THEMES AND METHODS IN SUSTAINABILITY RESEARCH

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ABSTRACT: The aim of the study was to identify emergent themes and utilized methods in sustainability research. The study was a bibliometric study with co-citation and bibliographic coupling analysis. The sample is comprised of 1,292 articles published in all the peer-reviewed *Scopus* business journals, between 1999 and 2018. The study differentiates from traditional bibliometric analyses, by scrutinizing not only theorist themes but also the employed methods. The co-citation analysis highlights three major themes that guide sustainability research: (1) Sustainable Supply Chain Management; (2) Corporate Social Responsibility; and (3) Sustainable Tourism. The bibliographic coupling analysis shows five major current research themes: (1) Sustainable Classic Supply Chain Structures; (2) Global and Emerging Economies Sustainable Supply Chain; (3) Selection of suppliers and *fuzzy* techniques; (4) New Sustainable Supply Chain Structures; and (5) Environmental Responsibility. Sustainability research appears in several areas of knowledge and presents a variety of methods without showing an inclination towards qualitative or quantitative approach. This results in more unified and sedimented themes that are primarily constituted by quantitative studies, and more diverse themes, emerging or dealing with difficult to measure phenomena that are addressed qualitatively. The theme of sustainability management is on the rise, which generates a positive expectation on the expansion of research over the coming years. However, we identified the absence of important themes related to green technologies, sustainable innovations and public policy.

KEYWORDS: bibliometrics, sustainability, co-citation, bibliographic coupling.

RESUMO: O objetivo do estudo foi identificar temas emergentes e métodos empregados na pesquisa em sustentabilidade. Para tanto, foi realizado um estudo bibliométrico com análises de co-citação e de pareamento bibliográfico. Amostra é composta de 1,292 artigos publicados entre 1999 e 2018 em todos os periódicos *peer-review* de *business* da Scopus. O estudo se diferencia de análises bibliométricas tradicionais ao se debruçar não só sobre os temas teóricos, mas também sobre os métodos empregados. Como principais resultados se destaca que a análise de co-citação evidencia três grandes temas que norteiam a pesquisa em sustentabilidade: (1) Gestão da Cadeia de Suprimentos Sustentável; (2) Responsabilidade Social Corporativa; e (3) Turismo Sustentável. A análise de pareamento bibliográfico mostra cinco grandes temas de pesquisa vigentes: (a) Estruturas Clássicas Sustentáveis da Cadeia de Suprimentos; (b) Economias Globais e Emergentes nas Cadeias de Suprimentos Sustentáveis; (c) Seleção de fornecedores e técnicas fuzzy; (d) Novas Estruturas de Cadeia de Suprimentos Sustentáveis; e (e) Responsabilidade Ambiental. A pesquisa em sustentabilidade possui estudos em diversas áreas do conhecimento e apresenta variedade de métodos nas publicações sem evidenciar uma tendência na abordagem qualitativa ou quantitativa, sendo que temas mais uníssonos e sedimentados são majoritariamente constituídos por estudos quantitativos; e temas mais diversos, emergentes ou que tratam de fenômenos de difícil mensuração são abordados qualitativamente. Conclui-se que a temática sobre gestão de sustentabilidade está em ascensão, o que gera uma expectativa positiva sobre o aprofundamento das pesquisas ao longo dos próximos anos. Entretanto, identificamos a ausência de temas importantes relacionados às tecnologias verdes, inovações sustentáveis e políticas públicas.

PALAVRAS-CHAVE: bibliometria, sustentabilidade, co-citação, pareamento bibliográfico.

