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The impact of greenwashing on sustainability through green supply chain integration: the moderating role of information sharing

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Abstract
This study investigates the impact of greenwashing on sustainability through the effects of green supply chain integration, considering the moderating role of information sharing. The research proposes a theoretical model tested using structural equation modeling (SEM) and a multigroup analysis to understand the moderating role of information sharing. Hypotheses were tested in a sample of 312 key respondents from Portuguese buying firms that perceived greenwashing practices in their suppliers. Results indicate that greenwashing negatively affects green supply chain integration, while green supply chain integration enhances sustainability performance. This effect is stronger when information-sharing pressure is higher. The study underscores the importance of actively addressing greenwashing to improve green supply chain integration, especially when sustainability is the desired outcome. The research's novelty lies in its contributions to building sustainable companies through green supply chain integration, trust, and partner communication.

Keywords Greenwashing · Green supply chain integration · Sustainability · Information sharing

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1 Introduction

Researchers and practitioners are increasingly paying attention to environmental, social, and economic concerns in response to market, customer, government, and other stakeholder pressures (Cancela et al., 2020; Elkington, 1998; Hussain et al., 2018b; Zhang & Zhu, 2019). The literature has shown that socially responsible companies achieve reputational gains, improve productivity, attract better employees, and successfully retain them in the company, while also increasing sales, customer loyalty, and profits (e.g., Javed et al., 2020).

In this context, recent studies have considered several drivers of social responsibility to explain the development of sustainability (Fu et al., 2020; Javed et al., 2020; Liao & Zhang, 2020; Pasricha et al., 2018). Other studies have assessed the role of specific stakeholder groups, such as employees, customers, and government, in driving sustainable practices in companies (Mallén Broch et al., 2020; Yu et al., 2020). Recent literature reveals that companies may improve sustainability practices in response to stakeholder pressures (Jakhar et al., 2020; Singh et al., 2022; Zhang & Zhu, 2019).

However, due to the pressure to develop a positive image and project an environmentally friendly reputation (Yang et al., 2020a,b) organizations might be tempted to lie, deceive, or exaggerate their environmental activities (Brouwer, 2016). In other words, they might be tempted to practice greenwashing, i.e., they pretend to be sustainable, but are not (Ferrón-Vílchez et al., 2021). The systematic adoption of greenwashing practices damages reputation, increases customer skepticism, and reduces trust in the company's corporate social responsibility (CSR) intentions (Santos et al., 2023b; Torelli et al., 2020). Nevertheless, the study of the effects of greenwashing and its influence on companies' sustainability practices is scarce (Santos et al., 2023a; Shi et al., 2020).

The concept of greenwashing lacks a universally accepted definition (Lyon & Montgomery, 2015). Nevertheless, it is widely agreed upon that greenwashing encompasses the act of misinforming or deceiving stakeholders in relation to a company's subpar environmental practices or the environmental benefits of their products or services, and the positive communication thereof (Delmas & Burbano, 2011). These behaviors can be categorized into two primary dimensions: execution (pertaining to the firm or product) and claim (likewise pertaining to the firm or product) (de Freitas Netto et al., 2020). Greenwashing, however, is characterized by deliberate and misleading decisions regarding the disclosure of information (De Jong et al., 2018), with the intent of creating an impression that a company's activities or products are environmentally friendly when, in reality, they are not. The central objective of such deceptive tactics is to project an image or reputation of sustainability and environmental responsibility (Yang et al., 2020a,b). Nonetheless, it is important to note that these unethical and irresponsible practices do not confer any competitive advantage (De Jong et al., 2018).

Prior research has predominantly concentrated on examining the impact of greenwashing on customers and employees (Ahmad & Zhang, 2020; Guerreiro & Pacheco, 2021; Hameed et al., 2021; Miao et al., 2023). However, a dearth of studies has been observed regarding the phenomenon of greenwashing in the context of procurement and supply chain management (Blome et al., 2017; Fahim & Mahadi, 2022; Pizzetti et al., 2021; Yang et al., 2020a,b). It is important to comprehend how these deceptive practices may erode enduring relationships between buyers and suppliers, a critical aspect for companies operating within the supply chain (Su et al., 2008) as it directly impacts market share, profitability (Wu et al., 2018a,b),

and the attainment of a competitive edge (Barbieri et al., 2022). Pizzetti et al. (2021) have underscored the prevalence of greenwashing scandals, often identified at the supply chain level, and the need for further investigation in this area. Several other researchers also underscore the necessity for additional research exploring the repercussions of greenwashing on stakeholders across the entire supply chain (Blome et al., 2017; Pizzetti et al., 2021; Santos et al., 2023a; Yang et al., 2020a,b). Nonetheless, the number of studies delving into the impact of greenwashing on sustainability via the prism of green supply chain integration remains limited (Shi et al., 2020).

Therefore, this study aims to contribute to the existing literature by assessing the effect of greenwashing on green supply chain integration and, consequently, on sustainability. Specifically, we investigate how the perception of supplier´s greenwashing practices can affect buyers' sustainability, considering the mediating role of green supply chain integration and the moderating role of information sharing. To explain the connection between greenwashing, green supply chain integration, and sustainability, we employ value creation and signaling theories to clarify the direct and indirect effects of these factors in Portuguese companies. These theories explain the possible benefits for firms in adopting CSR practices (Dögl & Holtbrügge, 2014; Schaefer et al., 2020; Su et al., 2016) through the integration of their stakeholders in value creation processes, to address existing environmental challenges and respond to stakeholders' needs and expectations (Silva et al., 2019). Value creation theory helps explain how the perception of supplier greenwashing practices can influence buyers' perceived value and overall trust and, therefore, their commitment and integration in the supply chain. Signaling theory emphasizes the importance of credible signals (Santos et al., 2023b) in conveying a commitment to sustainability, with information sharing moderating this process. Together, these theories provide a framework for understanding the complex interplay of factors that affect buyers' sustainability efforts and perceptions of supplier practices in the context of greenwashing.

