

Review

Green Supply Chain Management: Conceptual Framework and Models for Analysis

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Abstract: Sustainability and environmental concerns have been important topics of discussion in recent decades. Green supply chain management assures the effectiveness of public and company policies in greening their operations, increasing the market share, improving the company image and reputation, and increasing profits. The objective of this article is to propose a conceptual framework that considers dimensions, categories, and practices in green supply chain management. After an extensive review of the literature, we identified models and a set of green dimensions, categories, and practices used for green supply chain management. From the analysis of the findings, we propose a conceptual framework that is organized into 3 environmental dimensions, 21 categories, and 64 green practices. The framework can contribute to the literature, given that empirical studies mostly select a limited set of dimensions to evaluate supply chain green practices. Finally, this study offers directions for future research.

Keywords: green supply chain management; green practices; green strategy; green innovation; green operations



Citation: Herrmann, F.F.; Barbosa-Povoa, A.P.; Butturi, M.A.; Marinelli, S.; Sellitto, M.A. Green Supply Chain Management: Conceptual Framework and Models for Analysis. *Sustainability* **2021**, *13*, 8127. <https://doi.org/10.3390/su13158127>

Academic Editor: Andrea Appolloni

Received: 16 June 2021

Accepted: 16 July 2021

Published: 21 July 2021

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1. Introduction

In the past few years, approximately 70% of the leading companies in their sectors have emphasized sustainability in their work agenda. Leading companies' reports reinforce that the success of their sustainability efforts also depends on the collaboration with the supply chain (SC) actors [1,2]. In this context, green supply chain management (GSCM) has contributed to the effective implementation of eco-efficiency [3], renewable energy sources [4], and sustainable actions [5] in the SC, in innovation clusters [6] as well as in symbiotic industrial networks [7]. Green or sustainable supply chain management (SSCM) involves integrating environmental and economic objectives into the management of the operation strategy of the supply chain. Such integration helps reduce the carbon footprint while increasing financial return and profitability [8]. A wider concept is SSCM, which aims to maximize profitability and, at the same time, reduce the environmental impact and improve the social well-being of the various involved stakeholders [9]. Ahi and Searcy [10] identified 22 different definitions for GSCM and 12 for SSCM. In this article, we use the term GSCM, despite recognizing the alternative use of SSCM [11,12].

Bowen et al. [13], p. 176, define GSCM as the "Integration of the company's purchase plans with the environmental activities in SCM, to improve the environmental performance

of suppliers and customers.” GSCM also includes concerns about product design, use, reuse, disassembly, and final disposal [14], as well as warehousing, transportation, supplier development to meet green requirements in purchasing, and stimulus for the adoption of environmental certifications such as ISO 14000 [14,15]. Zhu and Sarkis [16] conceptualize GSCM as the integration of environmental thinking with operations management in the SC, starting with the product design and passing through the selection of raw materials, manufacturing processes, transportation and delivery, and the final consumer arriving at the final destination after use. Large and Thomsen [17] states that GSCM includes the design process, raw material selection, green procurement, the green manufacturing process, green distribution, and reverse logistics.

GSCM involves many functions within and outside organizations and a wide set of activities. However, a limited number of articles proposed GSCM models [18], most of them approaching the issue only partially [19]. A large number of empirical studies (case studies) published and a small number of GSCM models are cited by [18]. Other articles derive from case studies and mathematical and conceptual analyses [18,20–22], which characterizes a gap in the current research in GSCM. Therefore, the gap this article aims to bridge is to propose a structured model to guide GSCM analysis: a conceptual model framework that considers dimensions and categories to facilitate the discussion of green practices in GSCM.

This study poses the following research question: How do you organize green practices observed in GSCM in a model formed by dimensions and categories of analysis? In answer, this work highlights key factors that should be analyzed by GSCM models. Secondary purposes are to (i) review green management models and practices published from 2003 to 2019; (ii) propose a conceptual framework for managing green practices in GSCM, and (iii) propose directions for future research to amplify the application of the framework. These are the key issues of the study.

Green practices are operations that seek to reduce or eliminate negative impacts on the environment [23]. Greening is typically associated with the implementation of green practices in SCs [24,25], which requires multidimensional models and approaches [26]. This study approaches GSCM as a multidimensional problem. The model framework relies on dimensions supported by analytical categories [27], evolves from other models, and covers a larger set of dimensions and categories when compared to other models already proposed. Our framework details 64 green practices. These are the key factors addressed by this study. This number allows for more extensive analysis when compared with the models existing in the literature [23,28,29]. The models retrieved from the literature do not support more than 25 green practices, and this is the main novelty of our study.

Moreover, the framework provides support to identify environmental weaknesses and to assess and prioritize corrective actions in SCs. Green practices are considered at the level of the SC, covering internal practices and upstream and downstream relationships [5,30] as well as creating room for systemic possibilities [31] and systemic methods [32]. The key motivation of the study is the construction of a consistent tree-like structure or framework organizing key green practices that could facilitate many kinds of stakeholders (practitioners, managers, and scholars) who need to handle environmental concerns in managing supply chains.

The remainder of the article is organized as follows: Section 2 details the research methodology. Section 3 presents the results of the systematic review of the literature. Section 4 presents the conceptual framework and details of the dimensions, categories, and green practices. Section 5 discusses the research findings and conclusions.