RESUMEN: El objetivo del estudio es identificar temas emergentes y los métodos empleados en la investigación en sostenibilidad. Fue realizado un estudio bibliométrico con análisis de co-citación y de acoplamiento bibliográfico. La muestra está compuesta por 1,292 artículos publicados entre 1999 y 2018 en todas las revistas de negocios de Scopus revisadas por pares. El estudio se distingue de los análisis bibliométricos tradicionales, por analizar no sólo los temas teóricos, sino también los métodos que se emplearon. Como principales resultados se destaca que el análisis de co-citación destaca tres temas principales que guían la investigación de sostenibilidad: (1) Gestión de la Cadena de Suministro Sostenible; (2) Responsabilidad Social Corporativa; y (3) Turismo Sostenible. El análisis del acoplamiento bibliográfico muestra cinco temas principales de investigación actualmente: (a) Estructuras Clásicas Sostenibles de la Cadena de Suministro; (b) Cadena de suministro sostenible de las economías globales y emergentes; (c) Selección de proveedores y técnicas *fuzzy*; d) Nuevas estructuras de la Cadena de Suministro Sostenibles; y (e) Responsabilidad Ambiental. La investigación en sostenibilidad tiene estudios en varias áreas del conocimiento y presenta una variedad de métodos en sus publicaciones sin mostrar una tendencia hacia un enfoque cualitativo o cuantitativo, una vez que los temas más unificados y sedimentados están constituidos principalmente por estudios cuantitativos; y temas más diversos, emergentes o que tratan con fenómenos que son difíciles de medir, se abordan de forma cualitativa. Se concluye que el tema de la gestión de la sostenibilidad está en crecimiento, lo que genera una expectativa positiva sobre la profundidad de la investigación en los próximos años. Sin embargo, identificamos la ausencia de temas importantes relacionados con las tecnologías verdes, las innovaciones sostenibles y las políticas públicas.

PALABRAS-CLAVE: bibliometría, sostenibilidad, co-citación, acoplamiento bibliográfico.

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I. INTRODUCTION

The word "sustainability" has been used in many areas of knowledge and is often related to environmental issues and the use of natural resources. This term gained relevance beginning in the 1970s through environmental literature, and then was incorporated into global discussions (Vojnovic, 2014). The United Nations Conference on the Human Environment, held in 1972, is considered to be the first world-wide event to address the issue of sustainability, emphasizing the need to preserve natural resources and mitigate man-made environmental damages to natural resources (Declaration of the United Nations Conference on the Human Environment, 1972).

The sustainability approach expanded, with a strong focus in 1987, through the World Commission on Environment and Development (WCED), which coined the report 'Our Common Futures.' This report described the "sustainable development" concept as a process of integrative and global economic growth that considers both social and environmental issues as fundamental elements for the development of nations. It also established in this document the need to consciously use available natural resources and to preserve these resources for future generations (Report of the World Commission on Environment and Development: Our Common Future, 1987).

In the decades that followed, concerns regarding sustainability became more pronounced due to environmental degradation and social and economic inequalities between countries. Given this scenario, further discussions were held to reflect on the challenges of sustainability in the global context. After ECO 92 (United Nations Conference on Environment and Development) the issue of sustainability was elevated to the level of environmental policy which has a universal responsibility. Based on this decision, the United Nations (UN) formulated an action plan called Agenda 21. This plan aims to bring significant policy changes at the local, regional, and global levels to promote sustainable development (United Nations Conference on Environment and Development - Agenda 21, 1992).

In Business Administration, high impact studies corroborated to insert and expand company strategies of environmental management and social responsibility. Elkington (1994) discusses consumers' growing concerns about the environmental impact generated by companies, highlighting the need to create strategies that meet business' financial interests, but also the environmental and social expectations of stakeholders. Thus, the author considers and proposes three fundamental axes for sustainability: economic, social and environmental. This concept, 'Triple Bottom Line', has wide relevance in the scientific world, being adopted and implemented in various areas of knowledge, expanding and intensifying actions, research and debates about sustainability.

Considering the relevance of the sustainability concept, researchers and academics, of all nationalities, concentrated on this theme as a focus of study. According to Souza and Ribeiro (2013, p. 370), in Brazil, "there are few studies on scientific production in the area of environmental sustainability that deal with themes, authors, references and methodological approaches." Therefore, the research question of this study is: what are the main themes and methods of research on sustainability? Therefore, the objective of the study is to identify emerging themes and methods employed in sustainability research.