Thus, this study presents various contributions: First, it aims to expand the current literature by focusing greenwashing on the scope of B2B - a significant gap in the existing body of research (Santos et al., 2023a). Second, it links the perceptions of suppliers' greenwashing practices to important business outcomes, namely the client's sustainability (Barry et al., 2021). Third, the analysis of green supply chain integration and the assessment of the moderating role that information sharing plays in helping to maintain relationships when greenwashing transgressions occur are useful for managerial actions (Barry et al., 2021; Eckerd & Hill, 2012; Lee & Lee, 2019; Sordi et al., 2022). Fourth, it contributes to value creation and signaling theories, by exposing the negative effects of greenwashing on B2B context. Finally, it offers managers a practical basis for refraining from greenwashing practices to enhance buyer-supplier relationships and safeguard market share and profitability (Wu et al., 2018a,b).

This study contributes by filling a gap in B2B literature, connecting suppliers' greenwashing practices to client sustainability, providing insights for managerial actions in green supply chain integration and information sharing, and contributing to value creation and signaling theories, ultimately offering practical guidance for managers to avoid greenwashing and uphold buyer-supplier relationships. The research's novelty lies in its contributions to building sustainable companies through green supply chain integration, and partner communication.

In sum, the objective of this paper is to investigate the impact of greenwashing on sustainability through the effects of green supply chain integration, considering the moderating role of information sharing. Our results demonstrate that greenwashing undermines the integration of green supply chains and sustainable practices. These findings are supported by signaling and value creation theories. The value creation theory illustrates that companies integrate stakeholders into value creation processes to address existing environmental challenges and respond to stakeholders' needs and expectations quickly and competitively. However, the signaling theory suggests that greenwashing activities may exacerbate the effects of information asymmetry. In reality, companies are under pressure to internally integrate sustainability, yet they lack clarity regarding their sustainable practices and sustainable information, which explains these results.

2 Literature review and hypotheses development

2.1 Value creation and signaling theories

The first underlying theories studied regarding social responsibility were agency and stakeholder theories. Initially, social responsibility was used to protect shareholders, based on agency theory. However, due to the evolution of the market, the focus shifted to companies' sustainable continuity. Sustainable companies are those that can create value for all internal and external stakeholders. Given this evolution, studies started to be based on stakeholder theory: Jamali (2006) stated that organizations' current challenges are the need to change their priorities towards more holistic models of performance evaluation, at various levels, including measures related to multiple stakeholders. Companies with an improved vision and awareness of stakeholders' needs will potentially tend to focus on social responsibility (Hussain et al., 2018). However, with the evolution of markets, it becomes relevant to study various business contexts and delve into new supporting theories (Kowalski & Matusiak, 2019).

Nowadays, social responsibility is becoming increasingly important. Value creation theory provides an additional explanation for this rapid growth of interest in sustainability studies (Gómez-Bezares et al., 2017). According to Porter (1991), the value creation process is at the heart of integrated thinking and value creation. Strategically, the business model is a central cog in the value creation process which turns valuable resources and relationships (inputs) into results (outputs) that create value for stakeholders and society (outcomes and impacts) (Bouncken et al., 2020). Companies must integrate their stakeholders in value creation processes, to face existing environmental challenges and respond to stakeholders' needs and expectations, quickly and competitively (Gómez-Bezares et al., 2017; Wassmer & Dussauge, 2011). Valuable knowledge exists not only within the limits of the organization but also outside the firm. As such, firms' ability to explore, acquire, retain, integrate, and exploit knowledge, is central to firm value (Silva et al., 2019). In this context, companies can use sustainability as a resource and strategic capability to reduce the effect of their operations on the environment in which they operate and create value for stakeholders (Høvring, 2017; Kowalski & Matusiak, 2019).

In turn, greenwashing is a matter of information asymmetries between business partners (Torelli et al., 2020; Zhang et al., 2022). Signaling theory has been used by previous inves-

tigations in areas such as employee commitment and employer reputation (Dögl & Holtbrügge, 2014), accounting (Uyar et al., 2020), and mostly in management studies (Connelly et al., 2011). This theory has been notably used to explain the possible benefits for firms in adopting CSR practices (Dögl & Holtbrügge, 2014; Schaefer et al., 2020; Su et al., 2016), or on relationship performance when suppliers practice CSR (Jia et al., 2023). Nonetheless, greenwashing effects have also been investigated through signaling theory lenses, whether on corporate reputation and brand hate (Santos et al., 2023b) or on corporate financial performance (Li et al., 2023).

The information available between business partners influence decision-making processes (Connelly et al., 2011). However, business partners have access to information based on what firms communicate, and in the greenwashing phenomenon, the firm might appear to be more committed to the environment than it actually is (Connelly et al., 2010) by communicating false environmental practices (Seele & Gatti, 2017). Thus, considering that greenwashing describes misleading communications involving environmental issues (Torelli et al., 2020), this behavior infers the existence of asymmetric information. Therefore, the signaling theory (Spence, 1973) seems to be useful to investigate the distortive effect of greenwashing (Torelli et al., 2020) as it explains behaviors in the presence of asymmetric information (Boateng, 2019). Greenwashers are not solving the information asymmetry problem, they are increasing it (Ruiz-Blanco et al., 2022), thus jeopardizing the potential benefits of CSR, or even worst, damaging the companies' reputation (Lee et al., 2018a,b; Santos et al., 2023).

The combination of signaling theory and value creation theory may give us the rational to investigate and explain the damaging effects of greenwashing: sending business partners misleading signals may risk the supplier partner's trust and reduce supply integration (Lee et al., 2018a,b), jeopardizing sustainable performance and the joint creation of value.