2. Methodology and the Sample of Articles

Kassarjian [33] provides the following definition for a systematic literature review: “Systematic reviews aim to address problems by identifying, critically evaluating, and integrating the findings of all relevant, high-quality individual studies addressing one or more research questions.” Bearing such a definition in mind, our review pursues two

objectives: Summarize recent research retrieving and interpreting similarities, themes, and issues on GSCM and contribute to the conceptual development of the theme and the future formation of a theory [34]. From a methodological perspective, the systematic literature review includes qualitative and quantitative aspects combined to evaluate structural and content standards. Therefore, the methodology used in this study follows the steps below [34]:

- definition of the unit of research (models for structuring GSCM issues);
- delimitation of the search: (i) only articles in English in peer-reviewed scientific journals published between 2010 and 2020; (ii) the use of Science Direct (www.sciencedirect.com accessed on 16 June 2021) and Emerald (www.emeraldinsight.com accessed on 16 June 2021) databases; and (iii) four journals outside databases (*Chemical Engineering Transactions*, *International Journal of Applied Science and Engineering Research*, *Journal of Sustainable Development*, and *Journal of Operations and Supply Chain Management*);
- collection of articles according to the keyword green supply chain management, combined with green operation, green practices, and green performance;
- reading and selection of articles: the rough sample was entirely reviewed and a final, refined sample was identified;
- complete review of the final sample and description of the structural elements of the articles: bibliometric description of authors, journals, and studies;
- content analysis of the retrieved GSCM models for the identification of dimensions and categories of analysis;
- evaluation of the content of the articles of the final sample; and
- identification of similarities of dimensions and construction of the structure for the conceptual framework.

In the content analysis, we assessed models and classified green practices in GSCM according to dimensions and categories of analysis. Three external experts, two scholars from research institutes with experience in supply chain management and one scholar with previous experience in supply chains as a practitioner in the industry, participated in the analysis. The participation of specialists minimizes interpretation risks and subjectivities [34]. Finally, we constructed and proposed a conceptual framework for the management of green practices in SC.

3. Descriptive Analysis

Seuring and Müller [34] state that the first publications related to GSCM date from 1994. However, the main publications appear at the beginning of the 21st century and become significant from 2010 [35], the year of the beginning of the analysis. Table 1 shows the keywords employed in the search and the number of the roughly selected articles. Figure 1 represents the time distribution of the roughly selected articles.

Table 1. Keywords and selected articles.

Keywords	Connector	Keywords	Result
Green supply chain management	and	Green operation	25
Green supply chain management	and	Green practices	109
Green supply chain management	and	Green performance	32
		Total	166

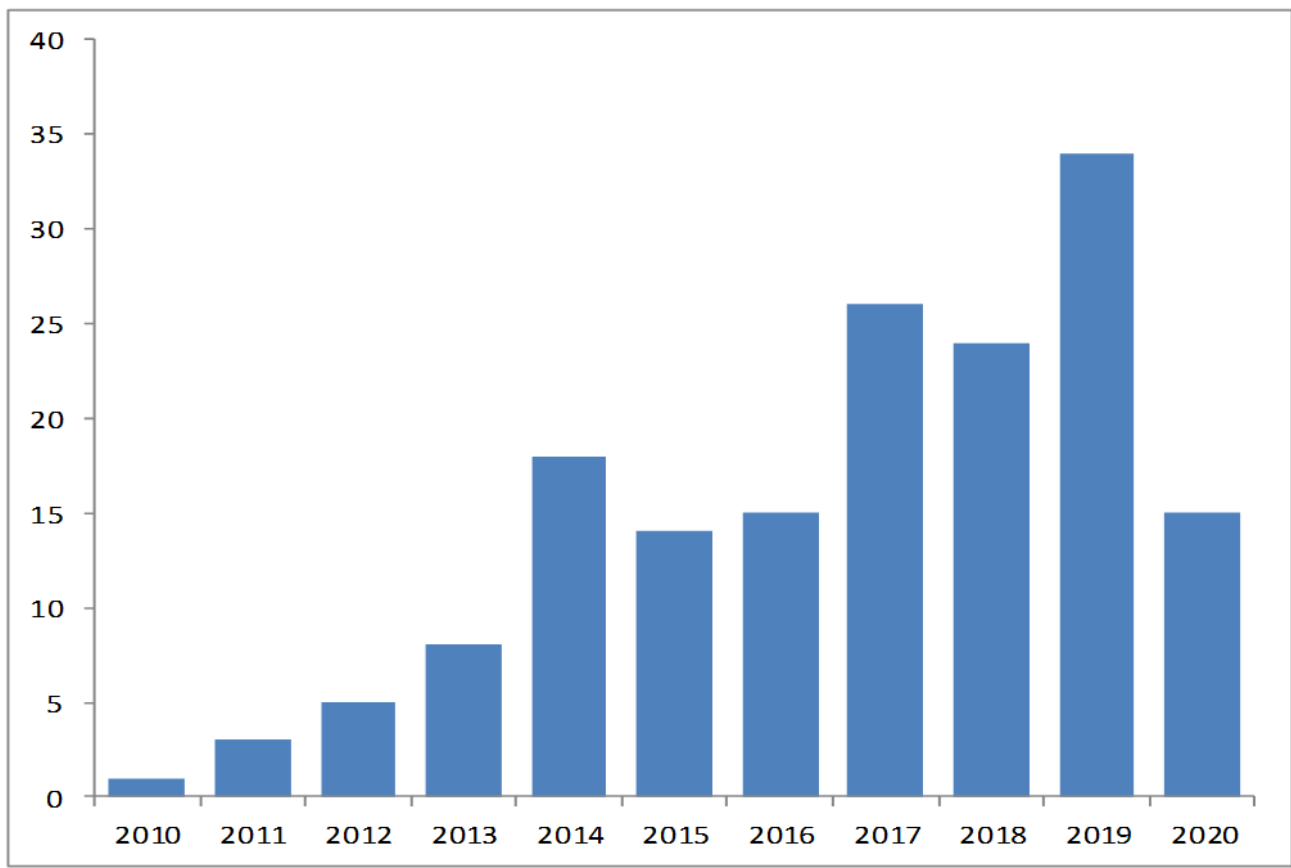


Figure 1. Time distribution of the first selection of articles.

