher ambition level need more detailed information, which in turn might "force" them to work more tightly together with their suppliers. Companies have different strategies to have their suppliers provide the data they need to fulfil the CSRD needs. For example, they can make responsibility as a prerequisite for all procurements. Under these circumstances, the supplier network must be ready to provide data to continue the collaboration. Collaboration can benefit companies in ways other than just sustainability reporting. By engaging at a sectorial or cross-sectorial level, companies can change the common approaches and practices shared by all members within the industry and along supply chains. The first step for meaningful collaboration would be to gain a better understanding of the actors within the ecosystem and to gain a better understanding of their interdependencies. To maximize the benefits and outreach of their sustainability strategies, the collaboration network could create transparency, share best practices, define common rules, and set standards. This, in return, could help optimize their operations so that both environmental and economic benefits are created for the participants. More frequent cooperation between companies also forms a trust-based relationship in which information can be shared more freely. Furthermore, continuous digitalization enables the creation of tools for improved data collection and analysis, information sharing, and knowledge distribution within the shipbuilding network. Accelerating the deployment of digital concepts linked with sustainability frameworks

leads to a more sustainable and competitive industrial ecosystem that cannot be achieved individually by companies.

Although the CSRD does not literally mandate collaboration, it indirectly guides towards it by requiring reporting. A company needs data for reporting its Scope 3 emissions, which can be based either on information received from network members or on proxies. The most accurate data can be acquired directly from network members, as it corresponds precisely to the goods and services used by the company. Due to that, every company should strive to increase the proportion of information obtained directly from the network. As a result, the amount of sustainability information flowing through the network can be assumed to increase, which enables improved business intelligence and more advanced decision-making. Additionally, disclosing and sharing information on GHG emissions can increase stakeholders' trust in the company. However, realizing this might require companies to change their operations, supply chain management and product life cycle assessments in a way that enables more accurately measuring emissions and properly reducing them. Understanding one's scope 3 emissions on a more comprehensive level can help identify and manage risks related to climate change. Incorporating sustainability aspects—whether environmental, social, or otherwise ethically loaded in nature—into the planning and design processes is necessary when discussing complex systems, such as cruise ships. This method of "building sustainability in" means that sustainability and its added information requirements are incorporated as a fundamental key component of the shipyard network ecosystem by improving information flows, clarifying plans and designs, internalizing future expectations, and enhancing the availability of all essential information during the entire life cycle of the ship.

Case Network Structure and Features

The network represented the case companies' collaborations with other entities, including 120 companies and organizations. Of these, 11 were case companies, while the rest included other companies, research institutions, and non-governmental organizations. The results from SNA produced intuitive visualizations to reveal the overall structures of the network and to show possible partnerships within the case network.

The entire network studied consisted of 120 companies, with 127 connections among them. The size of the case company network was analyzed by the in- and out-degrees of connecting ties. In- and out-degrees indicate the number of incoming and outgoing ties, which are presented in Table 1. Companies that have multiple ties have an influence because they share and receive knowledge and information from other actors. The lead company had, by far, the largest number of incoming and outgoing ties. In addition, four other case companies had more than 10 ties, while the other companies clearly had fewer collaboration ties. Two large companies had multiple collaboration ties, but some of the first-tier

supplier companies also had relatively many collaboration ties. These large companies have several suppliers on which they depend.

Table 1. Size of the case company network by in- and out-degrees.

#Company	In-degree	Out-degree
#1	37	22
#2	13	11
#3	18	13
#4	10	10
#5	6	7
#6	8	7
#7	6	7
#8	2	6
#9	14	11
#10	3	8
#11	2	3

To analyze the network structure, both density and centrality were examined. Density measures revealed the extent of connections within the network: a density value of 1 indicated that every company was interconnected, while a value of 0 meant no connections existed between companies. Centrality measures, ranging from 1 to 0, indicated the direction of the connections. A centrality value of 1 suggested that all ties were directed toward a single central company, whereas 0 indicated equal connections among all companies, resulting in a decentralized network.

