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FIFTEEN YEARS OF GREEN SUPPLY CHAIN RESEARCH

QUINZE ANOS DE PESQUISA EM GREEN SUPPLY CHAIN

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Charbel José Chiappetta Jabbour¹

Nelson Oliveira Stefanelli²

1 University of Lincoln, Lincoln, Lincolnshire, United Kingdom

2 FUCEPE Business School and Universidade Santa Ursula, Vitória, Espírito Santo, Brazil

ABSTRACT

Purpose – The purpose of this paper is to present a discussion concerning how supply chains have evolved through the introduction of environmental concerns into the managerial field.

Design/methodology/approach – The authors have reviewed several of the most relevant research results regarding Green Supply Chains and analyzed the status of cooperation among authors and countries.

Findings – The authors set a discussion on the concept of the Green Supply Chain, along with its practices, drivers, motivations and barriers, presenting a modern review regarding the cooperation network among the mains authors and countries.

Originality/value – Although research regarding Green Supply Chains has been intensively developed recently, there are several unexplored research avenues in which practitioners and scholars could advance. In order to support future studies concerning Green Supply Chains, ten research questions were elaborated.

Keywords - Green Supply Chain Management; Sustainable Supply Chain Management; Circular Economy; Sustainable Operations; Eco-innovation



RESUMO

Objetivo - O objetivo deste artigo é apresentar uma discussão sobre como as cadeias de suprimentos têm evoluído através da introdução de questões ambientais no campo gerencial.

Design / metodologia / abordagem - Os autores revisaram vários dos resultados de pesquisas mais relevantes sobre Cadeias de Suprimento Verde (Green Supply Chains) e analisaram o status da cooperação entre autores e países.

Resultados - Os autores discutem o conceito de Green Supply Chain, suas práticas, motivações, barreiras e barreiras, apresentando uma revisão moderna sobre a rede de cooperação entre os principais autores e países.

Originalidade / valor - Embora a pesquisa sobre Cadeias de Suprimento Verde tenha sido intensamente desenvolvida recentemente, existem vários caminhos de pesquisa inexplorados nos quais os profissionais e acadêmicos podem avançar. Para subsidiar estudos futuros sobre Green Supply Chain, foram elaboradas dez questões de pesquisa.

Palavras-chave - Green Supply Chain Management; Gestão Sustentável da Cadeia de Suprimentos; Economia circular; Operações Sustentáveis; Eco-inovação

1 INTRODUCTION

Increasing awareness of environmental issues has in the recent past become a worldwide concern (Wang et al., 2021). Consumers and governments have come to require more environmentally responsible actions from supply chains (Gong et al., 2019). At the same time, companies have also become more sensitive to environmental topics, such as pollution, global warming and waste (Demir et al., 2018; Gong et al., 2019).

Effective management of supply chains can provide significant operational advantages (Luthra, Garg and Haleem, 2016; Santos, Lannelongue and Gonzalez-Benito, 2019). Green Supply Chains contribute to the mitigation of environmental impacts without jeopardizing performance (Rani et al., 2019).

The earliest academic interest regarding green supply chains can be found in the early 1990s (Badi and Murtagh, 2019; Zhu and Sarkis, 2006).

The research question motivating this paper is: what are the forthcoming research possibilities regarding Green Supply Chains? Therefore, this paper aims to:

1. Conceptualize Green Supply Chains
2. Evidence the most cited papers on the Green Supply Chain theme
3. Analyze the structure of cooperation which exists among authors and countries regarding Green Supply Chains
4. Provide a future research agenda in order to nurture upcoming research in Green Supply Chains

2 ENVIRONMENTALLY SUSTAINABLE SUPPLY CHAINS

Srivastava (2007) points out that the definition of “Green Supply Chains” encompasses a large variety of concepts, in a spectrum that ranges from green purchasing to reverse logistics. Sarkis, Zhu and Lai (2011) explain that Green Supply Chains are developed when environmental concerns fit into organizational practices.

The process of “greening” supply chains refers to ecological initiatives which are integrated into supply chain practices and may bring some benefits (operational and financial advantages, for instance) while also mitigating environmental and social impacts (Acquah, Agyabeng-Mensah, and Afum, 2020).

