



Can Global Reporting Initiative reports reveal companies' green supply chain management practices?

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ARTICLE INFO

Handling Editor: Dr. Govindan Kannan

Keywords:

Green supply chain management
Green practices
Sustainability report
Global Reporting Initiative (GRI)
Eco-design
Transparency

ABSTRACT

Companies usually use Global Reporting Initiative (GRI) reports as a typical way to make their sustainability commitment transparent to stakeholders, without being concerned with making green supply chain management (GSCM) practices transparent. Given that the generic approach of the GRI framework makes it difficult to identify where and how GSCM practices are presented, this paper assumes that these GSCM practices are in the company's GRI reporting but are not transparent. Consequently, how GRI reports can reveal companies' GSCM practices remains underexplored in the literature. Guided by a qualitative approach, this study exploited data from the GRI reports of 30 Brazilian companies to verify the degree of GSCM transparency. Specifically, we use a theoretical structured framework for GSCM practices, consisting of four dimensions and 20 practices distributed among them. Our findings show that the current way of reporting actions to enhance companies' contribution to sustainable development can partially promote GSCM transparency. The findings also indicate which practices could be better documented in GRI reports to increase the visibility of GSCM actions, providing insights for managers and scholars seeking to define strategies to make GSCM more observable (e.g. total quality environmental management, environmental compliance and auditing programs, cooperation with suppliers, and scrap selling). Furthermore, the theoretical linkage between the GRI and GSCM contributes to theory by presenting a novel view of GSCM practices' transparency through the generic GRI guidelines.

1. Introduction

Due to the relevance of green supply chain management (GSCM) to sustainability issues, companies need to develop an adequate strategy for disseminating the results associated with their GSCM practices among customers, shareholders, and academia. In this sense, supply chain transparency is crucial to today's global companies' efficient, flexible, resilient, and sustainable operation (McGrath et al., 2021). Carter and Rogers (2008, p.368) defined GSCM as "the strategic, transparent integration and achievement of an organization's social, environmental, and economic goals in the systemic coordination of key interorganizational business processes for improving the long-term economic performance of the individual company and its supply chains." Firms that disclose a high level of information to their stakeholders are adopting a transparent strategy, which includes assessing

and managing supply chain activities, thus implementing GSCM practices (Longoni and Cagliano, 2018). Firms aiming to provide transparency to their supply chain prepare reports that may include issues such as participation in the supply chain, material provenance and traceability, financial transparency, and social, environmental, and corporate responsibility (McGrath et al., 2021).

One of the increasingly popular approaches to reporting sustainability outcomes is the Global Reporting Initiative (GRI) guidelines (Chiarini, 2017). However, what should a reader expect from a GRI report (Isaksson and Steimle, 2009)? Is it possible, for example, to identify how green a company's supply chain is by reading the GRI reports?

Despite the GRI being widely accepted, some studies have pointed out the insufficiency of transparency in GRI reporting, and that the use of GRI reporting is not efficient when used as a marketing tool to

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<https://doi.org/10.1016/j.jclepro.2022.135554>

Received 22 March 2022; Received in revised form 21 November 2022; Accepted 7 December 2022

Available online 8 December 2022

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communicate with stakeholders and society (Masud et al., 2018). Therefore, GRI guidelines may not be sufficient to ensure that a report answers questions concerning company sustainability (Isaksson and Steimle, 2009). In a more comprehensive approach, Chen et al. (2015) highlighted the possibility of using standard environmental data from GRI reports as a resource for future studies on environmental management practices (EMPs) to improve long-term financial performance.

These contradictory results on the applicability of the data reported in the GRI reports for evaluating the environmental performance of companies indicate the need for more research related to the topic. However, the literature linking the GRI and GSCM remains scarce. Thus, to address the gaps in the literature (i.e. the lack of answers concerning how to make GSCM performance transparent), we explore the following research question: “How are GSCM practices reported in GRI reports?”

Against this backdrop, the present study explores the ability of GRI reports to extract information about, and highlight (thus increasing transparency), GSCM practices. Most previous work has explored performance measurement approaches to assess GSCM or GRI reports as a source of information for evaluating companies' environmental performance. In contrast, the present research intends to:

- use the GRI reports of a sample of companies to identify the GSCM practices reported; and
- verify how information obtained through GRI reports can reveal the degree of companies' transparency related to GSCM practices.

To achieve these objectives, we develop propositions using GSCM and GRI concepts in Section 2. In this study, data were collected exclusively from the published annual reports of the sample companies, i.e. the GRI reports. The GSCM practices were coded using content analysis. This paper will contribute to the GSCM concept by presenting a theoretical linkage of the GSCM assessment approach to the GRI reporting principles in order to investigate any relationship between the GRI and GSCM. The proposed theoretical linkage advances the literature by offering a mechanism to assess an organization's GSCM transparency through GRI reports.

The remainder of this paper is structured as follows. Section 2 presents the mainstream research on GSCM and the GRI to enable the development of the propositions. Section 3 describes the procedures for obtaining and analyzing the data. In Section 4, the research findings are aligned with the research objectives. Finally, Section 5 summarizes the study's results, contributions, limitations, implications, and further research opportunities.

2. Literature review and proposition development

2.1. Green supply chain management (GSCM)

GSCM has the main objective of improving the environmental performance of the supply chain as a whole. In this sense, GSCM can be understood as fully integrating sustainability throughout the organization and collaborating with stakeholders, including supply chain partners, to achieve sustainability goals (Agarwal et al., 2018). In a highly comprehensive manner, Srivastava (2007) conceptualized GSCM “as integrating environmental thinking into supply chain management, including product design, material sourcing, and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life.” Therefore, the term GSCM implies integrating environmental concerns into supply chain management, which may require collaboration with partners (Sellitto, 2018), both upstream and downstream (Bag et al., 2020).

The integration of environmental concerns into supply chain management to achieve GSCM has been studied from several distinct perspectives. A study of manufacturers by Zhu et al. (2008) empirically investigated a construct and a scale for evaluating GSCM practices'

implementation. Cherrafi et al. (2018) investigated the relationship between green practices, lean, and green supply chain performance. Another study within the manufacturing sector critically analyzed the literature on GSCM pressure, practice, and performance (Choudhary and Singh Sangwan, 2021). Kumar et al. (2019) investigated the green practices adopted by Chinese SMEs in the packaging sector in order to assess the impact of these practices in improving operational performance. Based on the practice-based view and normalization process theory, Silva et al. (2019) suggested that innovation is a crucial mechanism in implementing GSCM practices. These studies emphasize the importance of studying environmental practices' implementation in the GSCM context.

2.2. Green supply chain management (GSCM) practices

The commitment to sustainability is the main characteristic of the green supply chain concept (Jannat Tumpa et al., 2019; Rao and Holt, 2005). GSCM can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance, or energy utilization efficiency (Srivastava, 2007). Its practices are associated with internal and external activities (Vachon and Klassen, 2006) and ecology (Li et al., 2020). Internal practices are associated with, for example, GSCM managers' commitment and the existence of environmental management systems (EMSs). External practices are linked to, for example, green purchasing and cooperation with suppliers. Investment recovery practices basically address scrap and discarded used material (Zhu and Sarkis, 2004). Ecology is related to, for example, eco-design projects (Zhu et al., 2008). Although more recent studies have proposed new categorizations for GSCM practices (Pinto, 2020; Tseng et al., 2019), the present work will use the categorizations proposed earlier by Zhu and Sarkis (2004) since the new propositions do not present further contributions to these GSCM practices.

2.2.1. Internal green supply chain management (GSCM) practices

Internal environmental management can be defined as “the practice of developing environmental sustainability as a strategic organizational imperative through commitment and support of the imperative from senior and mid-level managers” (Diab et al., 2015 p.150). There are several practices of internal environmental management that can be associated with GSCM (Zhu et al., 2008). For example, “Commitment to GSCM from top managers” is a significant causal factor for GSCM effectiveness in general (Dou et al., 2018). More effective management and commitment to implementing internal GSCM practices can secure access to international markets to increase long-term market share (Agyabeng-Mensah et al., 2020).