2.2 Greenwashing

Greenwashing has a multidimensional nature (de Freitas Netto et al., 2020) which makes it so difficult to define (Lyon & Montgomery, 2015). However, scholars seem to agree that this corporate practice refers to deceptive and intentional information disclosure decisions (De Jong et al., 2018) to misinform stakeholders and project a sustainable and environmental image or reputation (bMunir & Mohan, 2022; Yang et al., 2020a,b). Meaning that firms promote the perception that their practices or products are environmentally friendly when they are not. Hence, greenwashing is an organizational behavior that misleads or deceives stakeholders regarding their poor environmental practices or environmental benefits of their products/services and a positive communication regarding both (Delmas & Burbano, 2011). Greenwashing can be observed almost everywhere (De Jong et al., 2020), and has gained substantial interest in ethics and marketing fields (Lee et al., 2018a,b; Seele & Schultz, 2022). Even though greenwashing seems to have negative outcomes for consumers, society, companies, and other stakeholders (De Jong et al. 2018; Sun & Zhang, 2019), scholars have focused mostly on greenwashing effects on consumers. However, these practices also inflict damaging consequences on the perpetrating firms. For instance, Pizzetti et al. (2021) found that higher levels of greenwashing practices lead to higher levels of blame attribution and, consequently, a decrease in the intention to invest. Similar results were obtained by (Gatti et al., 2021), were it was found that investors are less prone to invest in greenwash-

ing companies, than in firms that exhibit corporate misbehavior unrelated to misleading communication. In addition, Ferrón-Vílchez et al. (2021) studies indicate that when greenwashing activities increase, managers are less prone to cooperate with the greenwasher. Besides, the detrimental effects of greenwashing are not limited to the greenwasher firm, as it also influences other firms in the same industry (Wang et al., 2020). This phenomenon can also be observed within the supply-chain (Pizzetti et al., 2021; Yang et al., 2020a,b) as suppliers' irresponsible environmental behavior can have negative impacts on buying firms (Quintana-García et al., 2021). Table 1 illustrates the theories used in this investigation, as well as previous studies resorting to the same approach.

Based on signaling and value creation theories greenwashing may impact sustainability performance. Therefore, supply chain integration appears as a potential buffer of the greenwashing effects, based on value creation theory. However, the signaling effect of greenwashing may lead to the decrease of the will to pursue on the supply chain integration, therefore, amplifying the greenwashing effects.

2.3 Green supply chain integration

Supply chain integration means providing maximum value to customers quickly and at a low cost (Kong et al., 2020; Zhao et al., 2008, 2011), by integrating and optimizing internal and external operational processes through strategic cooperation with supply chain partners, thereby achieving efficient service flow, product flow, information flow, or capital flow (Chaudhuri et al., 2018). From the perspective of supply chain integration, existing research generally divides it into internal and external integration (Liu et al., 2018). Internal integration requires all functional departments of the enterprise to work together to form an organic whole, while external integration refers to the integration of the enterprise and external organizations (upstream and downstream partners) (Kalyar et al., 2020).

Regarding the relationship between supply chain integration and enterprise performance, some scholars believe that supply chain integration can help optimize financial efficiency, improve operational efficiency, and enhance enterprise management capabilities and social benefits (Huo et al., 2015; Kim & Chai, 2016). Many researchers have studied the content of supply chain integration, including the decision-making process, information sharing,

Table 1 Construct-linked recent theories and relevant literature

Theory	Variables used	Source
Signaling	Greenwashing, green perceived risk, perceived environmental performance, corporate reputation, trust, brand hate, greenwashing level, perceptions of corporate environmental responsibility, corporate greenwashing and reaction to an environmental scandal, relationship between the signals, supply chain integration and the consumers' attitude as feedback to these signals, and environmental legitimacy.	Santos et al., (2023a) Torelli et al., (2020) Schena et al. (2015) Berrone et al. (2017)
Value Creation	Sustainability reporting, firm and sustainability performance, bank performance, firm innovation performance, enterprise innovation performance, strategic CSR practices, business value creation, innovation practice, sustainable innovation, substantial value, innovativeness, greenwashing, green strategic alliances, and green supply chain integration.	Anlesinya and Abugre (2022) Battisti et al. (2020) Buallay (2019) Buallay et al. (2020) De Jong et al. (2020) Kong and Zhang (2018) Seele & Schultz, (2022)

Source own elaboration

organizational coordination, and other supply chain management factors (Kauremaa & Tanskanen, 2016a). Most studies have confirmed that enterprises should carry out process integration and organizational integration based on information system integration to improve enterprise performance (Bartnik et al., 2018; Lu et al., 2018).

A meaningful component of cooperation effectiveness, within the green supply chain, is the assumption that partners share the same environmental interests, eliminating non-environmental behaviors, and implementing larger green activities (Li et al., 2020). Firms that implement internal green integration often insist on controlling activities, such as monitoring and assessment, on their suppliers, regardless of their will (Kong et al., 2020), which in turn, might lead them to try to mislead, embellish, or lie about their environmental concerns (i.e. practice greenwashing) (Li et al., 2020). Since information asymmetry exists in greenwashing practices, partner firms are not conveniently informed to make decisions that allow them to collect, from the contractual relationships, greater benefits (Bini et al., 2011). Thus, we believe that greenwashing may undermine trust and the willingness to deepen relationships with the provider, reducing the opportunities to increase the supply chain integration levels. Therefore, when the wrong signs are sent and greenwashing arises, the levels of integration in the supply chain tend to decrease (Lee et al., 2018a,b). Therefore, we propose the following hypothesis:

H1 Greenwashing influences green supply chain integration.

2.4 Green supply chain integration and sustainability

The evolution of the business world, facing pressure from stakeholders, forces companies to be aware of and include social responsibility in their current practices (Hussain et al., 2018). Companies now face the constant challenge of designing business strategies that are as sustainable as possible, which involves creating economic value while also mitigating the different environmental and social problems created in their daily activities. Companies now realize that to be socially legitimate, they must earn the respect of their business partners, customers, and society (Hussain et al., 2018a, b). It is essential to continuously innovate (Ardito et al., 2019) and seek to combine the logic of action of all stakeholders, including increasingly informed customers, and demanding business partners (Nason et al., 2018). They require a broader understanding of the interdependence between various stakeholders (Goettsche et al., 2016), directly or indirectly linked to their business. Therefore, the three dimensions of sustainability (economic, environmental, and social) must be included in companies' vision, reflecting their commitment to sustainability (Bonn & Fisher, 2011).

Nowadays, sustainability is understood as a strategic approach combining short-term survival and long-term socially responsible development. Other authors argued that a proactive, sustainable strategy is based on the efficient use of resources, increasing competitive advantages, reducing waste, promoting social reputation, better preferences, and the ability to generate innovation (Banerjee, 2001; Bhupendra & Sangle, 2015; Christmann, 2000). Baumgartner and Rauter (2017) also emphasized that the economic, environmental, and social impacts resulting from companies' sustainable performance have effects on society. However, these effects always depend on external stakeholders' perceptions and the existing socio-economic and cultural situation. In this sense, companies strive for the alignment of

their goals with the three dimensions of sustainability, as they increasingly consider environmental and social issues and no longer focus only on creating economic value (Gallego-Álvarez et al., 2011; Garcia et al., 2016; Muñoz-Torres et al., 2018; Svensson et al., 2018; Wu et al., 2017).