The density measures showed all possible connections: density value 1 meant that every company was connected to each other, and density value 0 meant that none of the companies were connected to any other company. Centrality measures show the direction of connections; different centrality values vary between 1–0. Centrality value 1 indicated a situation in which all connections were targeted to one company that was the most central, and 0 described conditions in which every company shared the same number of connections describing a network that was the most decentralized. Additionally, the case company network exhibited directed ties, reflecting one-sided relationships or reciprocity. Reciprocity measures gauged the likelihood of companies having an equal number of connections in both directions.

A slight majority of ties (with a reciprocity value of 0.62) were reported as reciprocal, indicating that SD initiatives involved collaborative actions among companies. The overall structure of the case network (see Figure 1) resembles a circle. The circular structure suggests recurring interactions and mutual relationships, reflecting feedback loops and network stability. Notably, four partner companies formed a complete cycle, including the lead partner and three first-tier suppliers. Nevertheless, the network visualization revealed an incomplete circle,

with three partner companies not connected to this cycle of ties with other company partners.

The network density was remarkably low (density measure of 0.01). Overall, the case companies' SD networks exhibited significant dispersion, implying that the case network itself did not play a central role in SD development. Instead, development actions primarily occurred outside the case network.

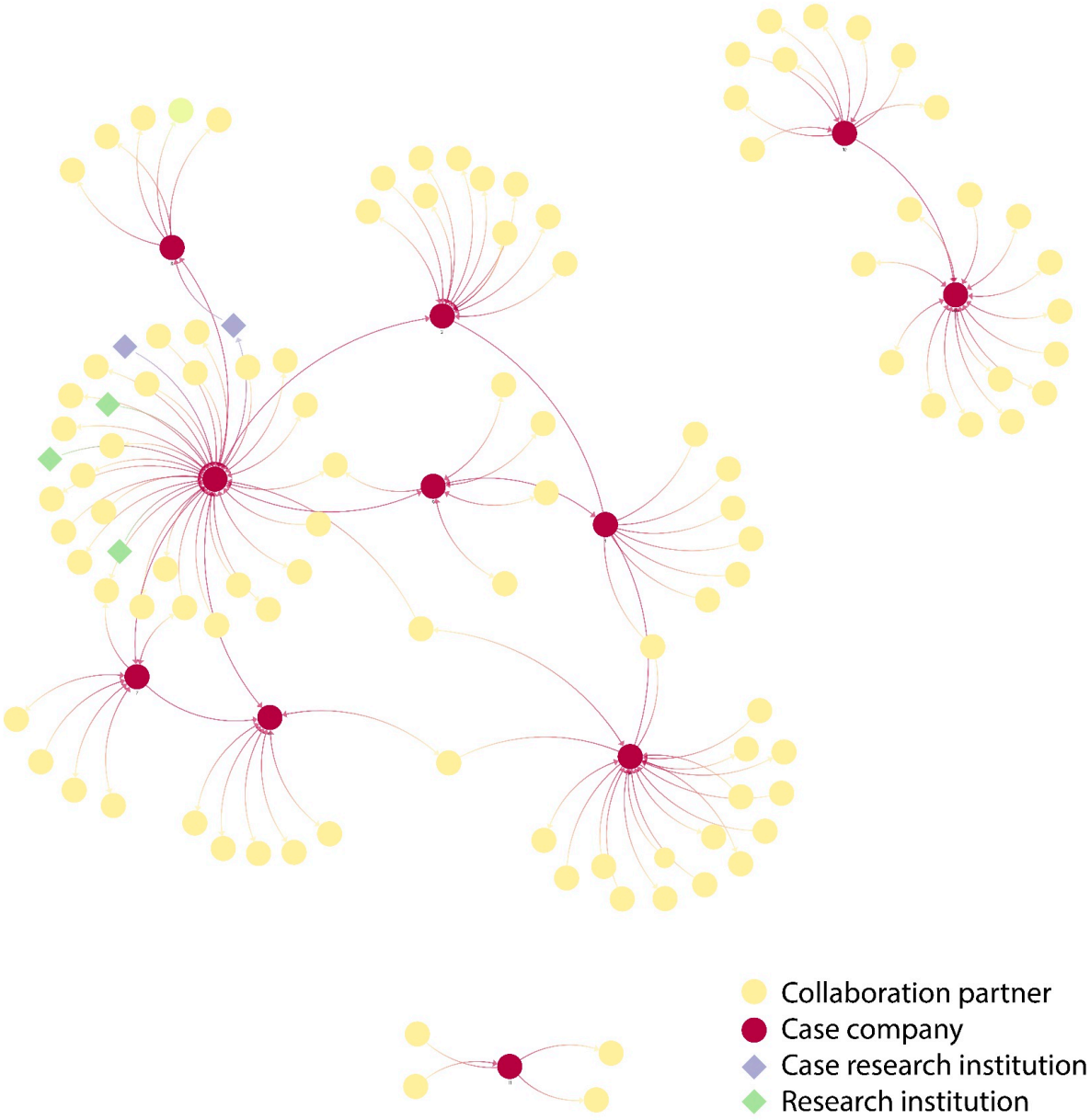

Figure 1. The overall structure of the case network.

To conclude, for Research Question 3a, concerning the overall network structure for the SD, it was found that the case network structure was loose, with low density among the case companies. This structure suggests

that SD initiatives are directed toward companies beyond the immediate case partners. At the whole network level, there are not many shared development actions at the point of data-gathering time.

Central companies within the case network

Several centrality metrics were used to obtain a versatile and accurate picture of the companies' ties (see Table 2). Specifically, the centrality of each company within the network was the focus, examining degree centrality, betweenness, closeness, and eigenvector metrics. These metrics shed light on the ties between actors—in this case, case companies [39]. Actor centrality was analyzed by the degree and heterogeneity of the ties. Additionally, outsider types based on centrality and external connections were identified. The analysis extended beyond case-specific actions to include any collaborations related to SD.

Degree centrality, which quantifies the number of direct connections a company has, enabled the assessment of a company's role and position (i.e., the direct relational activity of the company in the network). The lead company exhibited the highest degree of centrality, indicating its extensive relationships with other firms. Notably, first-tier supplier companies with numerous incoming and outgoing ties also held central positions. The degree centrality values ranged from 4 to 37.