Further, “Support from mid-level managers” can be achieved by improving the GSCM or proposing GSCM initiatives to the senior management team that can create synergistic effects on company performance (Cousins et al., 2019). The practice of “Cross-functional cooperation for environmental improvements” is a characteristic of effective GSCM (Kazancoglu et al., 2018); it can integrate other GSCM practices (Abdallah and Al-Ghwayeen, 2020). The “Total quality environmental management (TQEM)” practice uses total quality management (TQM) principles to eliminate environmental waste. The TQEM concept embodies the idea that TQM practices and environmental sustainability practices are complementary and positively related (Green et al., 2019). The extent of “Environmental compliance and auditing programs” practice implementation can be related to the level of transparency of a company's environmental initiatives. For example, low levels of transparency may suggest that the company has only a tangential environmental compliance perspective regarding its suppliers (Cousins et al., 2019).

“ISO 14001 certification” is often highlighted as proof of environmental performance in supplier selection (Qorri et al., 2018). Thus, companies need to strive internally to acquire ISO 14001 certification. Finally, the “Environmental management systems exist” practice is

independent of obtaining ISO 14001 certification. If a company already operates an EMS, it is more viable to expand activities and use GSCM to minimize environmental impacts in the supply chain (Sellitto, 2018).

2.2.2. External green supply chain management (GSCM) practices

External GSCM practices are those related to suppliers' and customers' relationships. These practices directly and positively impact environmental performance (Zhu and Sarkis, 2004).

The practice of "Providing design specifications to suppliers that include environmental requirements for purchased items" is essential to transmit the desired customer's requirements on environmental issues. "Cooperation with suppliers for environmental objectives" allows organizations to make cost savings and reduce delivery time, consequently reducing inventory levels (Abdallah and Al-Ghwayeen, 2020). The "Environmental audit for suppliers' internal management" practice assures the buyer that environmental policies, internal policies, assessments of environmental impacts, quantifiable environmental targets, plans of action, and responsibilities are implemented (Abdallah and Al-Ghwayeen, 2020). The practice of requiring "Suppliers' ISO 14000 certification" may minimize the necessity of auditing suppliers. The practice of "Second-tier supplier environmentally friendly practice evaluation" is suitable when the second-tier supplier treats its customer (the first-tier supplier) as a trustful partner. Hence, it is expected to be more involved in the GSCM program (Dou et al., 2018). Finally, the practices of "Cooperation with customers for eco-design," "Cooperation with customers for cleaner production," and "Cooperation with customers for green packaging" represent a collective implementation of environmental practices with the customers of a firm to achieve a common green objective with the commitment of fewer resources (Vachon and Klassen, 2006). Firms' cooperation with their supply chain partners can lead to firms' green practices being effectively implemented (Agyabeng-Mensah et al., 2020).

2.2.3. Investment recovery

The practices of "Investment recovery (sale) of excess inventories/materials," "Sale of scrap and used materials," and "Sale of excess capital equipment" are inextricably related. According to Famiyeh et al. (2018, p.610), "[t]he investment recovery aspects of the GSCM practices involve the extent to which organizations take steps to initiate the sales of excess inventories, scrap, used materials, and excess capital equipment."

2.2.4. Eco-design

Eco-design practices focus on the ecological efficiency of production systems and the meeting of stakeholder demands (Liu et al., 2018). Eco-design is defined as "the systematic consideration of design issues associated with environmental safety and health over the full product life cycle, during new production and process development" (Amemba et al., 2013, p.54). Eco-design involves designing products corresponding to eco-criteria throughout their lifecycle, from the purchasing of raw materials to the product's final form (Abdallah and Al-Ghwayeen, 2020; Wongthongchai and Saenchaiyathon, 2019).

The practice of "Design of products for reduced consumption of material/energy" requires the selection of suppliers from the green concept perspective that provide a final product that is environmentally friendly (Mathiyazhagan et al., 2013). "Design of products for reuse, recycling, recovery of material, component parts" practices are used at the eco-design stage to decrease emissions and toxic materials, reduce energy consumption, and improve waste treatment throughout the product life cycle (Al-Ghwayeen and Abdallah, 2018). "Design of products to avoid or reduce use of hazardous of products and/or their manufacturing process" practices require firms to extend their environmental initiatives to their customers and suppliers (Al-Ghwayeen and Abdallah, 2018), reducing the occurrence of environmental accidents and improving public health (Yildiz Çankaya and Sezen, 2019).

2.3. Global reporting initiative (GRI)

The GRI established its guidelines as an internationally accepted framework that promotes comparable sustainability reporting (Isaksson and Steimle, 2009): "The objective of sustainability reporting using the GRI Sustainability Reporting Standards (GRI Standards) is to provide transparency on how an organization contributes or aims to contribute to sustainable development" (GRI, 2021, p.4). In this context, "the organization shall report information that is correct and sufficiently detailed to allow an assessment of the organization's impacts" (GRI, 2021, p.20).

Section 300 of the GRI establishes a set of environmental norms to create standard requirements enabling all organizations and stakeholders to increase their transparency and responsibility (Gallego-Álvarez et al., 2018). However, there are some criticisms of the GRI approach, which focuses on specific issues in organizations. Such an approach can be distanced from the general view of how the company deals with sustainability (Fonseca et al., 2014). The GRI Standards consist of the following (GRI, 2021, p.5) (see also Fig. 1):

1. Universal Standards:

- GRI 1: Foundation 2021 (GRI 1) outlines the purpose of the GRI Standards, clarifies critical concepts, and explains how to use the Standards.
- GRI 2: General Disclosures 2021 (GRI 2) contains disclosures that the organization uses to provide information about its reporting practices and other organizational details, such as its activities, governance, and policies.
- GRI 3: Material Topics 2021 (GRI 3) provides step-by-step guidance on how to determine material topics. GRI 3 also contains disclosures that the organization uses to report information about its process for determining material topics, its list of material topics, and how it manages each topic.

2. *Sector Standards*: The organization uses the Sector Standards that apply to its sectors when determining its Material Topics, and when determining what information to report for the Material Topics.

3. *Topic Standards*: The Topic Standards contain disclosures for the organization to report information about its impacts in relation to particular topics.

Section 1 has highlighted the linkage between the GRI and GSCM. However, based on the brief description of the GRI framework presented above, it can be seen that the GRI guidelines are too generic. Therefore, the specific link between GRI reporting items and GSCM practices in company reports may not be so evident. Thus, this aims research to identify GSCM practices in the GRI reports, even if they are not clearly declared.

2.4. Proposition development

Previous research has used GRI reports to investigate organizations' performance in varied contexts. Environmental information reported by international companies has been analyzed in light of GRI reports (Gallego-Álvarez et al., 2018). The information obtained from GRI reports has also been used to analyze a bank's own green regulation (Masud et al., 2018). Chen et al. (2015) used content analysis of manufacturing companies' GRI reports and financial reports in Sweden, China, and India, enabling the relationship between EMPs and company performance to be established. Further, Isaksson and Steimle (2009) discussed whether GRI-based sustainability reports really contain the information needed for judging corporate sustainability.

The literature review presented in Sections 2.1 and 2.2 reveals a possible link between GSCM practices and GRI Standards. This correspondence can enable the examination of GSCM practices throughout GRI reports to identify whether they really contain the information needed for judging a company's GSCM. Accordingly, it is possible to

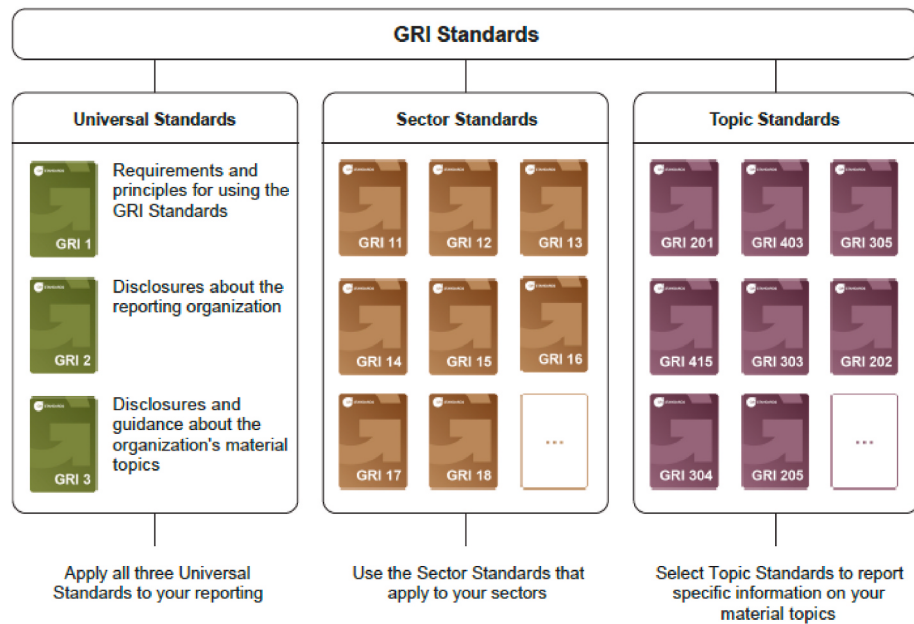


Fig. 1. GRI Standards structure (GRI, 2021, p.6).