Sustainability seeks self-regulation that searches for interconnected and balanced evolution of three dimensions: economic, environmental, and social (economic prosperity, environmental protection, and social equity) (Chen et al., 2017; Muñoz-Torres et al., 2018). This ideology of sustainable three-dimensional evolution is based on Elkington's triple-bottom-line concept (Elkington, 1998). Companies that consider themselves proactive at a sustainable level and are recognized can create value for all interested parties and are prepared to influence the three dimensions of sustainability, through management, with and for stakeholders (Fu et al., 2020; Jones, 1995). Sustainability is an integral part of companies' lives and is vital for businesses across all industries (Sim & Kim, 2021).

Following Porter (1991), the value creation process is at the heart of integrated thinking and value creation. Based on this theory, several authors reinforced that companies must integrate their stakeholders in value creation processes, to face existing environmental challenges and respond to stakeholders' needs and expectations, quickly and competitively. Incorporating sustainability into the supply chain, aligns with value creation theories by enhancing the overall value delivered to customers. It can lead to cost savings, improved product quality, higher customer satisfaction and loyalty, risk mitigation, and a competitive edge. These factors contribute to the creation of sustainable value for both customers and the organization, reinforcing the importance of green supply chain integration in achieving sustainability objectives. Based on these arguments, we suggest the following research question:

H2 Green supply chain integration influence sustainability.

2.5 Greenwashing and sustainability

Greenwashing is the act of making false or misleading claims about the environmental benefits of a product, service, or company's practices (Seele & Schultz, 2022). It is often used as a marketing tactic to make a company or product appear more environmentally friendly than it is (Gatti et al., 2021). On the other hand, sustainability looks for self-regulation that searches for interconnected and balanced evolution of three dimensions: economic, environmental, and social (economic prosperity, environmental protection, and social equity (Muñoz-Torres et al., 2018). Companies that consider themselves proactive at a sustainable level and are recognized can create value for all interested parties and are prepared to influence the three dimensions of sustainability, through management, with and for stakeholders (Fu et al., 2020). Sustainability is an integral part of companies' lives and is vital for businesses across all industries (Sim & Kim, 2021). This can include sourcing raw materials from environmentally responsible suppliers, reducing waste and pollution throughout the production process, and promoting the use of environmentally friendly products and services.

There is often a relationship between greenwashing and sustainability, as companies may use greenwashing to distract from a lack of genuine green practices in their sustainable prac-

tices. There is a negative relationship between greenwashing and sustainability performance (Torelli et al., 2020). This is because if a company's suppliers are engaging in greenwashing, the company may be relying on false or misleading information about the environmental impact of its suppliers' products or practices. As a result, the company's efforts to improve its sustainability performance may be less effective than it had hoped. Additionally, if a company's suppliers are engaging in greenwashing, it can damage the company's reputation (Santos et al., 2023b) and credibility. Consumers and other stakeholders may become skeptical (Nguyen et al., 2019) of the company's environmental claims if it is known that the company's suppliers are making false or misleading claims about their practices. This can make it more difficult for the company to attract and retain customers and other stakeholders who are concerned about the environment. Besides, according to signaling theory, greenwashing may send a negative signal to their stakeholders and, in doing so, damage the firms' profitability (Li et al., 2023). Based on the arguments above we suggest the following:

H3 Greenwashing influences sustainability.

2.6 Moderating effect of information sharing

Information sharing refers to the degree to which sensitive, exclusive, tactical, or critical information is shared and exchanged between supply chain partners (Lee & Lee, 2019; Li & Lin, 2006). It comprises formal and informal sharing that is useful to the other party and that encourages reciprocity (Barry et al., 2021). In this sense, information sharing is recognized as an individual behavior of deliberately sharing a particular type of information as a motivated response to an implicit expectation (or explicit request) of sharing information (Bălău & Utz, 2017). Previous studies have highlighted the benefits of this exchange in B2B context, as it encourages cooperation (Lee & Lee, 2019), trust, and performance (Barry et al., 2021), and it improves the efficiency of supply chain practices (Li & Lin, 2006). Information sharing is a pillar in supplier collaboration and coordination (Tseng et al., 2022), as it allows both stakeholders to work almost as a single entity (Li & Lin, 2006). This exchange is a relevant tactic for relationship building (Wang et al., 2016) and relational effectiveness (Hsu et al., 2008). Therefore, it plays a vital role in long-term relationships between buyers and suppliers (Lee & Lee, 2019; Wang et al., 2016). Information sharing is a step ahead, signaling that companies are interested to improve sustainable practices and sharing these improvements with their stakeholders (Connelly et al., 2011). Communication is a key element that fosters engagement and transparency, increasing satisfaction and commitment in long-term buyer-supplier relationships, besides diminishing perceptions of unethical behavior from partner firms (Eckerd & Hill, 2012; Sordi et al., 2022). When information sharing increases, the buyer company trusts the supplier more (Barry et al., 2021; Lee & Lee, 2019) and it is likely to maintain the connection with the supplier in the long run (Wang et al., 2016). Moreover, since information sharing reduces information asymmetry (Wang et al., 2016), and perceptions are often built on insufficient information (Yang et al., 2020a,b), we believe that the detrimental effects of greenwashing perceptions could be buffered by information disclosure regarding companies' environmental practices complemented by a close relationship and increased information sharing. Lastly, Fontoura and Coelho (2020) showed that knowledge and information sharing, contribute to the creation of a climate of trust

and sharing, that may help business partners take advantage of closer relationships and a stronger integration of their supply chains. Therefore, we propose the following hypothesis:

H4 Information sharing moderates the relationship between greenwashing and green supply chain integration.