The research sample is based on the 1,292 academic articles from 440 high impact factor journals indexed in the Scopus database for 20 years (1999-2018). Bibliometric analysis of co-citation and bibliographic matching were performed. Co-citation analysis emerged from three major themes that guide sustainability research: (1) Sustainable Supply Chain Management; (2) Corporate Social Responsibility; and (3) Sustainable Tourism. The bibliographic matching analysis shows five major current research themes: (1) Sustainable Classic Supply Chain Structures; (2) Global and Emerging Economies in Sustainable Supply Chains; (3) Selection of suppliers and fuzzy techniques; (4) New Sustainable Supply Chain Structures; and (5) Environmental Responsibility. Unlike most bibliometric studies that only address theoretical issues of bibliometric analysis, we also focus on methodological issues. Our main contribution is to demonstrate that in sustainability research, more unified and sedimentary themes are principally made up of quantitative studies and more diverse themes, emerging or dealing

with phenomena that are difficult to measure, are addressed qualitatively.

2. BIBLIOMETRICS

Bibliometrics is defined as the measurement of science, scientists, or scientific activity (Broadus, 1987) and as the application of mathematics and statistical methods to books and other media of communication" (Pritchard, 1969, p. 349). Therefore, the purpose of bibliometrics is to catalogue, classify and quantify knowledge in a given discipline. By considering the extent of the literature, bibliometrics can be used to delve into the research trends (Acedo, Barroso, & Galan, 2006; Furrer, Tomas, & Goussevskaia, 2008; Shafique, 2013; Whit & McCain, 1998), networks of scholars (Shane, 1997) and their productivity, or of a specific author (Ferreira, 2011), the themes investigated (Furrer et al., 2008; Schildt, Zahra, & Silanpää, 2006), or the track record of publications in a journal (Phelan, Ferreira, & Salvador, 2002; Ramos-Rodríguez & Ruíz-Navarro, 2004).

Bibliometric studies can use several techniques. The more common techniques are based on citations and co-citations analyses to assess scientific relevance and influence. Citation analyses are based on counting frequencies - the frequency with which a given work is cited by other scholars. The assumption is that scholars cite other works that are relevant to their own research and, hence, that highly cited works have a greater influence on the direction of the research (Culnan, O'Reilly, & Chatman, 1990) and shaping future literature (McCain, 1986, 1990). Co-citation analysis is often used to understand the intellectual structure of a discipline or topic (Leydesdorff, 1987; Ramos-Rodríguez & Ruíz-Navarro, 2004; Subramanyam, 1983). Co-citation is a form of document coupling that measures how frequently a pair of documents is cited together and the clusters of co-cited papers permits identifying the structure of science (Small, 1973) in a discipline or topic. That occurs, because as the same pairs of works (scientific articles or other source documents) are co-cited by many scholars, clusters start to emerge (Small & Garfield, 1993). The supposition is that the papers in these clusters share content commonalities.

Management scholars are no strangers to bibliometrics research (McCain, 1991). For instance, Acedo, Barroso, and Galan's (2006) bibliometric study examined the dissemination and main trends of the Resource-Based View (RBV). Ramos-Rodríguez and Ruíz-Navarro (2004) conducted a bibliometric study in a single journal, the Strategic Management Journal, to identify the works with the greatest impact on strategic management research and analyze the changes in the intellectual structure of the discipline over time. Nerur, Rasheed and Natarajan (2008) traced the evolution of the intellectual structure of the field of strategic management. Shafique (2013) studied innovation as a field of research among four major social science disciplines (economics, sociology, psychology and management) through citation and co-citation matrices. In international Business, Ferreira (2011) examined the impact of a scholar, Sumantra Ghoshal, on the research conducted in the discipline. In entrepreneurship, Schildt, Zahra and Silanpää (2006) identified the communities of scholars through co-citations. In information science, White and McCain (1998) conducted an author co-citation analysis to visualize the discipline.

3. METHOD

This section is composed by the description of the data collection procedures, following the sample is presented and described. Finally, data analysis procedures are described as well as good practices and assumptions of statistical techniques.