infer the following propositions connecting the GSCM and GRI literature:

Proposition 1. *GRI reports can evidence the existence of GSCM practices.*

Proposition 2. *It is possible to identify the degree of a company's green supply chain transparency through the GRI report.*

3. Methodology

3.1. Research design

This research is qualitative and exploratory in nature, which is considered adequate for research seeking to understand complex phenomena in-depth (Ridder, 2017). The study addresses the possibility of identifying GSCM transparency from the analysis of GRI reports. It analyzes secondary data [GRI reports produced by companies listed on the Bovespa Stock Exchange (B3; https://www.b3.com.br/en_us/). This data source is convenient and appropriate. It is convenient as the Brazilian Securities and Exchange Commission (CVM) states that all companies listed in B3 must further follow the reference form of disclosure on socio-environmental information. Furthermore, supply chain management researchers should exploit archival and secondary data (Calantone and Vickery, 2010). It is appropriate because the number of codes necessary to investigate green practice usage by companies is high (Table 1). This makes it impracticable to collect all the information through a survey using questionnaires. Previous GRI research has also used qualitative methods to collect data (Fonseca et al., 2014; Isaksson and Steimle, 2009).

Table 1 presents the codes used for clustering the GSCM practices data. As stated in Section 2.2, the present work will use the categorizations proposed earlier by Zhu and Sarkis (2004) since the new propositions do not present further contributions to these GSCM practices.

3.2. Data collection

B3 companies are the empirical analysis units (Yin, 2018) in the present study. A total of 30 companies took part in the study because of the relevance of their annual reports as listed on B3 in terms of sustainability indicators. The present study also used four other criteria to select the empirical units of analysis (Ridder, 2017; Yin, 2018). First,

Table 1

GSCM practices' coding.

GSCM practices (Zhu and Sarkis, 2004)	Code
Internal environmental management	
1-Commitment to GSCM from senior managers	Commitment from senior management
2-Support for GSCM from mid-level managers	Support from mid-level managers
3-Cross-functional cooperation for environmental improvements	Cross-functional cooperation
4-Total quality environmental management	TQEM
5-Environmental compliance and auditing programs	Compliance and auditing
6-ISO 14001 certification	Internal ISO 14001
7-Environmental management systems exist	EMS
External GSCM practices	
1-Providing design specifications to suppliers that include environmental requirements for the purchased items	Design specifications for purchase
2-Cooperation with suppliers for environmental objectives	Cooperation with suppliers
3-Environmental audit for suppliers' internal management	Suppliers' audit
4-Suppliers' ISO 14000 certification	Suppliers' ISO 14001
5-Second-tier supplier environmentally friendly practice evaluation	Second-tier supplier evaluation
6-Cooperation with customers for eco-design	Eco-design cooperation
7-Cooperation with customers for cleaner production	Cleaner production cooperation
8-Cooperation with customers for green packaging	Cooperation for green packaging
Investment recovery	
1-Investment recovery (sale) of excess inventories/materials	Inventories/materials selling
2-Sale of scrap and used materials	Scrap selling
3-Sale of excess capital equipment	Equipment selling
Eco-design	
1-Design of products for reduced consumption of material/energy	Material and energy/reducing
2-Design of products for reuse, recycling, recovery of material, component parts	3R
3-Design of products to avoid or reduce the use of hazardous of products and/or their manufacturing process	Hazardous materials

companies should be Brazilian. Second, they should be from the industrial segment, where GSCM has greater relative prominence compared to other sectors, e.g. banks, auditors, and even retail. Third, companies should have operations in business networks composed of other companies (i.e. raw materials suppliers). Finally, the selected companies should act as focal companies of the supply networks. Such focal companies have the power to influence other members of the supply chain, establishing rules or exerting control over their operations (Nohria and Eccles, 1992). These companies have huge importance for Brazilian industry, in terms both of their longevity and being in permanent contact with the end consumer, thus structuring the activities and products offered to the market. Table 2 presents a representative profile of the fundamental characteristics. As GRI reporting is a public document, companies' names have been kept in the presentation of the results.

The authors obtained the data from companies' GRI reports listed in Table 2 and imported all GRI reports into NVivo software (released in March 2020). The coding process included searching for keywords related to each GSCM practice. For example, for exploiting the practice "Commitment to GSCM from senior managers," we employed the keyword "commitment" (in Portuguese) with its derivative words and synonyms. Subsequently, each paragraph that contained the relevant keyword was read to identify the practice. If found, we coded the practice's paragraph accordingly. To ensure reliability and replicability, the list of the keywords in Portuguese used in the coding process and their English equivalent is presented in the Appendix.

3.3. Data analysis

The data analysis process followed a structured approach adapted from Boiral and Henri (2017). Thus, three main steps guided the content analysis: developing a categorization framework; categorizing GSCM practices reported in the companies' GRI reporting; and qualitative interpretation of the data.

The categorization framework was developed using a list of practices identified from the literature and presented in Table 1. Overall, the categorization framework grouped 20 GSCM practices into four

dimensions (internal environmental management, external GSCM practices, investment recovery, and eco-design) (Zhu and Sarkis, 2004). It is worth noting that, during the coding process, the practices "Support for GSCM from mid-level managers" and "Cross-functional cooperation for environmental improvements" were considered to be closely related and, therefore, grouped into a single code.

For categorizing GSCM practices reported in the companies' GRI reporting, the researchers used NVivo's export tool to create a report for each practice. For example, the findings on the "Commitment of senior management" practice appeared in 30 GRI reports, and there were 35 references related to that practice. Considering the "Design specifications for purchase" practice, 72 references were distributed among 29 GRI reports. Subsequently, we used the GSCM practices dimensions to cluster the practices reported; for example, the "Material and energy/reducing," "3R," and "Hazardous materials" practices were clustered into the "Eco-design" dimension. An additional step was inserted by looking for duplicates. This was performed to ensure the accuracy and reliability of the sample coding, and this is coherent with the steps in coding the text proposed by Duriau et al. (2007). This step made it possible to exploit the GRI reports to identify the GSCM practices reported, in line with our first objective (to "use the GRI reports of a sample of companies to identify the GSCM practices reported"). Table 3 presents the GSCM categorization with 30 GRI reports selected for analysis and 380 references coded.

Qualitative data interpretation was based on the reference reports. Reports were analyzed to verify if they could reveal the transparency of companies' supply chain management practices. This study, as mentioned, used the GRI references (i.e. paragraphs coded) as a recording unit, and, for this reason, they may contain more than one theme (code) (Cullinane and Toy, 2000). Therefore, during the paragraph analysis, some were linked to another code. Thus, the researchers analyzed the paragraphs' content "to identify the degree of a company's green supply chain transparency through the GRI report," in line with our second objective.

Table 2
Companies' characteristics.

	Company	Report year	Segment	No. of employees	Year established
#1	AMBEV	2020	Beers and soft drinks	29,153	1999
#2	AREZZO	2021	Fabrics, clothing and footwear	2376	1972
#3	BIOSEV	2021	Sugar and alcohol	9778	2013
#4	BRASILAGRO	2021	Agriculture	366	2005
#5	BRASKEM	2020	Petrochemicals	7656	2002
#6	BRF	2021	Meat derivatives	>100,000	2013
#7	CELULOSE IRANI	2020	Pulp paper	2000	1941
#8	COSAN	2020	Exploration, refining, and distribution	45,000	1936
#9	DURATEX	2020	Wood	10,667	1961
#10	EMBRAER	2018	Aeronautical and defense equipment	19,116	1969
#11	FEBRASA	2020	Steel industry	3102	1961
#12	FRAS-LE	2018	Road material	2420	1954
#13	GERDAU	2020	Steel industry	28,350	1901
#14	HERING	2021	Clothing	4635	1880
#15	HERINGER	2017	Fertilizers and pesticides	3050	1968
#16	JBS	2020	Meat derivatives	142,000	1953
#17	KLABIN	2020	Pulp paper	14,874	1899
#18	M. DIAS	2020	Miscellaneous foods	17,100	1934
#19	METALFRIO	2019	Machines and equipment (industrial)	1060	1960
#20	MINERVA	2020	Meat derivatives	19,950	1957
#21	NATURA	2018	Personal use products	6635	1969
#22	PARANAPANEMA	2018	Copper artifacts	2202	1956
#23	PORTOBELLO	2020	Construction products	3607	1977
#24	POSITIVO	2018	Computers and equipment	1965	1989
#25	RAIZEN	2019	Sugar and alcohol	29,000	2010
#26	SÃO MARTINHO	2020	Sugar and alcohol	12,871	1907
#27	SUZANO	2020	Pulp paper	850	1924
#28	VALE	2020	Miner metallic	74,411	1942
#29	WEG	2020	Engines, compressors, and others	33,342	1961
#30	WHIRLPOOL	2020	Home appliances	78,000	1911

Table 3

Summary of the number of GRI reports and references for each GSCM practice.