For Jabbour, Arantes and Jabbour (2013) there are four relevant themes to take into account when analyzing Green Supply Chains: i) the support of an Environmental Management System in order to facilitate green supply chain actions; ii) level of collaboration within the supply chain to support environmental actions; iii) the practices adopted regarding Green Supply Chains; and iv) understanding the drivers and barriers to the adoption of Green Supply Chains.

The scope of Green Supply Chain management may range from reactive to more proactive practices (de Oliveira et al., 2018. Srivastava, 2007). It can be an achievable option to reduce environmental impact and boost operational performance (Vialle et al., 2017). Additionally, it may help companies to access the market (Agyabeng-Mensah et al., 2020).

3. RESEARCH METHODS

This paper was developed using the Scopus database, with our search covering the last 15 years (2006-2020), in order to assess how research into “Green Supply Chains” has evolved over the years. Additionally, the structure of cooperation among authors and countries were analyzed.

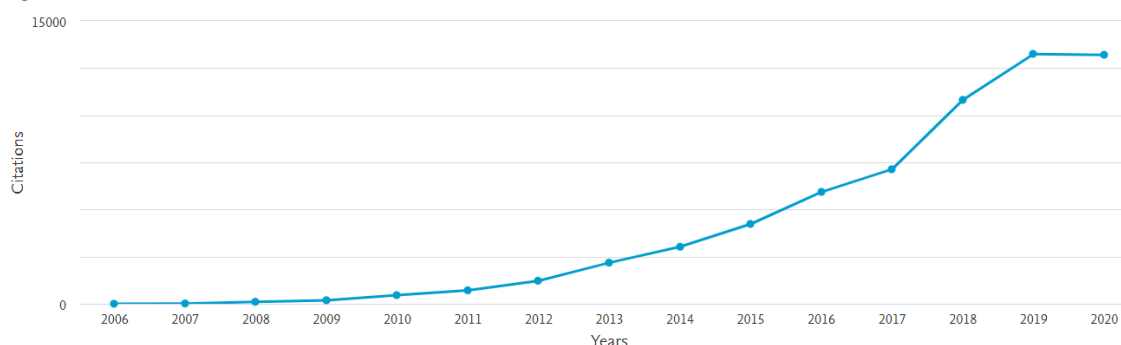
The Scopus database was chosen since it covers a wide range of journals and recent papers (Carvalho et al., 2020; Vieira and Gomes, 2009). Furthermore, Scopus is one of the most prestigious research databases in the world ((Chadegani *et al.*, 2013; Mongeon and Paul-Hus, 2016).

The search string used to identify articles was “Green Supply Chain” OR “Green Supply Chains”. The results were limited to:

- Date range: 2006 - 2020
- Document Type: “article” or “review”

The results using these filters returned more than 1800 cited papers. Figure 1 demonstrates the growth in citations of these papers over the last 15 years, which reached 13,236 citations in 2019, and 13,190 by September 2020.