By the title and the abstracts, we selected a refined, focused sample of 43 articles with the greatest adherence to the purpose of the research. We read in full the entire sample prior to proceeding with the descriptive analysis. The descriptive analysis contributes to the identification of the models, the dimensions, and the categories of analysis of green practices [36]. The descriptive analysis of the sample considered the following issues: Who are the main authors? What are the main journals? What are the main existing models for managing green practices in SC? What are the dimensions and categories identified in the sample? How often are the categories referenced?

3.1. Authors and Journals

Table 2 shows the three authors with the highest concentration of articles (individually or jointly) on GSCM and the main authors of the theme. The authors are also among the top 10 authors in the bibliometric review on GSCM published by Fahimnia et al. [35].

Table 2. Main authors of selected articles.

Main Authors	Number of Articles	% Total
Zhu, Q.	8	19%
Sarkis, J.	7	16%
Lai, K.	4	9%

Table 3 shows the journals. Five journals contribute 46% of the sample: *Journal of Cleaner Production*, *International Journal of Operations and Production Management*, *Transportation Research Part E: Logistics and Transportation Review*, *Procedia—Social and Behavioral Sciences*, and *Resources, Conservation, and Recycling*.

Table 3. Journals that published the articles of the sample.

Journals	Frequency	%
<i>Journal of Cleaner Production</i>	8	18.60%
<i>International Journal of Operations and Production Management</i>	4	9.30%
<i>Transportation Research Part E: Logistics and Transportation Review</i>	3	6.98%
<i>Procedia—Social and Behavioral Sciences</i>	3	6.98%
<i>Resources, Conservation, and Recycling</i>	2	4.65%
Other	23	53.49%
Total	43	100%

3.2. Models in GSCM

We identified six articles that consider complete and structured models for the evaluation of green practices in SC. We considered models that resemble a tree-like structure [37], that is, a top term supported by constructs that can be appraised by manifest variables or indicators [38].

3.2.1. Srivastava (2007)

The author reviews the literature on GSCM (approximately 1500 volumes, totaling 227 references). The author employed a tree-like structure, namely a top term (GSCM), 3 dimensions, and 14 categories, related to a set of green practices. As an early model, it has a certain amount of imbalance, as only two practices support the first dimension, the green design. Therefore, the author distributes the scope of GSCM into three main categories of analysis: environmental importance, eco-design, and green operations. Table 4 shows the organization of the dimensions and categories proposed by the author.

Table 4. Green supply chain management (GSCM) dimensions and criteria.

Overall	Dimension	Green Practice
GSCM	Green Design	LCA—Lifecycle assessment/analysis
		ECD—Environmentally conscious design (ECD)
	Green Operation	Disposal
		Pollution prevention
		Source reduction
		Location and distribution
		Pre-processing
		Inspection/sorting
		Collecting
		Production planning and scheduling
		Inventory management
		Remanufacturing
		Recycling
		Reducing

Source: adapted from [39].

3.2.2. Seuring and Muller (2008)

The authors review 191 articles published between 1994 and 2007, which supported the proposition of a sustainable theoretical framework and a set of green practices for GSCM [34]. According to the authors, focal companies are responsible for the environmental and social performance of suppliers and distributors, encouraging extension in the adoption of environmentally friendly practices. The authors also mention that the discussion of GSCM goes beyond environmental management and should include economic and social aspects. However, in their sample of articles, environmental concern is the most referenced category, as shown in Table 5.

Table 5. Dimensions discussed in articles on sustainable development.

Category	Number of Articles (<i>n</i> = 191)
Environment	140
Sustainable	31
Social	20

Source: adapted from [34].

The authors identified three main dimensions for GSCM: pressures, incentives, and barriers; green supplier management; and green product management. Table 6 summarizes the main points that support pressures, barriers, and incentives.

Table 6. Pressures, barriers, and incentives.

Pressures and Incentives	Number of Articles (<i>n</i> = 191)
Legal demand/regulation	99
Consumer demand	96
Response to stakeholders	90
Competitive dimension	71
Demand for groups on social and environmental aspects	38
Reputation—company image	30
Barriers	
Implementation costs	59
Complexity in coordination and exchange of information	48
Lack of communication in the supply chain	29

Source: adapted from [34].

Table 7 considers the main points that support green supplier management.

Table 7. Green supplier factors.

Support Factors	Number of Articles (<i>n</i> = 191)
Interconnected communication systems	89
Adoption of management systems	69
Adoption of monitoring, evaluation, and sanctioning practices	68
Training actions for buyers and suppliers	40
Integration of corporate policies	38

Source: adapted from [34].

Regarding green product management, the authors include a discussion of firms' ability to make products environmentally friendlier, which includes eco-design and lifecycle analysis, aiming mainly at the reduction of waste and agility in disassembly and disposal.

3.2.3. Zhu, Sarkis, Cordeiro, and Lai (2008)

The authors propose a model that structures green practices into five blocks: internal environmental management, green purchasing, cooperation with clients, eco-design, and investment recovery [29]. The authors identify that the variables have significant correlations with GSCM. Table 8 shows the model that the authors propose with a measurement scale to evaluate the implementation of GSCM practices. The model was tested for its validity and reliability in the Chinese industry.

Table 8. Structure of the green practice measurement model for GSCM.