GSCM practices' codes	Code acronym	No. of companies referencing this practice in their GRI reports	No. of references
Internal environmental management	IEM		
Commitment senior management	CSM	30	35
Compliance and auditing	COM	1	2
EMS	EMS	29	30
Internal ISO 14001	ISO-I	18	18
Support mid-level manager/Cross-functional cooperation	SMM	29	38
TQEM	TQEM	1	1
Total references for IEM			124
External GSCM practices	PRAC-E		
Cooperation with suppliers	CwS	2	3
Eco-design cooperation	EDC	6	9
Cleaner production cooperation	CPC	10	11
Cooperation for green packaging	CGP	2	4
Design specifications for purchase	DSP	29	72
Second-tier supplier evaluation	2 TE	0	0
Suppliers' audit	SUP-A	18	25
Suppliers' ISO 14001	ISO-E	3	4
Total references for PRAC-E			128
Investment recovery	INV-R		
Equipment selling	EQU-S	0	0
Inventories/materials selling	IMS	3	4
Scrap selling	SCR-S	2	2
Total references for INV-R			6
Eco-design	ECO-D		
3R	3R	18	48
Hazardous materials	H-MAT	17	26
Material and energy/ reducing	MAT-R	19	48
Total references for ECO-D			122
Total		30	380

4. Results: analysis and discussion

The results and analysis followed a thematic-theoretical structure, subdivided into the four fundamental practices/dimensions associated with GSCM. Although the categorization structure was well defined, the GRI reports analysis was more difficult than initially anticipated. Each GRI report had its own design in terms of sections, and similar practices

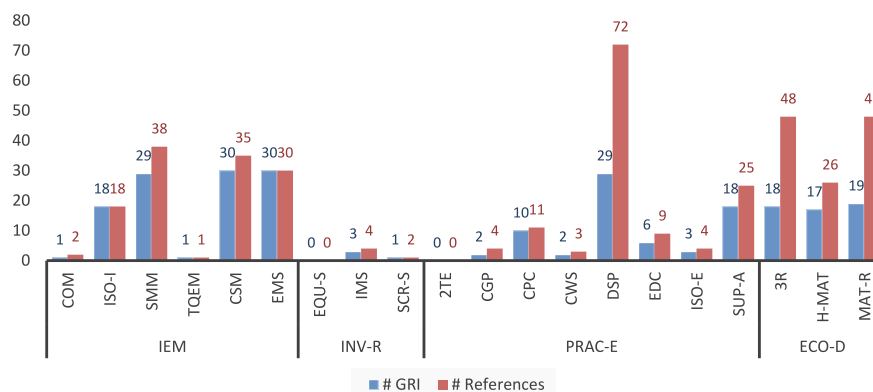
appeared under different approaches and sometimes in distinct sections of the GRI reports. Therefore, while looking for the GSCM practices in the GRI reports, following the process described in Section 3.3, the authors needed to anticipate some analysis to guarantee the proper practice coding. As shown in Table 3, only the practice “Inventories/materials selling” did not appear in any GRI report. Thus, the first proposition was confirmed (GRI reports can evidence the existence of GSCM practices).

To facilitate the comparison between the numbers of GRI reports and references, the data presented in Table 3 are illustrated in a graphical form in Fig. 2. It is easy to verify that companies do not have a homogeneous way of reporting their GSCM practices. Out of 20 GSCM practices, 11 were cited by less than 10 GRI reports. A total of nine practices appeared in more than half of the GRI reports. Only a few practices were recurrent in most of reports, namely “Commitment of senior management” (CSM) ($n = 30$), “Environmental management system” (EMS) ($n = 29$), “Support from mid-level managers”/“Cross-functional cooperation” (SMM) ($n = 29$), and “Design specifications for purchase” (DSP) ($n = 29$). The most representative dimension was “Eco-design,” with 122 references distributed among only three practices, and the least representative was the “Investment recovery” dimension.

The absence of uniformity in the GRI reports' practice reporting made the qualitative objective of identifying the practice's degree implementation challenging. However, this diversity in describing the practices enabled a rich content analysis regarding how each company sees the importance of GSCM practices. This finding reinforced the second proposition (“It is possible to identify the degree of a company's green supply chain transparency through the GRI report”). The content analysis of the references coded to detect the degree of a company's green supply chain transparency is presented in the following subsections using the following notation [references' percentage in the GSCM practices dimension (number of references)].

4.1. Internal environmental management

In this dimension, GSCM originally incorporated seven primary practices associated with internal environmental management. However, as mentioned in Section 3.3, two practices were merged, reducing this dimension to six codes. Documentary evidence from the 30 companies' GRI reports allowed us to identify some fundamental findings. First, among the internal practices, those associated with “Support for GSCM from mid-level managers” and “Cross-functional cooperation for environmental improvements,” considered as one code, stand out [31% ($n = 38$)]. This was followed by “Commitment to GSCM from senior managers” [28% ($n = 35$)] and “Environmental management systems exist” [24% ($n = 30$)]. The three internal practices that companies reported least in their GRI reports were “ISO 14001 certification” [15% ($n = 18$)], “Environmental compliance and auditing programs” [1% ($n =$

**Fig. 2.** GRI reports and frequency distribution by GSCM practices.

2)], and “Total quality environmental management” [1% ($n = 1$)].

Regarding the “Commitment to GSCM from senior managers,” all 30 companies presented associated evidence, notably AmBev and Embraer (both with three references each) and Metalfrío and Whirlpool (with two references each). For instance, AmBev emphasized how “the board and management monitor the actions developed with partners and manage them through the Global Procurement Responsibility Policy program.” Similarly, Embraer highlighted how different stakeholders, including vice presidents, cross-referenced the subject, submitting their various company CEOs to a company sustainability committee. Despite this, it should be noted that none of the 30 companies presented an explicit declaration of their GSCM commitment. Instead, the authors categorized the records inductively, inferentially, from the statements on environmental commitments presented by the companies. Another aspect that drew attention was the small number of companies that mentioned the environmental commitment they had, or requirements for other companies (downstream or upstream of their chain). Only three companies raised concerns (AmBev, Minerva, and Vale) in this context. For example, Vale emphasized how “most of our emissions are in the value chain” and how the company’s goals are aligned with the Paris Agreement’s ambitions. Although senior management commitment was not explicitly stated, as far as GSCM is concerned, this sends a strong message of commitment and trust (Dou et al., 2018).

Regarding “Support for GSCM from mid-level managers” and “Cross-functional cooperation for environmental improvements,” both categories showed a common characteristic, namely that the managers’ contribution occurred mainly through the integrated management of environmental improvement, expressed for example in committees and councils, among others. For example, Frax-le, a company with three records in each category, emphasized the existence of a corporate management system with “fundamental guidelines to ensure the planning, execution, analysis, and improvement of all company processes.” Similarly, Hering, a company with two references in both categories, emphasized how one mixed council conducts the GSCM and the cross-functional cooperation for environmental improvements. Such a mixed council comprises company members and an independent advisor: “This Committee aims to create a force to transform the vision of employees and the Company regarding sustainable issues.” Further, according to Hering, the Committee’s function is “to advise the Board on deliberations regarding the Company’s sustainability policies and practices, ensuring the integration of sustainability into the business strategy.” The support level from the middle-level management on environmental issues may ensure reaching environmental sustainability as a strategic organizational goal (Abdallah and Al-Ghwayeen, 2020; Zhu et al., 2008).

The “Total quality environmental management” category drew attention for its almost complete absence from the reports. Only one company, Raizen, showed explicit evidence related to the topic, although this did not directly report on environmental quality but rather on work safety. According to this company, the unit’s administrative coordinator, the operational managers, and at least one service member specializing in engineering, safety, and occupational medicine attend the total quality meetings. Considering that the TQEM practice is practically not mentioned in the GRI reports analyzed and that TQM improvement programs are more likely to implement GSCM practices (Green et al., 2019), it is reasonable that this aspect should be better related in the GRI reports.