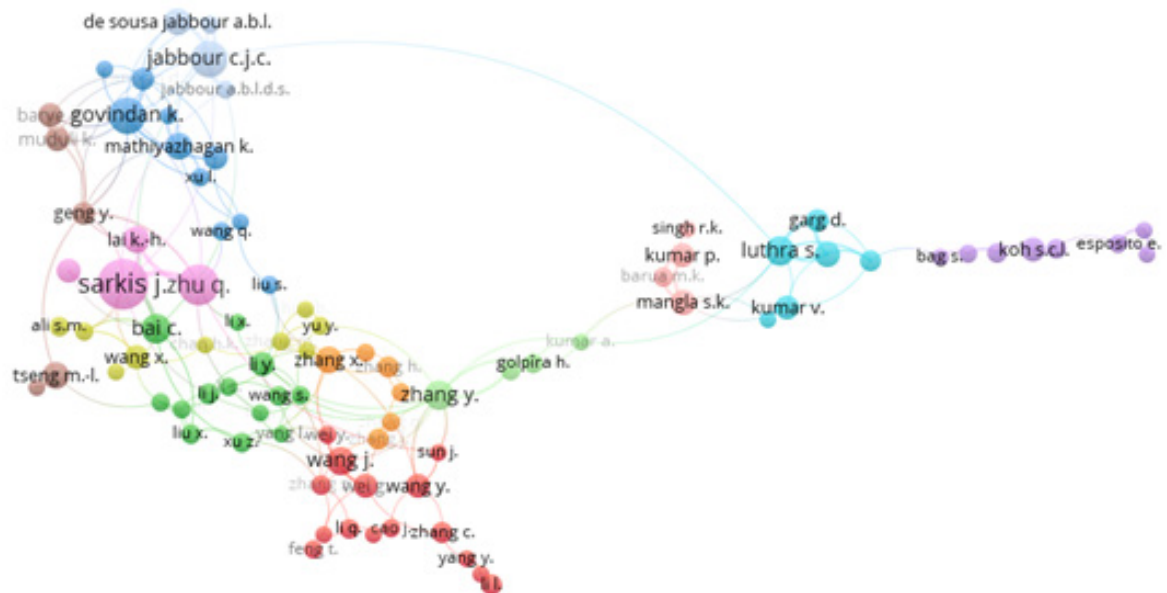
Figure 1 - Citations Overview



Source: Scopus database (2020)

Next, the VOSviewer® software was used to create a map based on bibliographic data using two units of analysis: Author (Figure 2) and Country (Figure 3).

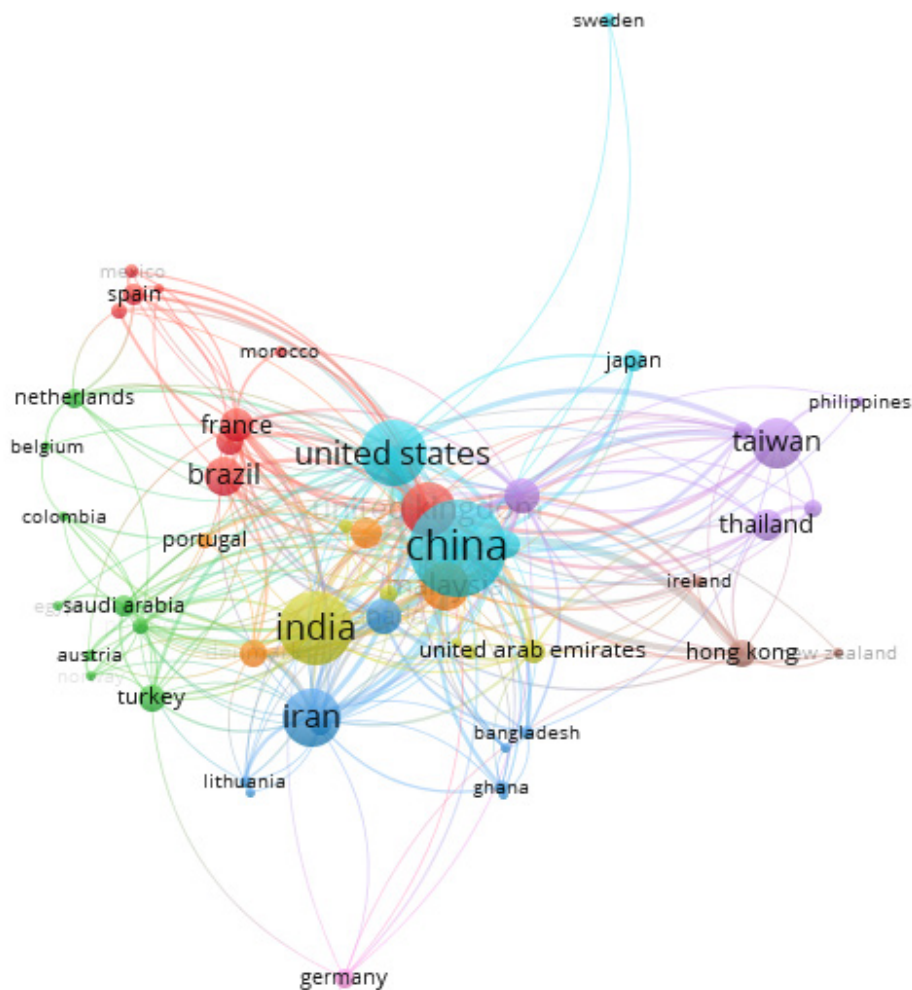
Figure 2 - Network visualization by author



Source: VOSviewer® (2020)

The software created twelve clusters when considering authors as the unit of analysis. In each cluster, there is a highlight for a “central” author. Thus, Joseph Sarkis, Qinghua Zhu, Kannan Govidan, Charbel José Chiappetta Jabbour, Kee-hung Lai and Sunil Luthra emerge as some of the authors who have developed relevant research networks.