2.7 The mediating role of green supply chain integration between greenwashing and sustainability

Greenwashing is intended to give the impression that a company is taking meaningful steps to protect the environment when it may not be doing enough or may even be generating negative impacts on the environment (De Jong et al., 2020; Gatti et al., 2021). On the other hand, green supply chain integration is fundamental to green initiatives that focus on minimizing, reusing, and recycling materials and energy to enhance environmental impacts at every phase of the manufacturing process, including design, procurement, production, distribution, and product recovery (Tippayawong et al., 2016), promoting sustainable advantages. Thus, green supply chain integration refers to the production and distribution of goods and services from suppliers and manufacturers to end users while accounting for monetary, informational, and material flows in the environment (Bartnik & Park, 2018; Trkman et al., 2007; Zhang et al., 2015). Geen supply chain integration integrates an environmental point of view.

Based on signaling theory, greenwashing introduces the wrong signs that may mislead and jeopardize trust in the supplier partner and reduce supply integration (Torelli et al., 2020; Zhang et al., 2022). However, whenever supply chain integration prevails, against all odds, according to value creation, the impacts on sustainability may be mitigated or even boosted (Kong et al., 2020; Wong et al., 2020). Supply chain integration is a strong predictor of sustainability, enabling the joint creation of value. Additionally, value creation theory, the "greenwashing" behavior of corporate sustainability reports significantly reduces the creation of "shared value" in the green supply chain, leading to the degree of asymmetry of sustainability information being negative for the sustainability development, since it is known that the quality of information dissemination plays an important role in sustainable development (Yu et al., 2020).

H5 Green supply chain integration will mediate the relationship between greenwashing and sustainability.

The relationships between the variables are depicted in Fig. 1.

3 Method

3.1 Sample and data collection

This investigation is based on cross-sectional data collected from 312 Portuguese companies through a structured online questionnaire. Respondents were contacted through five

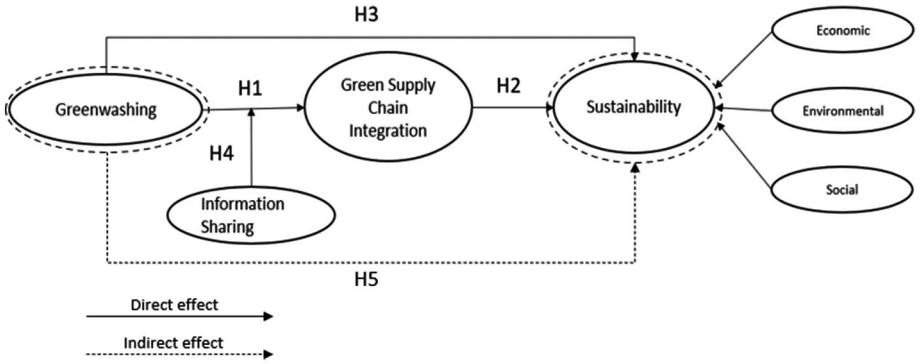

Fig. 1 Conceptual model. *Source* own elaboration

SME Associations, that sent a link to a key respondent from the two upper echelons of the hierarchy. Respondents were asked about their perception of the existence of greenwashing practices at one or more of their suppliers. The questionnaire contained a definition of greenwashing, followed by a filter question: "Please state how many suppliers you identify in this position". If the answer was none, the questionnaire was closed, and the answers were not included in the analysis. Respondents were then instructed to think of their on their greenwashing suppliers when answering the questions in the questionnaire. To ensure anonymity and the high standard of the instrument, respondents were not asked to provide any personal information or identify their companies or suppliers. All participants also gave their informed consent before accessing the questionnaire. Data for this investigation were collected from February to April 2022. Tables 2 and 3 provide an overview of sample characteristics and respondent demographics. Most companies surveyed (67%) admit to having one to two suppliers that they perceive as greenwashers. In 62.8% of cases, the relationship lasts between 1 and 5 years and, in 69.2% of the purchasing companies, the percentage of deliveries from greenwashing suppliers is greater than 10%. As for respondents, most are men (56.7%), over 43 years old (65.1%), department directors (56.1%), and with a degree (54.2%).

3.2 Measures

Measurement was based on scales established and tested in previous investigations, respecting the original structure, and slightly modified to better reflect the context of the investigation (Table 4). This meant using back translation procedures: the original English version was translated into Portuguese and then back translated into English by two experts. Before the investigation, the authors tested the instrument (20 respondents) to detect ambiguity and ensure the adequality of the constructs. The adequacy of the measurement model was assessed using confirmatory factor analysis (CFA) with AMOS 28 and Scale items can be seen in Table 4. A seven-point Likert scale was used, and participants were instructed to score each item from 1 ("strongly disagree") to 7 ("strongly agree"). Information sharing was based on the information flow integration scale of Rai et al. (2006).

Table 2 Sample profile ($n=302$)

Parameter perception of greenwashing	Frequency	%	Parameter buying firm	Frequency	%
Nr of suppliers			*Main activity*		
1–2	209	67	Service	153	49
3–5	67	21.5	Industry	159	51
>5	36	11,5	*Annual revenue (EUR)*		
Relationship length(years)			< €100,000	5	1.6
<1	46	14,7	€100,000 - €250,000	15	4.8
1–5	196	62,8	€250,001 - €500,000	25	8
6–10	50	16	€500,001 - €1,000,000	56	17.9
>10	20	6,4	€1.000,001 - €5,000,000	56	17.9
% of deliveries			€5,000,001 - €20,000,000	52	16.7
0–10%	90	28,8	> €20,000,000	103	33.0
11–20%	114	36,5	*Firm Age*		
21–50%	102	32,7	1–5	8	3.2
>50%	6	1,9	6–10	20	8.0
Nr. Employees			11–20	42	16.7
<10	67	21.5	>20	181	72.1
10–50	94	30.1			
51–100	76	24.4			
101–250	32	10.3			
251–500	32	10.3			
>500	11	3.5			

Table 3 Respondents' profile

Parameter respondent	Frequency	%	Parameter respondent	Frequency	%
Gender			*Age, Years*		
Male	177	56.7	18–26	4	1.3
Famale	135	43.3	27–34	32	10.3
Title			35–42	73	23.4
General Director	77	24.7	43–50	149	47.8
Department Director	175	56.1	>51	54	17.3
Administrative head staff	60	19.2	*Tenure*		
Education			1–5	63	20.19
Secondary School	68	21.8	6–10	104	33.33
Bachelor	169	54.2	11–20	111	35.58
MSc. /PhD.	75	24.0	>20	34	10.90