Regarding the “Environmental compliance and auditing programs,” only AmBev clearly showed such concern in its report. The company’s goal is that, by 2025, “100% of ... electricity comes from renewable sources.” Also, according to the company, they are “committed to reducing 25% of carbon emissions throughout our value chain.” While the terms “compliance” and “internal audit programs” appeared in all reports, they specifically refer to ethics and business risk. In a recent study, Agarwal et al. (2018) identified that implementing environmental compliance and auditing programs’ practices ranked the highest in a

survey concerning GSCM adoption administered to middle and senior-level managers of US manufacturing companies. Based on the Brazilian GRI analysis, it is impossible to infer that the Brazilian companies are not implementing this practice. Although this practice is either poorly related, or not related at all, it can enable better reporting of environmental compliance and auditing programs in GRI reports.

Concerning “ISO 14001 certification,” only 18 reports (60%) presented data related to the topic. For example, BRF emphasized how all environmental issues follow guidelines guided by ISO 14001. Despite this, in a complimentary analysis of the other companies, the authors observed how they appear to have a robust EMS. ISO 14001 certification is essential for environmental impact assessment, and it enables customers’ green requirements to be met (Kumar et al., 2019). Furthermore, ISO 14001 can help firms to achieve sustainability goals and the implementation of GSCM (Jabbour, 2010). Therefore, it is somewhat worrying that 40% of companies are not ISO 140001 certified.

Finally, the last internal practice relates to “Environmental management systems exist.” A total of 30 companies investigated showed evidence related to the topic. For example, Arezzo recognized the company’s recent advancements in environmental management. Since 2020, the company has focused more prominently on demands related to environmental legislation. In turn, Duratex emphasized how its system even incorporates the “management and monitoring of non-conformities.” Hering pointed out how it maintains a sustainability committee, according to the company, to “support the Board of Directors in all aspects related to the environment.” The group “identifies and discusses issues that impact results ... in order to mitigate any damage to natural resources.” GRI reports are an important part of any companies’ strategies for transparency of sustainability outcomes (Isaksson and Steimle, 2009). Therefore, it is reasonable for the reporting of the existence of an EMS to gain prominence in GRI reports.

4.2. External green supply chain management (GSCM) practices

Among the external practices, those associated with “Providing design specifications to suppliers that include environmental requirements for purchased items” [56% ($n = 72$)] and “Cooperation with suppliers for environmental objectives” [2% ($n = 3$)] stand out. The joint analysis of these practices occurred because the documentary evidence related to the first item proved to be directly related to the second. In other words, the reports of companies associated with the “Providing design specifications to suppliers that include environmental requirements for purchased items” also referred to “Cooperation with suppliers for environmental objectives.” The practice of “Environmental audit for suppliers’ internal management” also shows relative importance [20% ($n = 25$)]. While these three items stand out positively, the opposite is true for others. For example, none of the 30 companies presented evidence associated with “Second-tier supplier environmentally friendly practice evaluation” [0% ($n = 0$)]. These data show little concern among the companies investigated for evaluating green practices along the production chain. Other practices that the companies also little explored were “Cooperation with customers for cleaner production” [9% ($n = 11$)], “Cooperation with customer for eco-design” [7% ($n = 9$)], “Suppliers’ ISO 14000 certification” [3% ($n = 4$)], and “Cooperation with customers for green packaging” [3% ($n = 4$)].

All companies showed related evidence regarding “Providing design specifications to suppliers that include environmental requirements for purchased items” and “Cooperation with suppliers for environmental objectives.” For example, Arezzo emphasized how “to be approved, the supplier must insert documents related to its social and environmental practices.” Among the companies, M. Dias stands out, with nine associated references. This company highlighted how it seeks to “develop sustainable management with suppliers of critical inputs, based on criteria for selecting, qualifying, monitoring and developing suppliers.” In addition, it highlighted how it seeks to “qualify 100% of suppliers of raw materials considered critical to the business,” demonstrating

cooperation with suppliers. Despite this, still concerning “Cooperation with suppliers for environmental objectives,” it was noted that such “cooperation” occurs in response to contractual clauses and only sporadically through joint non-contractual initiatives. For example, Brasilagro highlighted how the “standard draft of contracts provides for fines to suppliers in case of deviations from the company’s premises and guidelines.” Regarding non-contractual partnerships, Celulose Irani highlighted how, regarding qualification, “there are records of suppliers and service providers that come to us for a joint analysis of opportunities to improve their practices.” Note how such an initiative goes beyond a mandatory dimension set out in contracts. Despite the number of references in GRI reports associated with these items, some “Cooperation with suppliers” issues were not addressed. For example, the analysis did not identify green packaging development actions, which reinforces that cooperation with suppliers for packaging development is an issue that needs attention (Choudhary and Singh Sangwan, 2021).

“Environmental audit for suppliers’ internal management” is another representative practice. Fras-le and Whirlpool stand out, with three references related to the topic. For example, Whirlpool adopts a risk-based approach to external supplier audits. According to the company, “all suppliers with identified issues must provide a corrective action plan and may be audited by a second time based on the severity of the audit results.” Fras-le highlighted how all suppliers disclose their results to the company. Such suppliers can even monitor their monthly indicators through an online platform. However, some aspects related to the audit stand out. For example, the term appears in GRI reports more associated with internal than external audits. In turn, when related to external audits, these aspects seem mainly associated with social issues to the detriment of environmental ones, which are fewer in number. On the one hand, this finding suggests the relevance for companies of social rather than environmental dimensions. However, on the other hand, it can also express the relative immaturity of companies regarding environmental issues or little concern for better detailing practices in their reports. An important point is that companies usually replace suppliers’ environmental auditing with the requirement to have ISO 14000 certification (McGrath et al., 2021).

Regarding “Suppliers’ ISO 14000 certification,” only four records related to three companies showed relative information (Celulose Irani, Fras-le, and Positivo). That is, only 10% of the investigated companies appeared to consider or require ISO 14001 in the evaluation of their suppliers. We may relate this result to an ultimately rigorous process of audits and inspections of the raw materials received, reducing the requirement for such certification. For example, for Celulose Irani, the qualification of pulp and paper suppliers is re-validated annually. The company seeks to assess the ability of suppliers to meet the requirements proposed, among others, by the ISO 14001 standard. Big companies, such as those investigated within this research, normally require ISO 14001 certification from their suppliers (Vachon and Klassen, 2006; Yu et al., 2014). Therefore, the small number of references to “Suppliers’ ISO 14000 certification” may require further investigation.

Another category stands out: “Second-tier supplier environmentally friendly practice evaluation.” None of the 30 companies reported assessing second-tier suppliers, restricting their reporting to first-tier suppliers only. Usually, focal companies evaluate and assess their second-tier through first-tier suppliers or third-parties (Dou et al., 2018). Second-tier evaluation may subsequently occur, but it is not reported in companies’ GRI reports because they refer only to the first-tier actions.

The last three practices are “Cooperation with customer for eco-design”, “Cooperation with customers for cleaner production”, and “Cooperation with customers for green packaging.” Concerning “Cooperation with customers for cleaner production,” Whirlpool highlighted how the company seeks to design “for efficiency,” helping consumers reduce energy and water usage while saving time and effort. In this vein, Vale highlighted how it engages with “clients to promote innovative technologies to reduce emissions (e.g., bioenergy, hydrogen, and CCUS–Carbon Capture, Utilization, and Storage).” Finally, regarding

“Cooperation with customers for green packaging,” only Celulose Irani and Ambev highlighted this practice. According to Celulose Irani, “packaging engineering creates a prototype, which is submitted for customer approval before production.” In addition, the company emphasized how it seeks “lighter and more resistant cases, ensuring higher performance and lower weights.” However, the documents revealed no solid cooperative relationship with customers on eco-design, cleaner production, or green packaging. On the other hand, Celulose Irani showed that it had developed a more eco-friendly product internally, with green packaging, and that used cleaner production, offering it to the market. From 128 references to the “External GSCM practices” dimension, only 19% (24 references) were related to cooperation with consumers, showing that GRI reports can improve reporting on these practices. However, supposing that companies are still developing these practices, they can achieve more effective cooperation with customer companies by investing in environmental education, which plays a key role in realizing green practices (Yildiz Çankaya and Sezen, 2019).