Betweenness centrality, which considers indirect connections, reveals information brokers—companies that lie on the shortest paths between others and play the most important role in controlling the flow of information in the network. The lead company had the highest degree of betweenness, while one large company had a relatively low degree of betweenness. Interestingly, a highly central first-tier supplier had one of the lowest betweenness values. Overall, the lead company acted as an information broker, while others had lower betweenness values, and one company remained isolated within the case network.

Next, closeness centrality, which indicates the minimal length of an indirect path, was explored to show the independence of a company from the controlling actions of others within the network. This measure is meaningful, especially in this case, as many of the case companies had a supplier role in relation to the lead company. Closeness values were very evenly distributed, with the lead company having a slightly higher closeness, while the three first-tier suppliers had clearly lower values.

Finally, eigenvector centrality assessed how well-connected companies were to other influential elements. Companies with high eigenvector centrality are the leaders of the network, and these companies have the strongest local influence on SD. Surprisingly, all the case companies exhibited low eigenvector values, suggesting a lack of highly influential groups. Instead, the network appeared decentralized, with each company working relatively independently on SD. Even the lead company did not form an exclusive insider circle within the case network.

Table 2. Centrality degrees in the company network.

#Company	Centrality degree	Betweenness degree	Closeness degree	Eigenvector value
#1	37	0.286	0.350	0.115
#2	13	0.125	0.296	0.046
#3	19	0.125	0.274	0.014
#4	10	0.120	0.278	0.026
#5	7	0.072	0.272	0.033
#6	8	0.071	0.259	0.038
#7	8	0.043	0.256	0.027
#8	7	0.030	0.239	0.027
#9	14	0.013	0.092	0.000
#10	10	0.004	0.113	0.000
#11	4	0.000	0.000	0.000

In addressing Research Question 3b—which case companies occupy central positions within the case network?—it was found that the lead company plays a pivotal role across various centrality metrics. Notably, one case company remains entirely isolated, lacking connections with other case participants. This isolated company forms a small, self-contained network. Overall, the case network exhibits low centrality, indicating that the case companies collaborate and pursue sustainability initiatives beyond the confines of the case-specific network (see Figure 2). The structure of the case partner company network resembles a chain characterized by connections primarily between the two other case companies, forming a linear sequence. Limited interaction was observed within the case network, where information flow was constrained between companies and their specific SD development partners. One of the respondents described the status of collaboration in the case company network in the following way: “Every company has its own projects, we are not aware how we could work together [with the case companies]. Projects are scattered and not easily combined”.