3.1 DATA COLLECTION

In order to capture the plethora of methodologies, methods, and instruments for sustainability research, we performed a full-scope search at the *Scopus* database. We chose to limit the timeframe to the last 20 years from 2018 backward; this was done to account for further future research with the purpose of replicating and expanding our procedures. The performed query can be done by later studies to arrive at the same sample. The search expression that was conducted in the *Scopus* database is the following: *TITLE-ABS-KEY ("sustainab*" AND "manag*") AND TITLE-ABS-KEY ("quantitat*" OR "qualitat*") AND SUBJAREA (busi) AND PUBYEAR > 1998 AND PUBYEAR < 2019 AND DOCTYPE (ar).* The first

tag (*TITLE-ABS-KEY*) searches for the indicated expressions in every title, abstract and keywords from the indexed database documents. The choice of including both the "*sustainab**" and "*manag**" expressions was made to select only documents that exclusively deal with sustainability and management. The asterisk is a wildcard operator that enables the search to extend to all possible closures of the expressions and, thus, allowing for all the sustainable published research in management to be captured. Also, the expressions "*quantitat**" and "*qualitat**" are employed to further refine the results to empirical documents that use either quantitative or qualitative methods of analysis. The tag *SUBJAREA (busi)* only encompasses documents indexed in *Scopus* journals that have business as the subject field. Finally, the last tag (DOCTYPE) restricts results to only peer-reviewed articles (*ar*). Our search expression, comprising of only articles between 1999 and 2018 in all the peer-reviewed *Scopus* business journals, tallied a total of 1,292 documents.

and organizations. It has, in 2017, an H-index of 132, a *Scimago* Journal Rankings (SJR) score of 1.47 and Journal Citation Report (JCR) 5-year impact of 6.352. Although it is the most prolific journal in our sample it is not the most impactful. That title belongs to Business Strategy and the Environment with 2017 stats of 75 H-index, 1.88 SJR and 6.426 and JCR 5-year impact.

3.3 DATA ANALYSIS

The first analysis performed was the citation analysis. In most bibliometric studies, we need to correct citation errors made by the authors of the sample's articles. For example, the document may be cited with an incorrect year or using a different abbreviation of the cited document's author name or the journal of the cited document is cited in a different manner. These misspellings can impede analysis by mistakenly duplicating a cited document and making it count and compute as two separate and different documents; thus, limiting the actual intellectual scope of influence of the cited docu-

Figure 1: Current scientific production
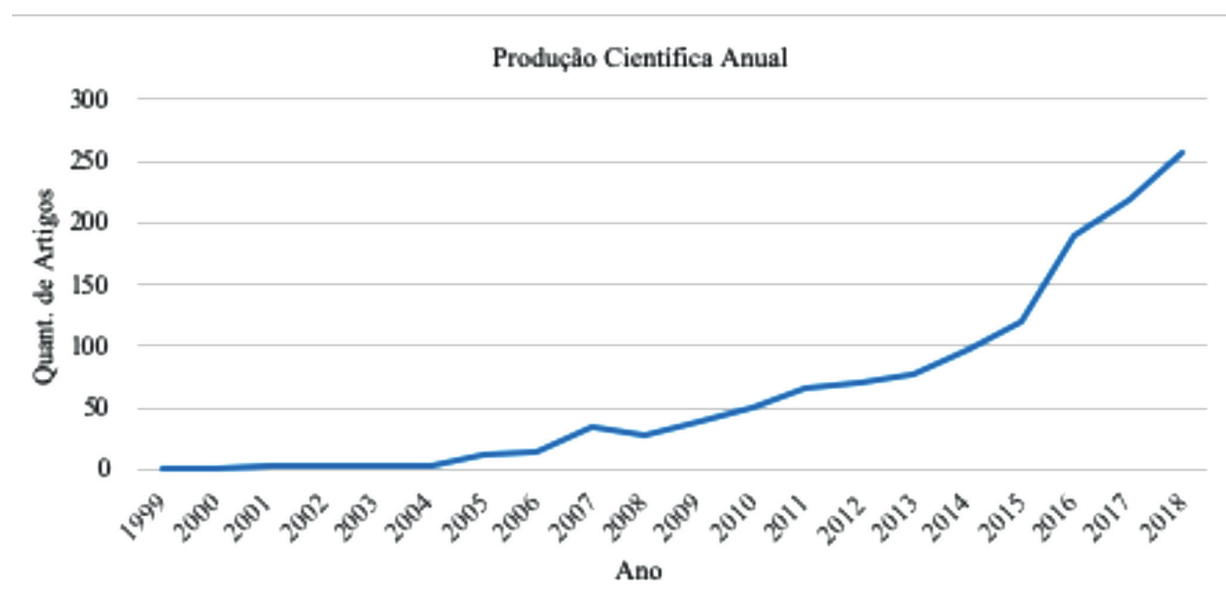
Source: Scopus (2019)