4.3. Investment recovery

Among the four dimensions of interest in this study, reports related to investment recovery are the ones companies explored the least. Even considering the three fundamental practices (equipment selling, excess material selling, and scrap selling), the companies generated only five records, four in excess material selling and only one associated with scrap selling. Therefore, none of the 30 companies reported initiatives associated with equipment selling. Among the excess material selling practices, Biosev had two references, and Duratex and Febrasa had one reference each. Biosev emphasized selling the surplus energy produced to the interconnected national system, destined to supply the municipalities. In addition, the company emphasized how it has advanced in the commercialization of the surplus “of energy generated by the processing of sugarcane bagasse, with purchase and sale contracts that enhance our financial performance.” Regarding scrap selling, only Celulose Irani and Minerva presented an associated record. According to Celulose Irani, it sold BRL 1200 in waste sales, and Minerva stated that it “seeks to work on reverse logistics and the circularity of the waste generated, selling materials with licensed third-party companies.” Investment recovery is about trying to include obsolete equipment, end-of-life products, and surplus items in the reverse logistics process, so that they can be recovered or disposed of correctly (Yildiz Çankaya and Sezen, 2019). However, reverse logistics systems in Brazil are under development (Rebehy et al., 2019), making the investment recovery through equipment selling, excess material selling, and scrap selling a challenging operation.

4.4. Eco-design

Among the three practices related to eco-design (design for 3R, hazardous materials, and material and energy reduction), the first and third stand out as the most emphasized, both [39% ($n = 48$)]. Both categories combined accounted for 78% of the records associated with this topic. Hazardous materials appeared in third place among the most mentioned practices [21% ($n = 26$)]. Regarding specifically the design for 3R, only 18 companies (60% of the total) presented related evidence, notably Whirlpool [19% ($n = 9$)], Natura [15% ($n = 7$)], and JBS [10% ($n = 5$)].

For example, Whirlpool emphasized how the company’s goal is to “make sure they recycle all products as much as possible.” For this, the company created a Sustainable Packaging Manual in 2020, aiming, according to the organization, “to boost innovation and packaging solutions.” Also, in this regard, Natura emphasized how, in 2018, it registered changes in the company’s commitment to collecting and disposing of the items it produces. The goal was to recycle “50% of the waste generated by Natura product packaging in Brazil by 2020, in

equivalent tons.” In addition, the company highlighted how it has started “selling oil and alcohol waste, which can be used in the manufacture of cleaning products and biodiesel.” Regarding hazardous materials, 17 companies (57%) reported having related initiatives. Among them, Weg, Brasilagro, Braskem, Fras-le, JBS, Suzano, and Whirlpool stand out. Weg emphasized that it has created a list of restricted substances, which is regularly updated based on major national and international regulations. According to the company, this list contributes “in several stages of the processes, such as manufacturing products and packaging.” In turn, Braskem is aiming to expand what the company calls the “I’m Green portfolio.” The idea is to include “300,000 tonnes of thermoplastic resins and chemicals with recycled content by 2025, and 1 million tonnes of these products by 2030.” Finally, 19 companies generated 48 records with material and energy reduction evidence. Again, Whirlpool stands out [18% ($n = 9$)], with triple the number of references compared to Portobello, the company with the second most references. According to Whirlpool, it has been working to “reduce to reduce emissions to keep global warming below 2 °C.” For this, Whirlpool emphasized that it is improving the greenhouse gas emissions management system, launched in 2018. In addition, the company reported that it is investing in innovations that automate water levels, increase plastic recycling, and increase water and energy efficiency. The three eco-design practices were better represented within the associated eco-design dimension when contrasted to the others GSCM dimensions.

The high performance of reporting eco-design practices is linked to the fact that these practices show how companies are minimizing their environmental impact over the product lifecycle (Agarwal et al., 2018). This is extremely important for GRI reports, the purpose of which is to create reports that integrate the social, environmental, and economic impacts of the business (Isaksson and Steimle, 2009).

5. Conclusions

In this study, we have focused on how GRI reports evidence the existence of GSCM practices and whether it is possible to identify the degree of the company’s green supply chain transparency using GRI reports. Building on a qualitative content analysis of 30 companies’ GRI reporting, the research has revealed that a representative number of GSCM practices can be found within the GRI reports. However, these practices are not related clearly. Further, the study has revealed that, for the degree of GSCM’s transparency be intentionally addressed in the GRI reports, some practices need to receive more attention during the elaboration of these reports.

5.1. Theoretical implications

This paper contributes to GSCM theory because it advances the study of GSCM practices by shedding light on firms’ environmental awareness through GRI reports. GRI reports have been used for the investigation of several issues pertaining to environmental initiatives (Boiral and Heras-Saizarbitoria, 2017; Chen et al., 2015; Isaksson and Steimle, 2009). However, the exploitation of GRI reports for information about GSCM practices has been investigated by few studies, and only in a tangential way (Chen et al., 2015; Gallego-Álvarez et al., 2018; Isaksson and Steimle, 2009). Therefore, this article extends previous studies by offering a theoretical linkage between GSCM practices and GRI reports. In a general way, this article presents a new look at environmental practices disclosed in the GRI reports to assess the transparency of GSCM practices. Besides these more comprehensive contributions to theory, it is possible to present more specific implications.

First, by identifying the relevance of GRI reports to the mapping of GSCM, this article contributes to filling a gap regarding the still limited understanding of the relevance of such reports in mapping GSCM and its transparency, especially concerning three of its dimensions: internal environmental management; external GSCM practices; and eco-design. Second, concerning internal environmental management, this study

suggests the relevance of integrating practices 2 and 3, related to “Support for GSCM from mid-level managers” and “Cross-functional cooperation for environmental improvements.” In this sense, although recent studies have already suggested improvements to Zhu and Sarkis’s (2004) model, none of them have advanced the proposition as has been called for (Pinto, 2020; Tseng et al., 2019). Therefore, the theoretical linkage between the GRI and GSCM adds value to theory by presenting a novel view of GSCM practices’ transparency through the generic GRI guidelines. Further, our steps used to code and analyze the reports can benefit scholars and practitioners in adopting or customizing them in novel contexts.

5.2. Practical and managerial implications

This article also has five important practical and managerial implications. First, although GRI reports provide evidence of GSCM practices, there is no standardization in their disclosure. In this sense, defining a standard for GRI reports, including criteria for disclosing practices associated with the GSCM, would be extremely welcome. Such standardization would allow managers, scholars, and policymakers to perform a comparative assessment between companies and extract benchmarking examples for each dimension more easily. They should mainly associate such benchmarking with eco-design, external GSCM practices, and internal environmental management dimensions, which presented more practices among the investigated companies.

Second, it is noteworthy that, among the dimensions, eco-design also stands out for the consistency between the number of companies presenting related reports and the number of references obtained. All three practices related to the dimension had between 17 and 19 companies that presented records, with a slight variation in the number of companies concerning the practices for the other three dimensions. For example, in the “Internal environmental management” dimension, while all 30 companies registered practices related to “Commitment senior management,” only one of them presented evidence related to TQEM. Such a finding may ultimately signal companies’ level of maturity in relation to the dimensions and their practices. In other words, while all eco-design practices seem to be more established or mature among industrial companies, those related to investment recovery, or even internal environmental management, are still little explored. This finding suggests an important practical implication. As the maturity of eco-design practices shows a minimum standard required of companies in the sector, managers and scholars could eventually understand practices that are still little reported as opportunities for companies to act or explore, thus helping them to stand out from the competition. For instance, only a few companies reported TQEM or cooperation in green packaging practices. Acting on such practices could make companies stand out in the industrial context.

The third implication is directly associated with the previous one. Companies have few initiatives related to, for example, investment recovery, thus highlighting the importance of investing in such initiatives. A fourth implication that companies need to make their statements about GSCM commitment clearer. In fact, none of the 30 companies investigated explicitly presented such a statement. By doing so, such companies, as they are central and focal, could demand similar commitments from companies downstream and upstream in their supply chain. Finally, a fifth implication is related to the importance of organizations investing more in committees and councils, which are at the heart of managing two essential internal practices: “Support for GSCM from mid-level managers;” and the “Cross-functional cooperation for environmental improvements.” Indeed, companies that have boards and committees seem more likely to develop both practices.

5.3. Policy implications

Since the present study only incorporated focal companies and, given their relevance to the entire supply chain, public policymakers could

create legal instruments that stimulate the impact of such companies in the layers of the production chain. In doing so, policymakers could stimulate the development of the chain through the actions of the focal companies. This initiative could be achieved, for example, through legal documents that stipulate minimum and standardized rules for the dissemination of GSCM results. Such documents could, for example, stipulate the need for companies to declare the absence of practices related to each of the dimensions, if applicable.