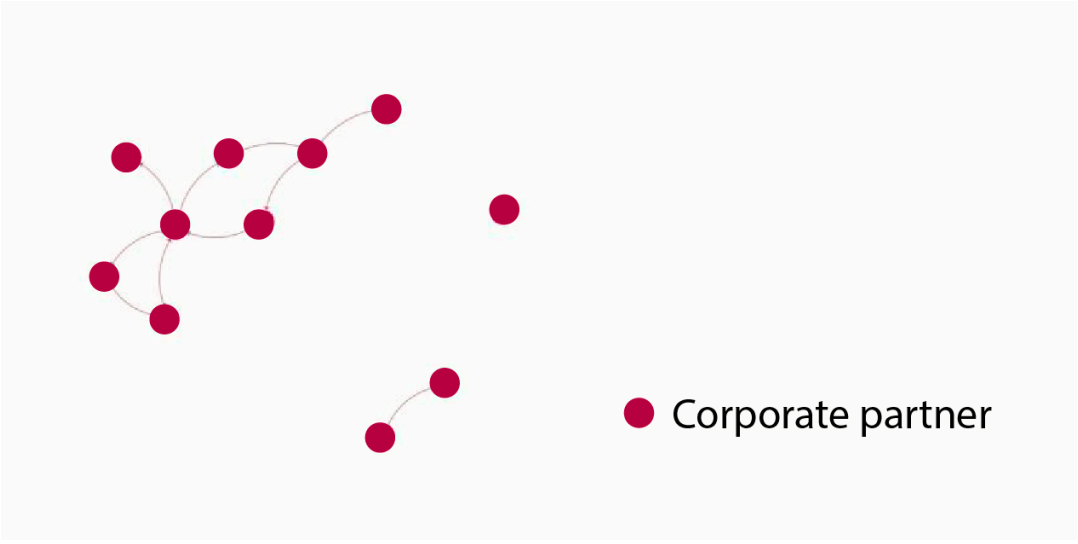

Figure 2. The collaboration network of the case companies.

Collaboration Modes

The predominant mode of collaboration involved conducting targeted experiments. These experiments focused on specific issues, such as identifying more sustainable materials and methods. Notably, the lead case company engaged with numerous other companies (a total of 23) in these experiments, actively seeking new collaboration opportunities with several (11) of them. However, when it came to general discussions on SD, the lead company reported interactions with only a few (4) partners. Upon analyzing the case partner companies beyond the lead organization, a different pattern was observed, as general discussions turned out to be the most common form of collaboration. These case partners actively explored new opportunities with a couple of other companies. Table 3 presents the different collaboration modes of the case network, including collaboration partners other than the case company partners.

Table 3. Number of collaboration partners in different modes of collaboration.

#Company	Concrete experiments	General discussions	Seeking opportunities
#1	23	4	11
#2	2	-	-
#3	-	14	1
#4	-	-	-
#5	-	-	-
#6	2	6	3
#7	3	-	1
#8	3	1	3
#9	4	9	-
#10	9	-	2
#11	-	-	-
Total	46	34	21

To answer whether the case companies engage in collaborative efforts related to SD (Research Question 3c), it was found out that the collaboration ties within the case network are notably scarce. Overall, the case companies maintain only a limited number of collaboration partnerships, primarily centered around general discussions concerning SD. Notably, the lead case company stands out with the highest number of collaboration partners and a greater emphasis on operational actions related to SD compared to the other case companies.

Obstacles and Hindrances

In the context of SD, collaboration obstacles and hindrances within each partnership maintained by the case company were investigated (see Table 4). It is important to note that the numbers in Table 4 encompass all collaboration partners, not exclusively those associated with the case companies. The most prevalent hindrance encountered across SD

partnerships was a lack of time. Nearly all the case companies (except two) cited time constraints as a significant challenge. Interestingly, two case companies reported no specific obstacles or hindrances related to SD. Technology emerged as a significant obstacle, particularly for the lead case company. Slow technological development hindered progress in two specific partnerships. Additionally, the scarcity of personnel was mentioned by two case companies, while know-how was a common hindrance across various partnerships. Notably, the lead case company faced the highest number of obstacles and hindrances in its SD collaborations.