Source own elaboration

Table 4 Measurement scales

Construct		Item	Loadings
Greenwashing (Laufer, 2003)		The supplier misleads with words about its environmental features.	0.941
		The supplier misleads with visuals or graphics about its environmental features.	0.915
		The supplier makes a green claim that is vague or seemingly unprovable.	0.923
		The supplier overstates or exaggerates how green its operations actually are.	0.918
		The supplier leaves out or masks important information making the green claim sound better than it is.	0.931
Sustainability (Hussain et al., 2019; Inman & Green, 2018)	Economic	Has managed to reduce its operating expenses.	0.946
		Has managed to improve efficiency in resource management.	0.961
		Has managed to reduce the number of materials and/or consumables used in carrying out its activities.	0.848
		Has improved its ability to deliver value to its internal and/or external customers, fulfilling established commitments.	0.819
		Has increased the quality of its products and/or services, ensuring the satisfaction of the needs and expectations of its stakeholders.	0.927
		Has seen an overall increase in its operational performance.	0.878
	Environment	Has managed to reduce its operating expenses.	0.925
		Has managed to improve efficiency in resource management.	0.919
		Has managed to reduce the number of materials and/or consumables used in carrying out its activities.	0.918
		Has improved its ability to deliver value to its internal and/or external customers, fulfilling established commitments.	0.892
		Has increased the quality of its products and/or services, ensuring the satisfaction of the needs and expectations of its stakeholders.	0.858
		Has seen an overall increase in its operational performance.	0.886
	Social	Our organization has complied with applicable security procedures.	0.903
		In our organization there has been an improvement in the working conditions of employees and suppliers.	0.848
		Our organization has seen an increase in its performance in health and safety at the workplace, in its business activities.	0.914
Green supply chain integration (Yang et al., 2020a,b; Zhou et al., 2020)		My company cooperates with supply chain partners for eco-design (green products/services).	0.959
		My company cooperates with supply chain partners for green distribution and transportation.	0.944
		My company achieves environmental goals through joint planning with customers.	0.932
		My company cooperates with customers for cleaner production, green packaging, or other environmental activities.	0.934
		My company actively involves customers in our new product development process.	0.960
		My company provides suppliers with environmental design requirements related to design specifications and cleaner production technology.	0.938
		My company collaborates with suppliers to set up environmental goals.	0.913
		My company works with our suppliers to seamlessly integrate our interfirm processes.	0.908

Source own elaboration

3.3 Model

A preliminary analysis was carried out, which included the verification of multivariate normality assumption (i.e., test whether each variable and the linear combinations of the variables are normally distributed (Tabachnick & Fidel, 2007) and check for the presence of outliers. The distribution was compared with the normal, and the skewness and kurtosis were verified, which proved to be non-significant, as their critical ratios were ranged between – 1,96 and 1,96 and multivariate kurtosis was lower than 5.

Table 5 shows the results of the estimation of the structural model. Composite reliability (CR) and the average variance extracted (AVE) were computed. All the scales showed values above 0.7 for CR and above 0.5 for AVE, which aligns with the recommendations (Hair et al., 1998). Discriminant validity is evidenced by the fact that all correlations between the constructs are significantly smaller than one. The squared correlations calculated for each pair of constructs are always smaller than the variance extracted for corresponding constructs (Shiu et al., 2011). Additionally, we computed the average heterotrait-monotrait (HTMT) ratio, proposed by Henseler et al. (2015), as an additional measure considering the potential limitations of the original Fornell and Larcker's (1981) discriminant validity test. All the values are significantly below the threshold of 0,9, according to Franke and Sarstedt (2019), which gives an additional support to discriminant validity.

3.4 Common method variance

To reduce the risk of standard method variance, we used some procedural methods suggested by Podsakoff et al. (2003): (1) all respondents were guaranteed anonymity and the confidentiality of the information collected and were assured that there were no right or wrong answers; (2) items were put in random order; (3) there was no use of scales with bipolar numerical values or verbal designations for the mid-points of the scales; (d) the questionnaire was divided into several sections with a brief explanation, reducing the risk of common method bias (Brammer & Millington, 2008). Besides, Harman's single factor test, common latent factor (CMF) analysis was used. The Harman test showed that any factor was able to explain more than 18.94% of the variance and that there was a multifactorial structure with 4 factors greater than 1, explaining 84.37% of the total variance. In addition, the authors conducted a common method latent factor in AMOS. The results revealed that the differences between the model's SRW, with and without the CMF, were less than 0.20. Therefore, CMB should not be a substantial problem in the data.

Table 5 Square correlations, cronbachs alpha, composite reliability, and average variance extracted

Construct	GW	GSCI	S	CR	AVE	Mean	Std. deviation
Greenwashing (GW)	**0.969**	0.618	0.661	0.97	0.86	5.65	1.11
Green Supply Chain Integration (GSCI)	-0.620	**0.983**	0.556	0.98	0.88	4.96	1.48
Sustainability (S)	-0.666	0.548	**0.981**	0.98	0.80	5.52	1.08

Note HTMT values at the top of the array; Diagonal in bold - Cronbach's Alpha; CR - Composite Reliability; AVE - Average Variance Extracted

Source own elaboration

4 Results

The authors calculated the structural model through AMOS 28 to test the proposed hypotheses. AMOS serves as a robust data analysis tool due to its capabilities in structural equation modelling, enhancing traditional multivariate analysis techniques like correlation, regression, and factor analysis. This software excels in constructing attitudinal and behavioral models, accurately incorporating intricate relationships like mediation and moderation. Notably, AMOS distinguishes itself from other data analysis tools by allowing the regression of multiple dependent variables on independent variables simultaneously. (Appiah-Kubi, 2024). This method has been successfully applied in similar studies (Appiah-Kubi, 2024; Isac et al., 2024; Yousaf et al., 2023) which validate our choice. The structural model demonstrated good adjustment with indices such as IFI (0.969), TLI (0.965), CFI (0.969), RMSEA (0.064), and CMIN/DF (2.262) (Hair et al., 2010).

We also performed three additional models, considering each one of the three dimensions of sustainability (economic, social and environmental). Table 6 shows the results of the regression estimates, from the global model and the three dimensions of sustainability. In turn, Table 7 depicts the results of the multigroup analysis considering the moderating effects of information sharing.