5.4. Limitations and suggestions for further studies

This study is not exempt from limitations. One of them lies in the difficulty in mapping the level of implementation of practices in the reports. Although the present study identified the initiatives' presence and relevance based on the number of its records, such assessments cannot suggest their level of intensity in terms of use. As mentioned above, this difficulty was partly because of the lack of uniformity in reporting practices. A second limitation relates to the categorizations, which occurred inductively, from the understanding of the researchers; therefore, they may be subject to criticism related to possible interpretation bias. For example, the researchers' analysis enabled, inductively, extracting GSCM commitment statements from the studied companies.

Novel studies could remedy the limitations presented above and develop essential avenues of research that remain little explored. For example, new research could investigate possible dependencies between practices and dimensions, addressing questions such as whether there are practices that give rise to others, or whether they are dependent on them, and if so, how such practices could be encouraged. For example, field analysis suggested that "Providing design specifications to suppliers that include environmental requirements for purchased items" and "Cooperation with suppliers for environmental objectives" are related to each other. Identifying other associations or dependencies could help companies better plan practices together.

Second, future studies could analyze whether there is any linear or recursive relationship between practices and dimensions. For example, longitudinal studies could show whether companies start with internal practices and then move to external ones, or vice versa. In this sense, these studies would contribute by demonstrating the existence of a path of practices to be followed until reaching relative maturity in GSCM.

Third, longitudinal studies on GRI reports would also be helpful in identifying the evolution of reporting by companies. In doing so, scholars could investigate, through these accounts, which areas or practices are gaining or losing business relevance over time.

Fourth, future studies could investigate companies' investment recovery practices, analyzing the reasons for their low incidence in GRI reports.

Fifth, although anecdotal evidence has alluded to the relevance of middle management in performing internal practices, further studies could investigate the associated influence, addressing questions such as how middle management impacts internal practices and practices in other dimensions. Such studies could shed light on the differentiated relevance of organizational levels to GSCM practices, developing models that encourage the combined participation of different professionals.

Finally, further studies could break down GSCM practices into deeper levels of activities. For example, given recent interest in the literature, a study on micro-practices could shed new light on the set of operational initiatives associated with each of the practices and dimensions.

CRediT authorship contribution statement

Marcio Cardoso Machado: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Victor Silva Correa:** Methodology, Writing – original draft, Writing – review & editing. **Maciel Manoel de Queiroz:** Validation, Writing – original draft, Writing – review & editing. **Getúlio Camelo Costa:** Conceptualization, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix

Table A1
Keywords for coding process

GSCM practices' codes	Keyword (Portuguese)	Correspondence to English language
Internal environmental management		
Commitment senior management	comprometimento	commitment
Compliance and auditing	compliance AND auditoria	compliance AND audit
EMS	sistema de gestão Ambiental	environmental management system
Internal ISO14001	ISO 14000 AND ISO 14001	ISO 14000 AND ISO 14001
Support mid-level manager/Cross-functional cooperation	Gerencia AND interfuncional	Manage AND cross-functional
TQEM	qualidade total	total quality
External GSCM practices		
Cooperation with suppliers	cooperação AND fornecedores	cooperation AND suppliers
Eco-design cooperation	cooperação AND eco-design	cooperation AND eco-design
Cleaner production cooperation	cooperação AND Produção mais limpa	cooperation AND Cleaner production
Cooperation for green packaging	Cooperação AND embalagem	cooperation AND packaging
Design specifications for purchase	compra AND design	purchase AND design
Second-tier supplier evaluation	auditoria	audit
Supplier's audit	auditoria	audit
Suppliers' ISO14001	ISO 14000 AND ISO 14001	ISO 14000 AND ISO 14001
Investment recovery		
Equipment selling	INV-R	
Inventories/materials selling	equipamento	equipment
Scrap selling	estoque and material	stock and material
Eco-design	sucata	waste
3R	reuso AND reciclagem AND redução	reuse AND recycling AND reduction

(continued on next page)

Table A1 (continued)

GSCM practices' codes	Keyword (Portuguese)	Correspondence to English language
Hazardous materials Material and energy/reducing	perigoso energia	hazardous energy