Overall	Indicator	Green Practice
GSCM	internal environmental management	Commitment of managers Implementation support Cooperation Total quality Audit program Implementation of ISO 14001 Environmental management system
	green purchasing	Eco product certification Cooperation with suppliers Environmental audit ISO 14001 suppliers Environmentally friendly practices in second-tier suppliers
	cooperation with clients	Cooperation with consumers—eco-design Cooperation with consumers—cleaner production Cooperation with consumers—green packaging
	Eco-design	Design products for the reduction of material/energy consumption Design of products for the reuse, recycling, and recovery of material Design products for the reduction of environmental waste
	Investment recovery	Investment recovery Sale of scrap and used material Sale of excess equipment

Source: adapted from [29].

3.2.4. Testa and Iraldo (2010)

The authors analyze the determinants and motivators of green practice adoption and environmental and organizational performance. The study applied to 4000 organizations from different sectors in seven countries and tested whether GSCM positively influences environmental performance and the reputation of firms. The study classified the determinants into external and internal factors, related respectively to the pressures of the stakeholders and the company's business strategies [40].

Regarding external factors, the authors verify that three institutional mechanisms influence environmental decisions: normative, coercive, and mimetic. Normative pressures occur when clients ask to align firm strategy with customer demands and regulatory pressure. Coercive pressure occurs when stakeholders influence the dissemination of environmental reports. Mimetic pressure results when the development of environmental practices in specific sectors or competitive arenas becomes so significant that it induces their adoption by followers. Regarding internal factors, the three most observed motivations for the adoption of GSCM practices are reputation, which involves environmental performance, lifecycle analysis, green logistics practices, and cooperation with partners; efficiency, which involves the reduction of raw materials and energy; and innovation, typically led by a focal company.

3.2.5. Azevedo, Carvalho, and Cruz Machado (2011)

The authors identify the relations between green practices and SC performance. The study applied to five Portuguese automotive supply chains. The authors retrieve from the literature a set of green practices analyzed at three levels: upstream of the focal company, developed by and depending exclusively on the focal company, and downstream of the focal company [23]. Table 9 transcends the evaluation of practices at the focal company level but also considers suppliers and consumers.

Table 9. The theoretical framework of the influence of green practices on the performance of the supply chain (SC).

SC Green Practices	Upstream	Focal Company	Downstream
1	Environmentally friendly practices in purchasing	Minimizing waste	Environmental collaboration with customers
2	Environmental collaboration with suppliers	ISO 14001 Certification	Environmentally friendly packaging
3	Working with designers and suppliers to reduce and eliminate products' environmental impact	Decreased consumption of hazardous and toxic materials	Working with customers to change product specifications
4	-	-	Reverse logistics

Source: adapted from [23].

3.2.6. Sellitto (2018)

Sellitto [37] unified previous research. Sellitto et al. [8] propose a green practice management model applied to the Brazilian automotive chain. The study tested and refined a model to evaluate the effectiveness of GSCM implementation. Sellitto and Hermann [28] improved the model by adding a fuzzy-based decision method and implemented it in the agro-food industry. Based on those studies, the application was extended to other industries [37]. The model adopts a tree-like structure, formed by an overall concept (GSCM), supported by three constructs (Strategy, Innovation, Operation), that are also supported by 16 green practices. Table 10 shows the model.

Table 10. The theoretical framework of green practices in SC.

Overall	Construct	Green Practice
GSCM	Strategy	Green strategy formulation Measurement and control of performance Cooperation with partners and adaptation Complexity management and communication Barriers Drivers
	Innovation	Green process Eco-design Green products Greenmarket
	Operation	Green purchasing Green manufacturing Green distribution Reverse logistics Disposal Pollution mitigation

Source: adapted from [37].

3.3. Summary of GSCM Models

To synthesize the analysis, it is necessary to integrate the retrieved categories and concepts into a single model as simply as possible. To do so, it is important to summarize the main results retrieved from the studies and to propose a model. From a paired analysis of the dimensions and categories exposed by the models, we found similarities in the category levels and dimensions. Table 11 summarizes the objectives and main results identified in the models. Figure 2 summarizes the dimensions and categories observed in the retrieved models.

Table 11. Selected studies related to GSCM.

Reference	Objective/Results
[39]	The article presents a comprehensive and integrated view of published literature in GSCM to facilitate study, practice, and research. The study proposes a structure based on three dimensions: the importance of GSCM, eco-design, and operations.
[34]	The article offers a review of the literature on GSCM considering 191 articles published between 1994 and 2007. The article also offers a conceptual framework to summarize the research in the field, comprising three parts: economic, environmental, and social dimensions.
[29]	The study evaluated the implementation of GSCM practices among manufacturers. The authors consider environmental management and cooperation in the strategic dimension, green purchases in the operations dimension, and eco-design in the innovation dimension.
[40]	The authors surveyed 4000 manufacturing companies to evaluate the determinants and motivations for GSCM implementation. They identified external and internal determinants. Strategic, innovative, and operational factors drive internal determinants. The study found that GSCM contributes to improving environmental performance.
[23]	The research identifies the influences of green practices in SC performance. The study was applied in the Portuguese automotive supply chain considering a set of practices and impacts at different levels of the SC.
[37]	The article tested and refined a model to evaluate the effectiveness of GSCM implementation in industrial SCs. The study assessed or estimated the effectiveness of green practices in SCs.

A considerable part of the categories is related to one or more authors. For example, eco-design is discussed by [23,29,34,37], Refs. [37,40] present three dimensions, while [39] introduces the operations dimension. The other authors did not introduce dimensions.

3.4. Identification of the Key GSCM Categories

The dimensions and categories mapped from the revised conceptual models helped to identify 21 categories and 3 dimensions. Table 12 relates articles to categories, analyzing the frequency of appearance. Eco-design, green purchase, and customer cooperation appear, respectively, in 84%, 56%, and 49% of the articles.