Additionally, a multigroup analysis was performed to test the moderation effects of information sharing, divided into two groups according to average: the low IS group (169 respondents) and the high IS group (143 respondents). Table 7 shows the results of moderating effect of information sharing. Z-Scores were computed to compare the difference between two groups, and the results show a significant difference between them (Afthanorhan et al., 2015).

We used bootstrapping, a non-parametric resampling procedure, to examine the mediation effects. The procedure employed for testing the mediation hypotheses or indirect effects (Hypothesis 5) followed the approach used by Cepeda-Carrion et al. (2016). Once again, the bootstrapping procedure was employed to generate t-statistics, significance levels, p-values, and 95% confidence intervals (percentile) for the mediators (Preacher & Hayes, 2008). The mediation effects of green supply chain integration on the relationship between greenwashing and sustainability were supported with a 95% bias-corrected bootstrap confidence interval. The results of the mediation analyses are presented in Table 8.

Greenwashing is negatively related to green supply chain integration and sustainability (β=-0.620, $p<0.001$ and β=-0.530, $p<0.001$, respectively), therefore hypotheses 1 and 3 are supported. The path association between green supply chain integration and sustainability is significant ($\beta=0.219$, $p<0.001$), supporting hypothesis 2. Hypothesis 4 suggests that information sharing acts as a buffer between greenwashing and green supply chain integration. The results show that higher levels of information sharing reduce the negative effects of greenwashing on green supply chain integration. Results also show that green supply chain integration significantly mediates the effect of green greenwashing and sustainability (β=-0.136, $\rho \leq 0.01$), therefore supporting H5.

At the same time, the impacts on the 3 dimensions of the sustainability performance are quite similar and show how greenwashing may damage sustainability in all its scopes.

Table 6 Results of the structural model

Hypothesis	Relationship	SRW	C.*R.*	*P*	Economic	*P*	Social	*P*	Environment	*P*	Supported/ Not supported
H1	GW → GSCI	-0.620	-12.638	***							Supported
H2	GSCI → S	0.219	3.892	***	0.234	***	0.208	***	0.199	***	Supported
H3	GW → S	-0.530	-9.033	***	-0.515	***	-0.510	***	-0.524	***	Supported

*** = $p < 0.01$

Note GW Greenwashing; GSCI: Green Supply Chain Integration; S: Sustainability

Source own elaboration

5 Discussion

In this study, we explored the mechanism underpinning the influence of greenwashing on sustainability, considering the actions of green supply chain integration and the moderation effect of information sharing. Greenwashed companies are recognized for promoting misperceptions of their sustainable practices among different stakeholders (De Jong et al., 2020; Munir & Mohan, 2022; Seele & Schultz, 2022). Previous studies have found that greenwashing has negative consequences on green washers but also on overall society: consumers, employees, business partners, and other stakeholders (Chen & Chang, 2013; De Jong et al., 2018; Parguel et al., 2011; Sun & Zhang, 2019).

Our findings suggest that greenwashing damages green supply chain integration and sustainable practices, supporting hypotheses 1 and 3. These results imply that the negative impacts go beyond the perpetrator firm, as client firms' sustainability is negatively affected. According to signaling theory, greenwashing activities are the basis to increase the effects of information asymmetry (Torelli et al., 2020; Zhang et al., 2022), which explains that misleading communications will promote the decrease of green supply chain integration and sustainable practices (Lee et al., 2018a,b; Santos et al., 2023; Seele & Gatti, 2017). In this sense, Ruiz-Blanco et al. (2022) explains that green washers are not solving the information asymmetry problem, they are increasing it and, mining the potential benefits of green supply chain integration and CSR practices, or even worst, damaging the company's reputation (Jia et al., 2023; Li et al., 2023; Santos et al., 2023b). Our results supports hypothesis 1, as shown that green supply chain integration has a positive impact on sustainability (Kowalski & Matusiak, 2019; Singh et al., 2022), revealing that green supply chain integration provides maximum value to sustainability, through strategic cooperation with supply chain partners, thereby achieving efficient service, improve operational and financial efficiency, and enhance enterprise sustainable management capabilities (Huo et al., 2015; Kauremaa & Tanskanen, 2016b; Kim & Chai, 2016). Value creation theory may explain this relationship, based on the connection between companies and stakeholders, and keeps an additional explanation for this rapid growth of interest in sustainability studies (Gómez-Bezares et al., 2017). Nowadays, companies are investing in value-creation processes as a strategic approach to respond to stakeholders' pressure about sustainability requirements (Baumgartner & Rauter, 2017; Bonn & Fisher, 2011; Song et al., 2018). Additionally, companies must integrate their green suppliers in value creation processes, to face existing sustainability challenges and respond to stakeholder's expectations and needs (Kowalski & Matusiak, 2019; Porter, 1991): this response needs to be fast and competitive, through firms' ability to explore, acquire, and retain, integrate, and exploit knowledge, with the business partners, to promote higher levels of sustainability and competitive advantage (Battisti et al., 2020; Buallay et al., 2020; Silva et al., 2019).

Therefore, to better explore the set of linkages proposed in our investigation model, we tested the indirect effects of greenwashing on sustainability through the effect of green supply chain integration. Green supply chain integration is recognized as a fundamentally green initiative that focuses on minimizing sustainable problems (Bartnik & Park, 2018; Trkman et al., 2007; Zhang et al., 2015). On the other hand, greenwashing consists of promoting publicity of advertisements about being sustainable, but real measures that collaborate with the minimization or solution of sustainable impacts are not adopted (De Jong et al., 2020; Gatti et al., 2021). Under signaling theory, green washers introduces wrong sings that may

Table 7 Results of the moderating effect of information sharing

Hypothesis	Relationship	SRW	C.R.	*P*	SRW	C.R.	*P*	Z-Score	Supported/Not supported
H4	GW →IS →GSCI	-0.465	-5.692	***	-0.534	-6.812	***	0.000	Supported
		High IS (*n* = *169*)			Low IS (nLow IS=143)				

*** = $p < 0.01$

Note GW: Greenwashing; GSCI: Green Supply Chain Integration; IS: Information Sharing

Source own elaboration

Table 8 Indirect effects

Hypotheses paths	Standardized Indirect effects	95% confidence interval	*P*
H5: GW → GSCI → S	-0.136	[-0.733; -0.582]	***