References

- Abdallah, A.B., Al-Ghwayeen, W.S., 2020. Green supply chain management and business performance: the mediating roles of environmental and operational performances. *Bus. Process Manag. J.* 26, 489–512. <https://doi.org/10.1108/BPMJ-03-2018-0091>.
- Agarwal, A., Giraud-Carrier, F.C., Li, Y., 2018. A mediation model of green supply chain management adoption: the role of internal impetus. *Int. J. Prod. Econ.* 205, 342–358. <https://doi.org/10.1016/j.jipe.2018.09.011>.
- Agyabeng-Mensah, Y., Ahenkorah, E., Afum, E., Nana Agyemang, A., Agnikpe, C., Rogers, F., 2020. Examining the influence of internal green supply chain practices, green human resource management and supply chain environmental cooperation on firm performance. *Supply Chain Manag.* 25, 585–599. <https://doi.org/10.1108/SCM-11-2019-0405>.
- Al-Ghwayeen, W.S., Abdallah, A.B., 2018. Green supply chain management and export performance: the mediating role of environmental performance. *J. Manuf. Technol. Manag.* 29, 1233–1252. <https://doi.org/10.1108/JMTM-03-2018-0079>.
- Amemba, C.S., Nyaboke, P.G., Osoro, A., Mburu, N., 2013. Elements of green supply chain management. *Eur. J. Bus. Manag.* 51, 51–61.
- Bag, S., Gupta, S., Kumar, S., Sivarajah, U., 2020. Role of technological dimensions of green supply chain management practices on firm performance. *J. Enterprise Inf. Manag.* 34, 1–27. <https://doi.org/10.1108/JEIM-10-2019-0324>.
- Boiral, O., Henri, J.F., 2017. Is sustainability performance comparable? A study of GRI Reports of Mining Organizations. *Bus. Soc.* 56, 283–317. <https://doi.org/10.1177/0007650315576134>.
- Boiral, O., Heras-Saizarbitoria, I., 2017. Corporate commitment to biodiversity in mining and forestry: identifying drivers from GRI reports. *J. Clean. Prod.* 162, 153–161. <https://doi.org/10.1016/j.jclepro.2017.06.037>.
- Calantone, R.J., Vickery, S.K., 2010. Introduction to the special topic forum: using archival and secondary data sources in supply chain management research. *J. Supply Chain Manag.* 46, 3–11.
- Carter, C.R., Rogers, D.S., 2008. A framework of sustainable supply chain management: moving toward new theory. *Int. J. Phys. Distrib. Logist. Manag.* 38, 360–387. <https://doi.org/10.1108/09600030810882816>.
- Chen, L., Tang, O., Feldmann, A., 2015. Applying GRI reports for the investigation of environmental management practices and company performance in Sweden, China and India. *J. Clean. Prod.* 98, 36–46. <https://doi.org/10.1016/j.jclepro.2014.02.001>.
- Cherrafi, A., Garza-Reyes, J.A., Kumar, V., Mishra, N., Ghobadian, A., Elfezazi, S., 2018. Lean, green practices and process innovation: a model for green supply chain performance. *Int. J. Prod. Econ.* 206, 79–92. <https://doi.org/10.1016/j.jipe.2018.09.031>.
- Chiari, A., 2017. Environmental policies for evaluating suppliers' performance based on GRI indicators. *Bus. Strat. Environ.* 26. <https://doi.org/10.1002/bse.1907>.
- Choudhary, K., Singh Sangwan, K., 2021. Green supply chain management pressures, practices and performance: a critical literature review. *Benchmark: Int. ahead-of-print*. <https://doi.org/10.1108/BIJ-05-2021-0242>.
- Cousins, P.D., Lawson, B., Petersen, K.J., Fugate, B., 2019. Investigating green supply chain management practices and performance: the moderating roles of supply chain ecocentricity and traceability. *Int. J. Oper. Prod. Manag.* 39, 767–786. <https://doi.org/10.1108/IJOPM-11-2018-0676>.
- Cullinane, K., Toy, N., 2000. Identifying influential attributes in freight route/mode choice decisions: a content analysis. *Transport. Res. Part E* 36, 41–53.
- Diab, S.M., Al-Bourini, F.A., Abu-Rumman, A.H., 2015. The impact of green supply chain management practices on organizational performance: a study of Jordanian food industries. *J. Manag. Sustain.* 5, 149–157.
- Dou, Y., Zhu, Q., Sarkis, J., 2018. Green multi-tier supply chain management: an enabler investigation. *J. Purch. Supply Manag.* 24, 95–107. <https://doi.org/10.1016/j.pursup.2017.07.001>.
- Duriau, V.J., Reger, R.K., Pfarrer, M.D., 2007. A content analysis of the content analysis literature in organization studies: research themes, data sources, and methodological refinements. *Organ. Res. Methods* 10, 5–34. <https://doi.org/10.1177/1094428106289252>.
- Famiyeh, S., Kwarteng, A., Asante-Darko, D., Dadzie, S.A., 2018. Green supply chain management initiatives and operational competitive performance. *Benchmarking* 25, 607–631. <https://doi.org/10.1108/BIJ-10-2016-0165>.
- Fonseca, A., McAllister, M.L., Fitzpatrick, P., 2014. Sustainability reporting among mining corporations: a constructive critique of the GRI approach. *J. Clean. Prod.* <https://doi.org/10.1016/j.jclepro.2012.11.050>.
- Gallego-Álvarez, I., Lozano, M.B., Rodríguez-Rosa, M., 2018. An analysis of the environmental information in international companies according to the new GRI standards. *J. Clean. Prod.* 182, 57–66. <https://doi.org/10.1016/j.jclepro.2018.01.240>.
- Green, K.W., Inman, R.A., Sower, V.E., Zelbst, P.J., 2019. Impact of JIT, TQM and green supply chain practices on environmental sustainability. *J. Manuf. Technol. Manag.* 30, 26–47. <https://doi.org/10.1108/JMTM-01-2018-0015>.
- GRI, 2021. GRI 1: foundation 2021. In: Global Sustainability Standards Board (GSSB). GRI Standards, pp. 1–39.
- Isaksson, R., Steimle, U., 2009. What does GRI-reporting tell us about corporate sustainability? *TQM J.* 21, 168–181. <https://doi.org/10.1108/17542730910938155>.
- Jabbour, C.J.C., 2010. Non-linear pathways of corporate environmental management: a survey of ISO 14001-certified companies in Brazil. *J. Clean. Prod.* 18. <https://doi.org/10.1016/j.jclepro.2010.03.012>.
- Jannat Tumpa, T., Mithun Ali, S., Hafizur Rahman, M., Kumar Paul, S., Chowdhury, P., Abdul Rehman Khan, S., 2019. Barriers to green supply chain management: an emerging economy context. *J. Clean. Prod.* 2019, 1–12. <https://doi.org/10.1016/j.jclepro.2019.117617>.
- Kazancoglu, Y., Kazancoglu, I., Sagnak, M., 2018. A new holistic conceptual framework for green supply chain management performance assessment based on circular economy. *J. Clean. Prod.* 2018, 1282–1299. <https://doi.org/10.1016/j.jclepro.2018.06.015>.
- Kumar, N., Brint, A., Shi, E., Upadhyay, A., Ruan, X., 2019. Integrating sustainable supply chain practices with operational performance: an exploratory study of Chinese SMEs. *Prod. Plann. Control* 30, 464–478. <https://doi.org/10.1080/09537287.2018.1501816>.
- Li, G., Li, L., Choi, T.-M., Suresh, J., Sethi, P., Kumar, S., Narayanan, S., Salvador, F., 2020. Green supply chain management in Chinese firms: innovative measures and the moderating role of quick response technology. *J. Oper. Manag.* 2020, 958–988. <https://doi.org/10.1002/joom.1061>.
- Liu, J., Feng, Y., Zhu, Q., Sarkis, J., 2018. Green supply chain management and the circular economy: Reviewing theory for advancement of both fields. *Int. J. Phys. Distrib. Logist.* 48, 794–817. <https://doi.org/10.1108/IJPDLM-01-2017-0049>.
- Longoni, A., Cagliano, R., 2018. Inclusive environmental disclosure practices and firm performance: the role of green supply chain management. *Int. J. Oper. Prod. Manag.* 38, 1815–1835. <https://doi.org/10.1108/IJOPM-12-2016-0728>.
- Masud, M.A.K., Hossain, M.S., Kim, J.D., 2018. Is green regulation effective or a failure: comparative analysis between Bangladesh Bank (BB) green guidelines and global reporting initiative guidelines. *Sustainability* 10. <https://doi.org/10.3390/su10041267>.
- Mathiyazhagan, K., Govindan, K., NoorulHaq, A., Geng, Y., 2013. An ISM approach for the barrier analysis in implementing green supply chain management. *J. Clean. Prod.* 47, 283–297. <https://doi.org/10.1016/j.jclepro.2012.10.042>.
- McGrath, P., McCarthy, L., Marshall, D., Rehme, J., 2021. Tools and technologies of transparency in sustainable global supply chains. *Calif. Manag. Rev.* 64, 67–89. <https://doi.org/10.1177/00081256211045993>.
- Nohria, N., Eccles, R.G., 1992. *Networks and Organizations*. Harvard Business School Press, Boston.
- Pinto, L., 2020. Green supply chain practices and company performance in Portuguese manufacturing sector. *Bus. Strategy Environ.* 29, 1832–1849. <https://doi.org/10.1002/bse.2471>.
- Qorri, A., Mujkić, Z., Kraslawski, A., 2018. A conceptual framework for measuring sustainability performance of supply chains. *J. Clean. Prod.* <https://doi.org/10.1016/j.jclepro.2018.04.073>.
- Rao, P., Holt, D., 2005. Do green supply chains lead to competitiveness and economic performance? *Int. J. Oper. Prod. Manag.* 25, 898–916. <https://doi.org/10.1108/01443570510613956>.
- Rebely, P.C.P.W., Andrade dos Santos Lima, S., Novi, J.C., Salgado, A.P., 2019. Reverse logistics systems in Brazil: comparative study and interest of multistakeholders. *J. Environ. Manag.* 250. <https://doi.org/10.1016/j.jenvman.2019.06.124>.
- Ridder, H.-G., 2017. The theory contribution of case study research designs. *Bus. Res.* 10, 281–305. <https://doi.org/10.1007/s40685-017-0045-z>.
- Sellitto, M.A., 2018. Assessment of the effectiveness of green practices in the management of two supply chains. *Bus. Process Manag. J.* 24, 23–48. <https://doi.org/10.1108/BPMJ-03-2016-0067>.
- Silva, G.M., Gomes, P.J., Sarkis, J., 2019. The role of innovation in the implementation of green supply chain management practices. *Bus. Strat. Environ.* 219, 819–932. <https://doi.org/10.1002/bse.2283>.
- Srivastava, S.K., 2007. Green supply-chain management: a state-of-the-art literature review. *Int. J. Manag. Rev.* 9, 53–80.
- Tseng, M.L., Islam, M.S., Karia, N., Fauzi, F.A., Afrin, S., 2019. A literature review on green supply chain management: Trends and future challenges. *Resour. Conserv. Recycl.* <https://doi.org/10.1016/j.resconrec.2018.10.009>.
- Vachon, S., Klassen, R.D., 2006. Extending green practices across the supply chain: the impact of upstream and downstream integration. *Int. J. Oper. Prod. Manag.* 26, 795–821.
- Wongthongchai, J., Saenchaiyathon, K., 2019. The key role of institution pressure on green supply chain practice and the firm's performance. *J. Ind. Eng. Manag.* 12, 432–446. <https://doi.org/10.3926/jiem.2994>.
- Yildiz Çankaya, S., Sezen, B., 2019. Effects of green supply chain management practices on sustainability performance. *J. Manuf. Technol. Manag.* 30, 98–121. <https://doi.org/10.1108/JMTM-03-2018-0099>.

- Yin, R.K., 2018. In: *Case Study Research and Applications: Design and Methods*, Sixth. SAGE Publications, Beverly Hills, CA.
- Yu, W., Chavez, R., Feng, M., Wiengarten, F., 2014. Integrated green supply chain management and operational performance. *Supply Chain Manag.* 19, 683–696. <https://doi.org/10.1108/SCM-07-2013-0225>.
- Zhu, Q., Sarkis, J., 2004. Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *J. Oper. Manag.* 22, 265–289. <https://doi.org/10.1016/j.jom.2004.01.005>.
- Zhu, Q., Sarkis, J., Lai, K.H., 2008. Confirmation of a measurement model for green supply chain management practices implementation. *Int. J. Prod. Econ.* 111, 261–273.