Figure 3 - Network visualization by country



Source: VOSviewer® (2020)

The software created nine clusters when considering countries as the unit of analysis. The larger the circle, the more relevant this country is regarding research conducted on this theme. Thus, the USA, China, India, the UK, Iran, Brazil, Malaysia, Indonesia, Hong Kong, Taiwan, Denmark, Malaysia and France are among the countries highlighted in this regard.

The number of documents (papers) ranked by author, citations and total link strength are indicated below (Table 1, Table 2 and Table 3, respectively), showing the top 5 authors in each category. According to the VOSviewer® Manual (2020), the total link strength attribute illustrates the total strength of the co-authorship links of a given researcher with other researchers.

Table 1 - Number of documents (papers) per author

Author	Documents
Sarkis, J.	45
Zhu, Q.	29
Govindan, K.	24
Jabbour, C.J.C	24
Bai, C.	16

Source: Adapted from VOSviewer® software

Table 2 - Number of citations per author

Author	Citations
Sarkis, J.	8035
Zhu, Q.	6405
Lai, K. H.	4576
Govindan, K.	3276
Diabat, A.	1649

Source: Adapted from VOSviewer® software

Table 3 - Total link strength per author

Author	Total link strength
Sarkis, J.	61
Zhu, Q.	40
Govindan, K.	31
Jabbour, C.J.C	30
Luthra, S.	30

Source: Adapted from VOSviewer® software

Joseph Sarkis and Qinghua Zhu appear in all three categories, leading the rankings (first and second place, respectively). The only representative from South America is Charbel Jose Chiappetta Jabbour.

Next, the number of documents (papers) organized by country, citations and total link strength are indicated below (Table 4, Table 5 and Table 6, respectively), this time showing the top 5 countries in each category.

Table 4 - Number of documents (paper) per country

Country	Documents
China	460
India	276
USA	213
Iran	172
UK	145

Source: Adapted from VOSviewer® software

Table 5 - Number of citations per country

Country	Citations
USA	15860
China	14693
India	10252
Taiwan	7639
UK	7631

Source: Adapted from VOSviewer® software

Table 6 - Total link strength per country

Country	Total link strength
China	279
USA	208
UK	170
India	91
Malaysia	77

Source: Adapted from VOSviewer® software

China leads these rankings when analyzing the number of documents (papers) and the total link strength, whereas the USA is the leader in terms of number of citations, which may indicate papers with greater diffusion among researchers in the field.

Finally, Figure 4 indicates the top 10 most cited papers on the “Green Supply Chain” theme. A complete literature review by Samir K. Srivastava is the most cited paper on this subject. Joseph Sarkis and Qinghua Zhu appear in four of the top 10 papers.

Figure 4 - Most cited papers (Top 10)

Year	Title	Authors	Journal	Citations
2007	Green supply-chain management: A state-of-the-art literature review	Srivastava S.K.	International Journal of Management Reviews	1990
2011	An organizational theoretic review of green supply chain management literature	Sarkis J., Zhu Q., Lai K.-H.	International Journal of Production Economics	966
2006	Extending green practices across the supply chain: The impact of upstream and downstream integration	Vachon S., Klassen R.D.	International Journal of Operations and Production	835
2008	Confirmation of a measurement model for green supply chain management practices implementation	Zhu Q., Sarkis J., Lai K.-H.	International Journal of Production Economics	720
2008	Drivers and barriers to environmental supply chain management practices: Lessons from the public and private sectors	Walker H., Di Sisto L., McBain D.	Journal of Purchasing and Supply Management	707
2007	Green supply chain management: pressures, practices and performance within the Chinese automobile industry	Zhu Q., Sarkis J., Lai K.-h.	Journal of Cleaner Production	631
2007	The moderating effects of institutional pressures on emergent green supply chain practices and performance	Zhu Q., Sarkis J.	International Journal of Production Research	568
2012	Green supply chain management practices: Impact on performance	Green Jr. K.W., Zelbst P.J., Meacham J., Bhaduria	Supply Chain Management	559
2013	A comparative literature analysis of definitions for green and sustainable supply chain management	Ahi P., Searcy C.	Journal of Cleaner Production	550
2012	A novel hybrid MCDM approach based on fuzzy DEMATEL, fuzzy ANP and fuzzy TOPSIS to evaluate green suppliers	Buyukozkan G., Ilfi G.	Expert Systems with Applications	539