*** = $p < 0.01$

Note GW Greenwashing; GSCI: Green Supply Chain Integration; S: Sustainability

Source own elaboration

mislead and jeopardize the supply partners' trust reduce green supply chain integration (Torelli et al., 2020; Zhang et al., 2022), and significantly reduce the creation of "shared value" between businesses partners, since it is known that quality of information dissemination plays an important role in sustainability development (Chen et al., 2020; Sordi et al., 2022; Yang et al., 2020a,b). However, greenwashing practices are jeopardizing companies' efforts towards sustainability. First, directly, ruining the business partners efforts to become more sustainable, mining trust, reputation and introducing non-compliances in the processes and in the outcomes (Guo et al., 2018; Santos et al., 2023b). Second, indirectly, through the effects on supply chain: even if supply chain might act like a buffer in this relationship, minimizing the negative impacts of the greenwasher misleading practices, the result translates into a decreasing on the efforts to integrate the supply chain, and therefore, again, on the decreasing of the sustainability outcomes. These results support hypothesis 5.

Additionally, we studied the moderating effect of information sharing on the relationship between greenwashing and green supply chain integration. Information sharing is recognized as deliberately sharing a particular type of information as a motive response to an implicit expectation of sharing information (Bălău & Utz, 2017). Our results demonstrated that information sharing reduces information asymmetry, which reveals that the detrimental effects of greenwashing perceptions could be buffered by information disclosure regarding companies' sustainable practices (Fontoura & Coelho, 2020). These results are consistent with hypothesis 4, which reinforced that when information sharing is low, the negative impacts of greenwashing on supply chain integration are bigger as well as on the overall sustainability.

Overall, it is important for companies to carefully evaluate their suppliers and ensure that they are genuinely engaged in environmentally responsible practices, rather than just making false or misleading claims, to achieve good sustainability performance.

6 Conclusion, implications, limitations and future investigations

In conclusion, our research has shed light on the detrimental effects of greenwashing on the integration of green supply chains and sustainable practices. Through the lens of signaling and value creation theories, we have provided empirical evidence supporting the notion that companies must actively engage stakeholders in value creation processes to effectively address environmental challenges and competitively meet stakeholders' expectations. Moreover, our findings highlight the insidious nature of greenwashing activities, which not only erode trust and transparency but also exacerbate information asymmetry within organizations. Despite increasing pressure for sustainability integration, companies often struggle with the ambiguity surrounding their sustainable information, hindering meaningful progress.

Moving forward, companies must prioritize genuine sustainability efforts and adopt transparent communication practices. By fostering a culture of accountability and aligning internal processes with sustainable objectives, organizations can mitigate the risks associated with greenwashing and cultivate long-term relationships with stakeholders based on trust and integrity. Ultimately, our study underscores the importance of holistic approaches to sustainability that prioritize authenticity and stakeholder engagement. By embracing these principles, companies can pave the way for a more sustainable future while simultaneously enhancing their competitive advantage in the global marketplace.

6.1 Theoretical implications

Our research significantly contributes to the scientific community by examining the impact of greenwashing on sustainability through green supply chain integration and moderated by information sharing. Three distinct contributions mark our study: Firstly, we employ signaling and value creation theories to elucidate how greenwashing practices affect companies and their strategies, particularly in the realms of green supply chain integration and sustainability. Secondly, we underscore the pivotal role of green supply chain integration as a driver for companies' sustainability efforts, outlining its influence on knowledge integration and capability development. Lastly, we highlight information sharing as a crucial condition, guiding companies in aligning their sustainability initiatives with supplier demands, even in the face of greenwashing practices. These findings not only deepen our theoretical understanding of sustainability dynamics but also offer practical insights for businesses navigating the complexities of green supply chains. Overall, our research contributes valuable perspectives that advance both theoretical frameworks and practical considerations in the field of sustainable business practices.

6.2 Managerial implications

This study provides insights for managers by helping them expand their understanding of the impact of greenwashing and supporting their decisions on sustainable practices.

Our findings emphasize the importance of abandoning greenwashing practices in green supply chain integration and sustainability. As sustainability is typically unique to most companies, managers should pay considerable attention and allocate resources to overcome information asymmetry, which helps them understand the external dimension of a

company and create new approaches to decision-making and operations. The adoption of socially responsible practices may imply additional investments, but the results seem to be rewarding, given the damaging effects of greenwashing. Thus, companies seeking to embrace successful sustainable practices should be aware of the importance of adopting the right sustainability positioning, promoting the right communication, actions, documents, advertisements, and campaigns about their environmental/ecologically green, sustainable, and eco-friendly actions, sharing information with their business partners. Lastly, this study reinforced the importance of managers aligning their objectives with social responsibility practices, directing new developments at green supply chain integration processes.

6.3 Policy implications

Our results also present policymakers' implications. Recognizing the impacts of greenwashing, governments and relevant authorities should consider strengthening regulations and enforcement mechanisms to discourage greenwashing practices within supply chains and implementing incentives or rewards for companies that actively engage in green supply chain integration. Governments could allocate resources for research and development initiatives focused on sustainable practices within the supply chain, raising awareness about greenwashing and its detrimental effects on sustainability. In summary, addressing greenwashing requires a comprehensive and multi-faceted approach involving regulatory measures, information sharing, incentives, education, and collaborative efforts. By implementing policies that target these areas, governments can contribute to the creation of more sustainable supply chains and foster a business environment that values transparency and environmental responsibility.

6.4 Limitations and directions for future research

This work has some inherent limitations that should be addressed in future research. While we acknowledge the importance of reproducibility, it's important to note that our data collection is based on potential non-probabilistic sampling, introducing certain limitations to the generalizability of our findings. At the same time, longitudinal data is more suitable for establishing strict causality. Additionally, we specifically focused on Portuguese companies, and while this environment might be particularly effective for studying social responsibility performance because it is recognized as a sustainable sector facing higher pressures from stakeholders, future research could be extended to other countries, specific industries, or other respondent profiles.

Future investigations could also propose other variables or introduce other mediating and moderating mechanisms into the models to improve the current knowledge of greenwashing effects in several contexts. The severity of greenwashing or even greenwashing critical incidents are yet to be explored. At the same time, customer recovery in a greenwashing scenario needs future investigation, to help companies overcome potential damages.

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