3.2 SAMPLE

Our sample is comprised of 1,292 articles published in 440 *Scopus*-indexed journals during a 20-year period (1999-2018). According to Table 1, the journal with the most articles in our sample is the Journal of Cleaner Production, being one of the main outlets for sustainability research in management, business

ment in the citation analysis. The corrections were manually completed by one of the authors of the study and were double-checked by another author in order to assess the effectiveness of the correction and reliability of the sample's citations.

The 1,292 documents in the sample cited 69,191 documents. To select the top cited documents, we employed *Lotka's Law* of bibliometrics. It states that

Table 1: Sample journals (top 10)

SOURCES	ISSN	FIRST YEAR AVAILABLE AT *SCOPUS*	*SCOPUS* H-INDEX (2017)	*SCIMAGO* JOURNAL RANKING (SJR) (2017)	*JCR* IMPACT 5-YEARS (2017)	NUMBER OF ARTICLES
Journal of Cleaner Production	0959-6526	1993	132	1.47	6.352	153
Business Strategy and the Environment	0964-4733, 1099-0836	1992	75	1.88	6.426	z37
Journal of Sustainable Tourism	0966-9582	1993	76	1.54	4.169	34
Espacios	0798-1015	2007	6	0.14		27
Journal of Business Ethics	1573-0697, 0167-4544	1982	132	1.28	3.955	22
African Journal of Hospitality Tourism and Leisure	2223-814X	2017	2	0	n/a	15
Social Responsibility Journal	1758-857X, 1747-1117	2011	20	0.32	n/a	15
International Journal of Applied Business and Economic Research	0972-7302	2008 - 2017 (canceled)	8	0.32	n/a	14
Journal of Cultural Heritage Management and Sustainable Development	2044-1266, 2044-1274	2011	8	0.26	n/a	13
Evaluation and Program Planning	0149-7189	1978	51	0.47	1.320	12

very few articles (around 5%) would be representative of the field (Nath, & Jackson, 1991). Usually, in established fields no more than 50 cited references would represent between 5 and 10% of the total citations. Restricting the top cited documents to at least four times cited by the sample enabled us to retain 204 top-cited documents that accounted for 2,181 citations (3.15% of the entire sample citations). Despite these 204 documents not reaching the critical representativeness of at least 5% of the sample citations, it represents a large critical mass of the most important citations in the sample.

To generate the co-citation analysis, we derived a squared co-occurrence matrix of the 204 top-cited documents. This matrix is symmetric with the top-cited references as both columns and rows; and each cell is the number of times a certain document (column/row) was co-cited with another document (row/column). The co-citation matrix was then used to perform a factor analysis using principal components analysis (PCA) using Varimax as a rotation technique. The Varimax rotation technique, in relation to the other orthogonal rotations, tries to maximize loads of the items, making the factors contain only a few variables with high loads.

The bibliographic coupling analysis exists to identify the sample's documents that have shared citations. This is done by generating a co-occurrence matrix of all the 1,292 documents in the sample regarding the number of citations they have in common. To perform a sufficient PCA factor analysis, we selected only the sample documents that have at least 6 shared citations, bringing the analysis to 78 articles.

The factorial analysis is based on some precautions and assumptions to be observed (Quevedo et al., 2016). The first one is the KMO (*Kaiser–Meyer–Olkin*) measure, which measures the proportion of inconsistencies among the variables that can be derived from the common variance, also called systematic variance. KMO is computed between 0 and 1. Low values (close to 0) indicate there are large partial correlations in comparison to the sum of the correlations, that is, there is a predominance

of correlations of the variables that are problematic for the factorial analysis. Hair et at. (2009) suggest that individual KMOs smaller than 0.5 be removed from the factorial analysis. Consequently, this removal causes the overall KMO of the remaining variables of the factor analysis to be greater than 0.5.