Table 4. Number of partnerships where obstacles/hindrances were reported.

#Company	Lack of technology	Lack of personnel	Lack of time	Lack of know-how
#1	10	8	12	1
#2	2	-	-	-
#3	-	-	15	3
#4	-	-	-	-
#5	-	-	6	-
#6	1	-	1	5
#7	-	-	-	-
#8	2	1	14	3
#9	3	-	7	4
#10	-	-	13	-
#11	-	-	2	-
Total	18	9	70	16

To respond Research Question 3d—if any, what are the obstacles/hindrances companies face regarding collaboration with their SD partnerships?—we conclude that most of the case companies identified obstacles or hindrances with their partners on SD. The most commonly mentioned obstacle/hindrance was the lack of time to collaborate on SD, which was identified by most of the case companies.

CONCLUSIONS AND DISCUSSION

The findings raise questions on the level of preparedness for CSRD reporting on scope 3 emissions and, especially, on what profound changes are to be expected in the case companies' operations and collaboration regarding sustainability. The shift to mandatory scope 3 GHG emissions reporting forces companies to widen their emission reporting to activities that are relevant to their operations but could be ignored before. Reporting and quantifying scope 3 emissions can be very resource-intensive, as global supply chains are long and complex. Accordingly, it is important to start the work on that well in advance and, depending on the possibilities, try to establish customs to ease reporting in the following years. Although the CSRD does not specifically encourage companies to

cooperate on data collection for the emission calculations, it is at the core of the scope 3 emissions calculations. In the beginning, additional effort might be needed to make operational changes, e.g., in supply chain management, to measure emissions accurately. Once comprehensive information on scope 3 emissions can be gathered, it can also be used to manage climate-related risks. Disclosing and sharing GHG data can build stakeholders' trust and the closer the collaboration is established throughout the company's value chain, the easier it is to agree on common practices and to share and automatize information flows within the collaboration network. In the future, in extreme cases where collaboration is not possible with partners, companies could even need to set up reporting their GHG emissions as a condition for partnerships in order to ensure they can comply with the reporting requirements.

The key findings indicate that the SD network is relatively small, with some case companies having only a few partners for collaboration. The overall network structure is loose, with a low density between the case companies. Notably, the lead company plays a central role in SD collaboration. The case network resembles a chain structure, suggesting limited interaction and information flow between the case companies. The most common modes of sustainability collaboration are general discussions and operational experiments, which are driven by the lead case company. What comes to obstacles and hindrances, interestingly, despite commonly reported time constraints, a lack of personnel was also mentioned by three case companies. This apparent contradiction suggests that increasing human resources could potentially mitigate the time-related obstacles hindering sustainability collaboration.

The overall picture of the current situation shows a sparse network in which SD topics are scattered to one-to-one company discussions or separate experiments. Network capital could be more effectively used for coordinated development programs, wider knowledge sharing, and maybe even sharing human resources between companies. This kind of collaborative development would decrease dependence on the lead company's role in sustainability issues and allow for more open innovation within the supply chain. The business-academia project in this case seemed to offer a limited number of development programs, but anyhow, the meaning of the joint project as an idea-sharing platform for future-focused development should not be underestimated.

The interorganizational SD reflects the complexity and interwovenness of the topic. Mechanisms to meet growing sustainability standards are a relatively new area of research, as the experiences and data drawn from them are currently only emerging.

Although there are a growing number of studies with large numeric datasets, the complexity of the phenomenon makes it very difficult to understand how companies handle sustainable transformation—in this case, the assessment and reporting of processes and structures—and what

implications this will have for companies' economic and environmental performances.

The case network studied here is a small part of the industrial ecosystem formed around the lead case company. Our results show the circumstances within the case network, but the results of this study may not apply to the entire supplier network. Our assumption is that the case companies are dynamic and could allocate resources to SD collaboration.