Source: Scopus (2020)

4 FINAL CONSIDERATIONS AND RESEARCH AGENDA

The debate and discussion currently surrounding environmental concerns in business and management are not going to cease to exist. Although research regarding Green Supply Chains has been intensively developed in recent years, there are a number of unexplored research avenues in which practitioners and scholars could advance. In order to support future studies concerning Green Supply Chains, the following research questions may be considered.

RQ1. What are the factors that affect resilience in green supply chains in emerging economies? Does this differ from the situation in more developed economies?

RQ2. What are the specific barriers to adopting Green Supply Chain practices following the COVID-19 pandemic?

RQ3. How can different theories be combined to explain organizational behavior regarding Green Supply Chains?

RQ4. How can different methods be combined to better understand Green Supply Chain barriers and drivers?

RQ5. How can Green Supply Chains be connected to the Circular Economy, comparing different organizational realities?

RQ6. What is the role of Green Supply Chains in improving ESG (Environmental, Social and Governance) scores?

RQ7. How will Green Supply Chains evolve to embrace Industry 4.0?

RQ8. How can experiments (as a research method) support the advancement of Green Supply Chain practices?

RQ9. What are the main impacts (e.g. financial, operational, reputational) for Green Supply Chains following the COVID-19 pandemic?

RQ10. Will Green Supply Chains shrink after COVID-19? What can companies do to face this new challenge?

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AUTHORS

1. Charbel José Chiappetta Jabbour

Global (Chair) Professor at Lincoln International Business School, University of Lincoln (UK), which has been named as the Modern University of the Year in The Times and Sunday Times Good University Guide 2021. Previously, he was a Full Professor of Management at the 'triple crown' accredited Montpellier Business School (MBS) in France. He has been visiting professor at a number of universities, with a strong collaboration with business schools from emerging markets, including UNIP and FIA. He was a visiting researcher at the University of London (UK) and the Institute for the Advanced Study of Sustainability - United Nations University (Japan). With almost 10,000 citations according to Google Scholar, his research impact is ranked as Top 2.5% globally, according to Research Gate. He has led the supervision of dozens of researchers (PhDs, and post-docs).

E-mail: cchiappettajabbour@lincoln.ac.uk

ORCID (Required of all authors): <https://orcid.org/0000-0002-6143-4924>

2. Nelson Oliveira Stefanelli

PhD in Business Administration, Master in Business Administration, Bachelor of Business Administration and Bachelor of Accounting from the Faculty of Economics, Administration and Accounting of Ribeirão Preto, University of São Paulo (FEA-RP/USP). Associate Professor at FUCEPE Business School and Universidade Santa Ursula. He has professional experience in large companies of diverse segments (automotive, agribusiness and oil & gas).

E-mail: nelsonstefanelli@fucape.br

ORCID: <https://orcid.org/0000-0002-3695-9243>

Contribution of authors.

Contribution	[Author 1]	[Author 2]
1. Definition of research problem	√	
2. Development of hypotheses or research questions (empirical studies)	√	√
3. Development of theoretical propositions (theoretical work)	√	√
4. Theoretical foundation / Literature review	√	√
5. Definition of methodological procedures	√	√
6. Data collection		√
7. Statistical analysis	√	√
8. Analysis and interpretation of data	√	√
9. Critical revision of the manuscript	√	
10. Manuscript writing	√	√
11. Other (please specify)		