The second assumption to be validated in a factorial analysis is Bartlett's sphericity test. The test is applied in a correlation matrix and is based on the null hypothesis (Ho) that a correlation matrix is an identity matrix. An identity matrix is an array in which all the diagonal elements are 1 and all the elements outside the diagonal are 0. The assumption is that the correlation matrix is different from the identity matrix for the factor analysis to be performed, so Bartlett's sphericity must have a p-value less than 0.05 to reject Ho.

The third assumption of a valid factor analysis is the commonality of the rotated variables. The commonalities indicate the common variance shared by factors with certain variables. Greater commonality indicated that a greater amount of inconsistency in the variable was extracted by the factorial solution. For a better measurement of factorial analysis, communalities should be 0.5 or greater (Hair et al., 2009).

Finally, the last caution to be taken when using a factorial analysis is to pay attention to the cross-loads of the rotated variables. Cross-loads occur when a variable has a load on two different factors, and the minimum threshold for cross-load is load values above 0.5. Hair et al. (2009) recommend that high cross-loads be ignored if the variable has a load greater than 0.5 on the factor that it originally belongs to according to the theory.

For each of the assumptions of the factor analysis, one must take corrective actions and perform the whole analysis again by navigating hierarchically through the assumptions again to ascertain new violations. That is, if, for example, a variable was removed by low commonality, we must again investigate the KMO values of each variable, the systemic KMO value and the p-value of the Bartlett sphericity test. In this process, the highest violation in the hierarchical chain of assumptions must be corrected. If there are two variables with the same type of assumption violation, one must first correct the variable with the worst measurement index of that violation. For example, if two variables exhibit commonality

below 0.5, one should first remove the one with the least commonality and redo the analysis and verify if the other variable that had low commonality still presents violations of commonality in the new scenario in which the variable with highest breach measurement was removed. This procedure is repeated until a final solution is reached without a breach of assumptions (Table 2).The first component is named "Sustainable Supply Chain Management" and reflected in 39 articles. This group includes the inclusion of the concept of sustainability in the context of supply chains, as a way of generating value and competitive advantage for companies, from the environmental and social dimensions at various levels of the chain.

Some sample studies that analyze this concept from a performance perspective are: Bai, Sarkis, Wei and Koh (2012), Carter and Rogers (2008), Golicic and Smith (2013), Erol, Sencer & Sari (2011), Hervani, Helms and Sarkis (2005), Wang and Sarkis (2013), Rao and Holt (2005).

The research by Van Hoof and Thiell (2014) highlights the results of cleaner production projects within supply chains in the context of Small and Medium Enterprises, which means that this concern does not only consider large companies. As well as the research by Walker, Di Sisto and McBain (2008) on barriers and facilitators of environmental management practices comparing the public and private context.

In this study group, country-specific contexts were analyzed, such as India (Mitra & Datta, 2014), Malaysia (Zailani, Jeyaraman, Vengadasan & Premkumar, 2012) and China (Zhu & Sarkis, 2004).

Companies that adopt this perspective influence the whole chain, for instance, having an impact on supplier choice, as analyzed by Bai and Sarkis (2010), Ageron, Gunasekaran and Spalanzani (2012) and Weber, Current and Benton (1991).

As it is still a theme that is under construction, we highlight the theoretical studies focused on the definition of conceptual frameworks (Hassini, Surti, & Searcy, 2012), literature review according to Ahi and Searcy (2013), Srivastava (2007), Miemczyk , Johnsen and Macquet (2012), Seuring and Müller (2008) and Sarkis, Zhu and Lai (2011); as well as research agendas and studies on the future challenges of sustainable supply