Future avenues for further research include, for example, how to organize effective operational development and innovation in networked SD. Supplier companies' individual SD networks should be further studied to reflect how SD collaboration is composed downstream and whether it is as centralized as the case network studied here. More understanding is needed on the operational efficiency of SD; for example, how automation can be effectively harvested, utilized, and extended over company limits to achieve evidence-based information sharing. To ensure fluent information flow between companies, future research should focus on data security and tackle other legal aspects. The imminent further research needs to point to the evaluation of preparation level and capacity levels in companies to understand interlinked SD and the meaning of information sharing as a business value.

DATA AVAILABILITY

The dataset of the study is available from the authors upon reasonable request.

AUTHOR CONTRIBUTIONS

Literature Review LJ, NH, KK; Methodology, LJ, NH; Analysis, LJ; Writing—Original Draft Preparation, LJ, NH; Writing—Review & Editing, KK, SH; Visualization, LJ, Project Administration, SH.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

REFERENCES

1. European Commission. The European Green Deal. Available from: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en. Accessed on 16 Jul 2024.
2. European Union. Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 Amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as Regards Corporate Sustainability Reporting. Available from: https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32022L2464. Accessed on 24 Mar 2025.
3. Stenzel A, Waichman I. Supply-chain data sharing for Scope 3 emissions. NPJ Clim Action. 2023;2(1):7.

4. Carnovale S, Rogers DS, Yeniyurt S. Broadening the perspective of supply chain finance: The performance impacts of network power and cohesion. J Purch Supply Manag. 2019;25(2):134-45.
5. Stål HI, Riumkin I, Bengtsson M. Business models for sustainability and firms' external relationships—a systematic literature review with propositions and research agenda. Bus Strat Environ. 2023;32(6):3887-901.
6. Fu Q, Abdul Rahman AA, Jiang H, Abbas J, Comite U. Sustainable supply chain and business performance: The impact of strategy, network design, information systems, and organizational structure. Sustainability. 2022;14(3):1080.
7. Hummel K, Jobst D. An overview of corporate sustainability reporting legislation in the European Union. Account Eur. 2024;21(3):320-55.
8. Heimo O, Vainio-Kaila T, Kinnunen K, Hänninen S, Helle S, Majaniemi S, et al. The flow of sustainability information through interorganisational shipbuilding ecosystem. Available from: https://openaccess.cms-conferences.org/publications/book/978-1-964867-22-9/article/978-1-964867-22-9_11. Accessed on 24 Mar 2025.
9. Guandalini I. Sustainability through digital transformation: A systematic literature review for research guidance. J Bus Res. 2022;148:456-71.
10. Negri M, Cagno E, Colicchia C, Sarkis J. Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. Bus Strat Environ. 2021;30(7):2858-86.
11. Papathanassis A. Cruise tourism research: A horizon 2050 paper. Tour Rev. 2025;80(1):165-80.
12. Kulkov I, Hellström M, Tsvetkova A, Malmberg J. Sustainable cruise tourism: Systematic literature review and future research areas. Sustainability. 2023;15(10):8335.
13. Di Vaio A, Varriale L, Lekakou M, Stefanidaki E. Cruise and container shipping companies: A comparative analysis of sustainable development goals through environmental sustainability disclosure. Marit Policy Manag. 2021;48(2):184-212.
14. Harrison D, Prenkert F, Hasche N, Carlborg P. Business networks and sustainability: Past, present and future. Ind Mark Manag. 2023;111:A10-7.
15. Mejia C, Kajikawa Y. Estimating Scope 3 greenhouse gas emissions through the shareholder network of publicly traded firms. Sustain Sci. 2024;19(4):1409-25.
16. Kinderman D. The challenges of upward regulatory harmonization: The case of sustainability reporting in the European Union. Regul Gov. 2020;14(4):674-97.
17. Aguado-Correa F, De La Vega-Jiménez JJ, López-Jiménez JM, Padilla-Garrido N, Rabadán-Martín I. Evaluation of non-financial information and its contribution to advancing the sustainable development goals within the Spanish banking sector. Eur Res Manag Bus Econ. 2023;29(1):100211.
18. Aureli S, Del Baldo M, Lombardi R, Nappo F. Nonfinancial reporting regulation and challenges in sustainability disclosure and corporate governance practices. Bus Strat Environ. 2020;29(6):2392-403.