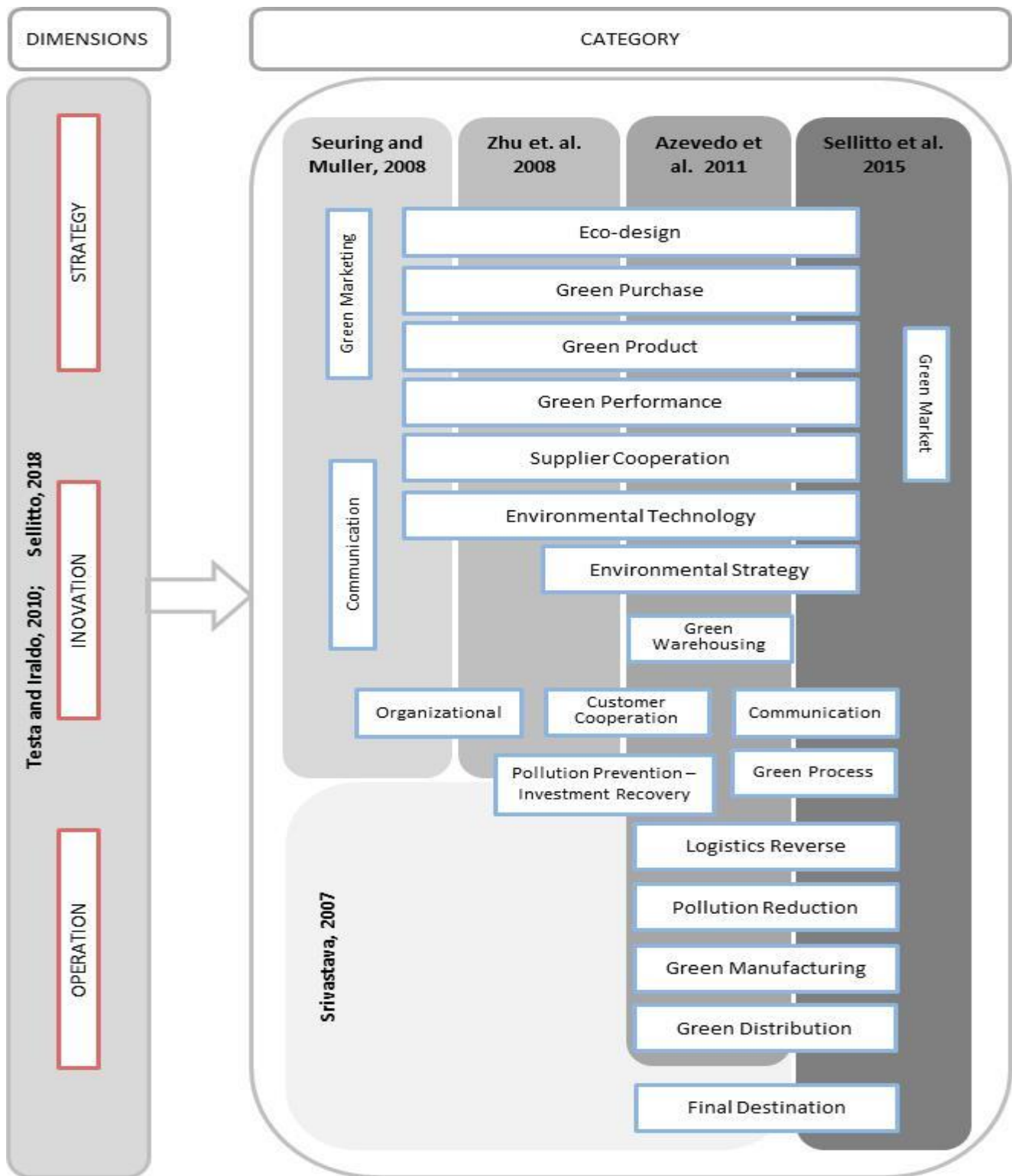


Figure 2. Dimensions and categories observed in reviewed models.

Table 12. Dimensions and categories in GSCM.

Category	Authors																							
	[5]	[8]	[14]	[20]	[23]	[25]	[30]	[34]	[39]	[40]	[41]	[42]	[43]	[44]	[45]	[46]	[47]	[48]	[49]	[50]	[51]	[52]	[53]	
Communications		x			x			x																
Customer Cooperation	x	x			x										x	x		x		x	x			
Eco-Design	x	x	x		x	x		x	x		x	x		x	x				x	x	x	x	x	x
Environmental Strategy		x		x	x						x		x				x	x						
Environmental Technology					x			x								x	x							
Final Disposal of Waste		x							x															
Green Distribution		x			x		x		x	x					x									x
Green Manufacturing		x			x		x		x					x				x			x		x	
Green Marketing				x																				
Green Markets		x																						
Green Performance		x			x										x	x	x							
Green Processes	x	x		x	x					x														x
Green Products		x	x	x	x	x		x		x				x		x								x
Green Purchases	x	x			x	x		x						x	x	x			x	x	x			
Green Warehousing					x										x									x
Investment Recovery	x				x				x			x	x		x	x		x				x		
Organizational	x		x	x		x		x				x	x		x	x		x						
Pollution Prevention					x				x		x							x						
Pollution Reduction		x			x				x									x						
Reverse Logistics		x		x	x	x	x		x		x				x				x				x	
Supplier Cooperation					x			x							x	x		x			x	x		

Table 12. Cont.