19. EFRAG (European Financial Reporting Advisory Group). ESRS E1 Climate Change. Available from: https://www.efrag.org/sites/default/files/media/document/2024-08/ESRS%20E1%20Delegated-act-2023-5303-annex-1_en.pdf. Accessed on 24 Mar 2025.
20. World Business Council for Sustainable Development, World Resources Institute. Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. Available from: https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf. Accessed on 24 Mar 2025.
21. World Resources Institute. Greenhouse Gas Protocol: Corporate Value Chain (Scope 3) Accounting and Reporting Standard. Available from: https://ghgprotocol.org/sites/default/files/standards/Corporate-Value-Chain-Accounting-Reporing-Standard_041613_2.pdf. Accessed on 24 Mar 2025.
22. Fahimnia B, Sarkis J, Davarzani H. Green supply chain management: A review and bibliometric analysis. Int J Prod Econ. 2015;162:101-14.
23. Rohrbeck R, Schwarz JO. The value contribution of strategic foresight: Insights from an empirical study of large European companies. Technol Forecast Soc Change. 2013;80(8):1593-606.
24. Sudusinghe JI, Seuring S. Supply chain collaboration and sustainability performance in circular economy: A systematic literature review. Int J Prod Econ. 2022;245:108402.
25. Brandenburg M, Gruchmann T, Oelze N. Sustainable supply chain management—a conceptual framework and future research perspectives. Sustainability. 2019;11(24):7239.
26. Lee CY, Chong HY, Liao PC, Wang X. Critical review of social network analysis applications in complex project management. J Manag Eng. 2018;34(2):04017061.
27. Dyllick T, Muff K. Clarifying the meaning of sustainable business: Introducing a typology from business-as-usual to true business sustainability. Organ Environ. 2016;29(2):156-74.
28. Ben Arfi W, Hikkerova L, Sahut JM. External knowledge sources, green innovation and performance. Technol Forecast Soc Change. 2018;129:210-20.
29. Gong Y, Jia F, Brown S, Koh L. Supply chain learning of sustainability in multi-tier supply chains: A resource orchestration perspective. Int J Oper Prod Manag. 2018;38(4):1061-90.
30. Klassen RD. Collaboration and evaluation in the supply chain: The impact on plant-level environmental investment. Prod Oper Manag. 2003;12(3):336-52.
31. Monaghan S, Lavelle J, Gunnigle P. Mapping networks: Exploring the utility of social network analysis in management research and practice. J Bus Res. 2017;76:136-44.
32. De Haan FJ, Rotmans J. A proposed theoretical framework for actors in transformative change. Technol Forecast Soc Change. 2018;128:275-86.
33. Wulf A, Butel L. Knowledge sharing and collaborative relationships in business ecosystems and networks: A definition and a demarcation. Ind Manag Data Syst. 2017;117(7):1407-25.

34. Rupo D, Perano M, Centorrino G, Vargas-Sanchez A. A framework based on sustainability, open innovation, and value cocreation paradigms—a case in an Italian maritime cluster. Sustainability. 2018;10(3):729.
35. Creswell JW, Clark VLP. Designing and Conducting Mixed Methods Research. Thousand Oaks (US): SAGE Publications; 2007.
36. Borgatti SP, Mehra A, Brass DJ, Labianca G. Network Analysis in the Social Sciences. Science. 2009;323(5916):892–95.
37. Froehlich DE, Rehm M, Rienties B. Mixed Methods Social Network Analysis: Theories and Methodologies in Learning and Education. 1st ed. Milton (Canada): Routledge; 2019.
38. Mohr J, Mohr R. Kumu. Available from: https://kumu.io/. Accessed on 24 Mar 2025.
39. Marsden PV. Egocentric and sociocentric measures of network centrality. Soc Networks. 2002;24(4):407-22.

How to cite this article:
Jokinen L, Harju N, Kinnunen K, Hänninen S. Implications of Corporate Sustainability Reporting Directive (CSRD) to Company Network Collaboration. J Sustain Res. 2025;7(1):e250018. https://doi.org/10.20900/jsr20250018