Category	Authors																				Statistics		
	[54]	[55]	[56]	[57]	[58]	[59]	[60]	[61]	[62]	[63]	[64]	[65]	[66]	[67]	[68]	[69]	[70]	[71]	[72]	[73]	Frequency	Classification	% of Authors
Communications				x						x							x				6	15	14%
Customer Cooperation	x		x	x	x	x	x		x	x		x	x	x		x			x		21	3	49%
Eco-Design	x	x	x	x	x		x	x	x	x			x		x			x	x	x	36	1	84%
Environmental Strategy				x		x				x		x	x	x							14	10	33%
Environmental Technology				x					x	x						x					8	13	19%
Final Disposal of Waste										x	x	x							x		6	15	14%
Green Distribution				x				x		x					x	x					12	11	28%
Green Manufacturing		x			x	x							x		x				x		15	9	35%
Green Marketing												x	x						x		6	15	14%
Green Markets				x																	2	21	5%
Green Performance				x						x									x		9	12	21%
Green Processes						x								x							7	14	16%
Green Products	x	x		x	x	x				x	x		x	x							18	7	42%
Green Purchases	x	x		x	x				x	x	x		x		x	x		x	x	x	24	2	56%
Green Warehousing								x							x	x					5	20	12%
Investment Recovery					x	x	x	x	x	x		x									16	8	37%
Organizational				x		x		x		x		x	x	x					x		19	4	44%
Pollution Prevention												x		x							6	15	14%
Pollution Reduction			x									x									6	15	14%
Reverse Logistics	x		x			x	x	x			x					x			x	x	19	4	42%
Supplier Cooperation	x		x	x	x	x		x		x		x	x	x		x			x		19	4	44%

4. Conceptual Framework and Green Practices

The information provided by the articles helped to define the framework categories. Subsequently, invited specialists reviewed the main concepts underlying the categories and aggregated similar ones (e.g., green design and eco-innovation were jointly framed as eco-design). The systematic review of the literature provided information and data, but the specialists' review guided and grounded the construction of the conceptual framework. Categories were organized considering their relationship with the dimensions and their relations and interactions within the SC (upstream, internal activities in the focal company, and upstream level). The specialists, together with the researchers, also classified 64 green practices retrieved from the literature in accordance with the categories.

Some of the categories can influence more than one sector of a typical SC. To deal with and illustrate this characteristic, the SC structure was separated into upstream (incoming materials and services), internal supply chain (the focal company and some small companies whose strategy is controlled by the focal company), and downstream (distribution and delivery materials and services) [23]. For example, the environmental strategy involves the three phases of the SC, supplier cooperation involves the first two, while customer cooperation involves the last two. Figure 3 shows the final conceptual framework, formed by 21 categories, 3 dimensions, and 64 green practices.

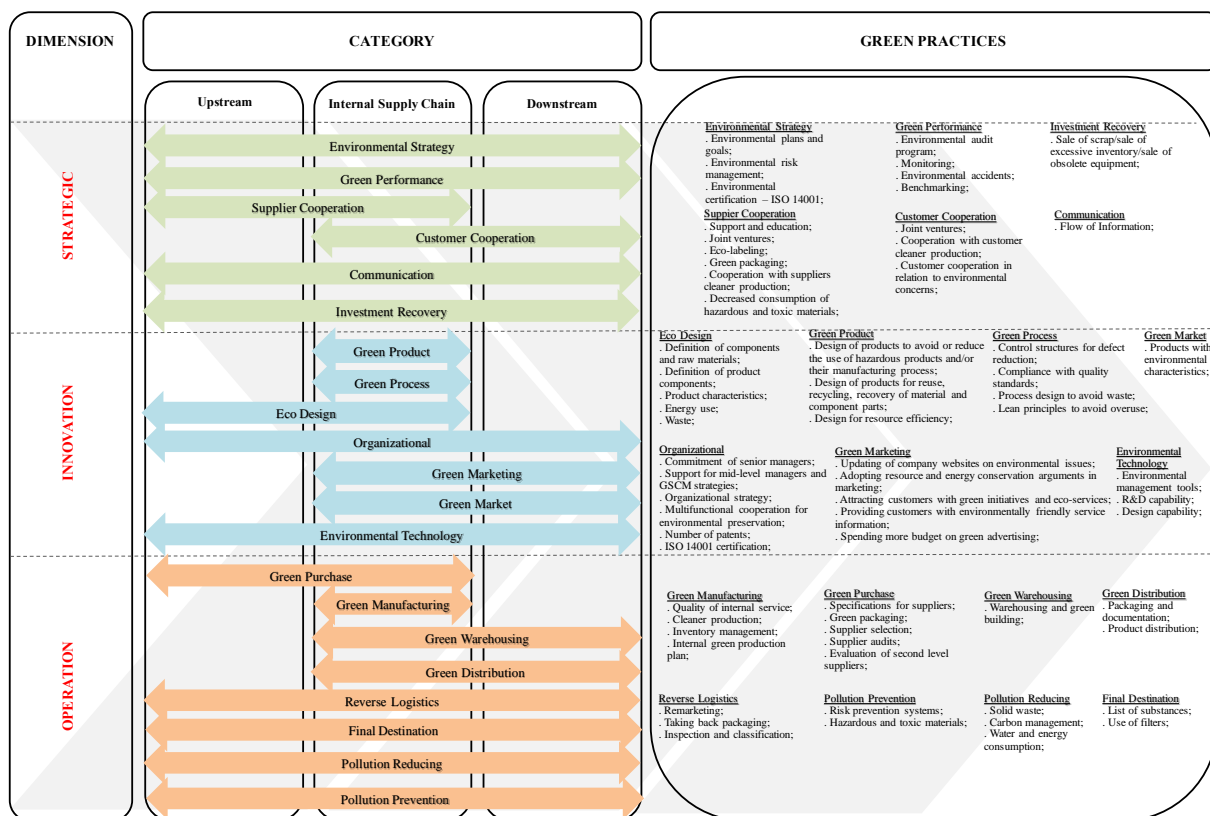


Figure 3. A conceptual framework for green practices in GSCM.

4.1. Green Practices within the Categories of the Strategic Dimension

The strategic dimension includes 6 categories and 18 documented practices. Table 13 shows the practices allocated in the categories of the dimension and suitable references that provide empirical evidence of the application.

Table 13. Green practices in the categories of the strategic dimension.

Green Practices	Activities	Reference
Environmental plans and goals	Environmental plans and objectives of the company that integrate the strategies of the organization and the supply chain.	[21,57,63]
Environmental risk management	Adopting tools to assess, monitor, and mitigate environmental risks.	[57,72]
Environmental certification—ISO 14001	ISO 14001 supports the reduction of the consumption of raw material and waste and improves the quality of the products/services produced for customers.	[20,23,47]
Environmental audit program	Monitoring national environmental compliance and audit programs.	[16,46,47,61]
Monitoring	Monitoring the environmental performance of suppliers, including the second level.	[23,34,46,47]
Environmental accidents	Developing actions to reduce environmental accidents.	[72]
Benchmarking	Sharing best practices with other members of the supply chain.	[46,47]
Support and education	Supporting and training actions in the development of technologies that improve environmental performance and operation, and the adoption of environmental certifications.	[34,47,54]
Joint ventures	The purchasing company works closely with its suppliers and establishes common teams and long-term joint programs to develop green innovations and solutions.	[54,67]
Eco-labeling	Eco-labeling for the identification of environmentally friendly products.	[45,51]
Green packaging	Actions that facilitate the recycling, reuse, and/or return of packaging.	[23,43]
Cooperation with suppliers and customers and cleaner production	Valuing activities that result in eco-efficient processes.	[29,72]
Decreased consumption of hazardous and toxic materials	Developing practices associated with lower consumption of hazardous and toxic materials.	[43,73]
Customer cooperation about environmental concerns	Actions that value compliance with legislation, eco-efficiency, and the improvement of products and processes.	[51]
Flow of information	Interconnected structures and systems that ensure the flow of information among supply chain stakeholders, ensuring competitive priorities related to company operations, quality, and customer satisfaction.	[23,34,70]
Sale of scrap, excessive inventory, and obsolete equipment	Evaluating the processes considering the possibility of the sale, recycling, and/or reuse of scrap, sale of inventory, and obsolete equipment, transforming surplus or idle resources into revenue.	[61,63,73]

4.2. Green Practices within the Categories of the Innovation Dimension

Green innovation supports environmental sustainability by promoting changes to processes with less environmental impact [40,52]. Product and process innovations are involved in energy saving, pollution prevention, waste recycling, green or corporate product design, and environmental management [20]. Table 14 shows the practices allocated in the categories of the dimension and suitable references that provide empirical evidence of the application.

4.3. Green Practices within the Categories of the Operations Dimension

Environmental costs, production, logistics, processes, purchasing, and the reverse logistics process characterize SC green operations. Table 15 shows the practices allocated to the categories of this dimension and suitable references that provide empirical evidence of the application.

Table 14. Green practices in the categories of the innovation dimension.

Green Practices	Activities	References
Design of products	Design that prevents or minimizes the use of hazardous and toxic products.	[34,43,63]
Design of products for reuse, recycling, or recovery of material and parts	Designing modular products and easy-to-disassemble options that help to repair, recycle, and remanufacture end-of-life returns.	[20,31,43,55,63]
Design for resource efficiency	Designing consumption-reducing products and energy.	[4,31,54,63,73]
Control structures	Developing automated or error-proof control systems for defective parts or products.	[6,20]
Compliance with quality standards	Adopting a standardized set of inspection criteria and quality standards.	[20]
Process design	Designing processes that minimize or eliminate unnecessary movements, waste, and scrap.	[5,68]
Lean principles	Analyzing the processes to identify activities and operations considered unnecessary and that do not add value to the final product.	[6,20]
Definition of components and raw materials	Actions that reduce the consumption of material in production, use of materials that generate less pollution or waste, use of non-toxic materials, and use of recycled or recyclable materials.	[31,53]
Definition of product components	Developing components with materials that can be recycled and derived from renewable sources.	[34,53]
Product characteristics	Simplifying product characteristics, reducing weight and raw material consumption.	[40,53]
Energy use	Using energy-efficient equipment and developing new processes, materials, and technologies.	[4,7,40,56]
Waste	Minimizing waste generated in the production process, reusing waste, and ensuring acceptable limits of hazardous substances (compliance with emission limits).	[39,53,69,70]
Commitment of senior managers	Leadership, commitment, and understanding of managers concerning the importance of GSCM to the organization and the chain.	[5,25,42,46,61]
Support for mid-level managers	Manager education on green practices for the supply chain.	[5,42,65]
Organizational strategy	Implementing GSCM in organizational strategy and integrating corporate policies.	[25,34,65]
Multifunctional cooperation	Developing multifunctional groups with different expertise working in the analysis and evaluation of green practices.	[67]
Number of patents	Research and development capability of innovations, facilitating new patents.	[25,66]
ISO 14001 certification	Companies that implement ISO 14001 are likely to improve their internal environment through their network of suppliers and customers.	[20,46,71]
Updating of company websites on environmental issues	Using websites to disseminate environmental reports and practices.	[22,50,67]
Adopting resource and energy conservation arguments in marketing	Developing tools and technologies to make lifestyles more sustainable and encourage social change.	[67,72]
Attracting customers with green initiatives and eco-services	Developing actions that influence consumers and industrial buyers through advertising that reflects the company's commitment to the environment.	[22,67]
Providing customers with environmentally friendly service information	Developing services and practices that may result in actions that contribute to the environment.	[67,72]
Spending more budget on green advertising	Investment incorporates complementary actions since companies gain a competitive advantage.	[22,66]
Products with environmental characteristics	Alignment of the product development process with the consumer market and environmental issues.	[8,53,66]
Environmental management tools	Developing environmental management tools for the supply chain to subsidize evaluation, monitoring, and the environmental quality of products and the cost of waste among the chain members.	[34,46,47,62]
R&D capability	Infrastructure for R&D.	[63,71,72]
Design capability	Capability to rapidly develop new designs.	[63,72,73]

Table 15. Green practices in the categories of the operations dimension.

Green Practices	Activities	Reference
Specifications for suppliers	Providing project specifications to suppliers that include environmental requirements for purchases.	[63,73]
Green packaging	Requiring suppliers to use environmentally friendly packaging (reusable, degradable, and non-hazardous).	[5,49]
Supplier selection	Using environmental criteria to select suppliers.	[66,73]
Supplier audits	Conducting audits to assess suppliers' internal environmental management.	[5]
Evaluation of second-level suppliers	Assessing the environmental management of second-tier suppliers	[5,34,49]
Quality of internal service	Using standards and criteria to monitor the internal quality of operations and services.	[55,66]
Cleaner production	Developing methods and practical tools that protect human and environmental health to support sustainable development.	[39,55,71,73]
Inventory management	Adopting methods and tools that allow inventory management.	[42,44]
Internal green production plan	Planning the production, manufacturing, and resource allocation modules to apply environmental strategies.	[44,66]
Warehousing and green building	Developing warehouse spaces conducive to environmental activities.	[43,61]
Packaging and documentation	Enabling the use of packaging that can be reused, collecting packaging, and optimizing the return journey of transport structures.	[43,53]
Product distribution	Optimizing the schedule and routing of deliveries of materials and components to the customer.	[40,53,55]
Remarketing	Developing markets for remanufactured products.	[20,67]
Returnable packaging	Encouraging the return of packaging for reuse and recycling.	[23,24,30,49]
Inspection and classification	Classifying waste from production and consumption to facilitate subsequent activities.	[39,73]
List of substances	Mapping the list of hazardous, toxic, and noxious substances for monitoring and control purposes.	[63]
Use of filters	Using emission and discharge control filters.	[63]
Solid waste	Developing actions that support the reduction of solid waste.	[23,67]
Carbon management	Developing plans and goals for reducing greenhouse gases.	[69]
Water and energy consumption	Reducing water and energy consumption in operations.	[39,46]
Risk prevention systems	Employment risk prevention systems and environmental accidents/emergencies.	[23,41]
Hazardous and toxic materials	Decreasing consumption of hazardous/noxious/toxic materials.	[23]

5. Final Remarks, Implications, and Directions for Future Research

This study proposes a comprehensive conceptual framework that bridges the gap related to the need for effective models for GSCM. The conceptual framework considers dimensions, categories, and green practices identified in the literature. The proposed model can contribute to the literature given that empirical studies mostly select a limited number of dimensions to evaluate supply chain green practices.

The study has practical implications, mainly for service and industrial practitioners, managers, scholars, and government policymakers. Practitioners can use the results to implement management programs based on GSCM principles. Each category of analysis may provide guidelines for future implementation of green practices in SC. Practitioners can also use the prescribed model to assess the status of their SC regarding eco-efficiency, energy management, and other emergent issues regarding how manufacturing and service supply chains handle environmental issues. In handling our model of analysis, and supported by multicriteria techniques, managers can prioritize dimensions, constructs, and indicators according to the importance they demonstrate concerning SC strategic objectives. Scholars can use the proposed model for further in-depth studies, such as surveys in regional energy-intensive industries, waste producers, and various generators of carbon footprints.

Finally, governmental policymakers of regional development policies can use the model to stimulate the development of regional initiatives aimed at innovative industries. Public policies developed on the basis of our model may promote equality and development regarding environmental issues, mainly concerning service and manufacturing SC.

Although the article analyzes green practices in SC retrieved from the systematic review of the literature, the study did not consider other elements such as pressure and incentives that influence green practices and their results. Predominantly, green practices in SC will be more or less effective according to the presence or absence of enablers or moderators such as pressure and incentives.

The sample size of articles, 43 articles, is the main limitation of this study. A secondary limitation is the number of dimensions, practices, and categories identified. This number can increase with the social dimension, which will imply using other keywords besides the current “green supply chain management.”

From the study, we derive future research directions. As quantitative models to GSCM analysis use a limited number of dimensions, further research should introduce new dimensions. Examples of new dimensions are corporate social responsibility and networking operations. The proposed conceptual framework requires empirical studies on the dimensions and categories in GSCM through the implementation of case studies. Another area in which studies are needed is more surveys in entire industries. An example is the agro-food SC, since such an industry has a significant impact on the international economic and environmental scenario [74]. Over time, there have been a limited number of studies evaluating the adoption of green practices in agro-food SC [28,38,74], mainly regarding production [75], warehousing, and transportation [76]. Similar studies could be applied to research on emerging markets [18], e-business [77], e-commerce [78], and renewable energy industries [79].

Author Contributions: Conceptualization, F.F.H. and A.P.B.-P.; methodology: A.P.B.-P.; validation and formal analysis: M.A.B. and S.M.; writing—original draft: F.F.H. and A.P.B.-P., writing—review and editing, M.A.B., S.M., and M.A.S.; supervision, M.A.S.; project administration, M.A.S.; funding acquisition, A.P.B.-P. and M.A.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Acknowledgments: CNPq: the Brazilian Agency for Scientific Research partially supported this study under the grant numbers [464140/2014-5; 303574/2016-0; 302570/2019-5]. Unisinos partially supported this study by grants provided by the Doctoral College Tordesillas.

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

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