Table 2: Co-citation analysis

ARTICLE	SUSTAINABLE SUPPLY CHAIN MANAGEMENT	CORPORATE SOCIAL RESPONSIBILITY	SUSTAINABLE TOURISM
coc 1 - Hassini, Surti & Searcy (2012)	.890		
coc 2 - Ahi & Searcy (2013)	.874		
coc 3 - Bai & Sarkis (2010)	.874		
coc 4 - Brandenburg, Govindan, Sarkis & Seuring (2014)	.861		
coc 5 - Bai, Sarkis, Wei & Koh (2012)	.848		
coc 6 - Gold, Seuring & Beske (2010)	.846		
coc 7 - Seuring (2013)	.836		
coc 8 - Ageron, Gunasekaran & Spalanzani (2012)	.834		
coc 9 - Carter & Rogers (2008)	.822		
coc 10 - Golicic & Smith (2013)	.820		
coc 11 - Srivastava (2007)	.818		
coc 12 - Erol, Sencer & Sari (2011)	.814		
coc 13 - van Hoof & Thiell (2014)	.798		
coc 14 - Miemczyk, Johnsen & Macquet(2012)	.796		
coc 15 - Hervani, Helms, & Sarkis (2005)	.792		
coc 16 - Pagell & Wu, Z. (2009)	.774		
coc 17 - Mitra & Datta (2014)	.764		
coc 18 - Seuring & Müller (2008)	.764		
coc 19 - Handfield, Sroufe & Walton(2005)	.763		
coc 20 - Ahi & Searcy (2015)	.761		
coc 21 - Pagell & Shevchenko (2014)	.750		
coc 22 - Wang & Sarkis (2013)	.750		
coc 23 - Zailani, Jeyaraman, Vengadasan & Premkumar (2012)	.750		
coc 24 - Carter & Liane Easton (2011)	.746		
coc 25 - Dou, & Sarkis (2010).	.738		
coc 26 - Weber, Current & Benton (1991)	.720		
coc 27 - Sarkis, Zhu & Lai (2011)	.715		
coc 28 - Linton, Klassen & Jayaraman(2007)	.714		
coc 29 - Rao & Holt (2005)	.710	.452	
coc 30 - Walker, Di Sisto & McBain (2008)	.707		
coc 31 - Hofmann, Busse, Bode & Henke (2014)	.707		
coc 32 - Kleindorfer, Singhal & Van Wassenhove (2005)	.704		
coc 33 - Hoejmose & Adrien-Kirby (2012)	.703		
coc 34 - Tang, C. S., & Zhou, S. (2012)	.699		

Table 2: Co-citation analysis (cont.)

ARTICLE	SUSTAINABLE SUPPLY CHAIN MANAGEMENT	CORPORATE SOCIAL RESPONSIBILITY	SUSTAINABLE TOURISM
coc 35 - Govindan, Khodaverdi & Jafarian (2013)	.689		
coc 36 - Zhu & Sarkis (2004)	.675		
coc 37 - Paulraj (2011)	.639		
coc 38 - Carter & Jennings (2004)	.570	.550	
coc 39 - Andersen & Skjoett-Larsen (2009)	.553	.512	
coc 40 - Orlitzky, Schmidt & Rynes (2003)		.839	
coc 41 - Margolis & Walsh (2003)		.825	
coc 42 - Barnett (2007)		.820	
coc 43 - Russo & Fouts (1997)		.813	
coc 44 - Brammer & Millington (2008)		.805	
coc 45 - McWilliams Siegel & Wright (2006)		.803	
coc 46 - Clarkson (1995)		.797	
coc 47 - Berman, Wicks, Kotha & Jones (1999)		.764	
coc 48 - Buysse & Verbeke (2003)		.760	
coc 49 - Hart (1995)		.756	
coc 50 - Garriga & Melé (2004)		.753	
coc 51 - Aragón-Correa & Sharma (2003)		.744	
coc 52 - Freeman (2010)		.743	
coc 53 - Waddock & Graves (1997)		.740	
coc 54 - Fombrun & Shanley (1990)		.738	
coc 55 - Walley & Whitehead (1994)		.737	
coc 56 - Carroll (1979)		.726	
coc 57 - Sharma & Vredenburg (1998)		.723	
coc 58 - Hunter (1995)			.817
coc 59 - Buckley (2012)			.814
coc 60 - Simpson (2001)			.793
coc 61 - Clarke (1997)			.787
coc 62 - Liu (2003)			.786
coc 63 - Saarinen (2006)			.772
coc 64 - Okazaki (2008)			.763
coc 65 - Sharpley (2000)			.735
coc 66 - Hunter (1997)			.723
coc 67 - Bramwell & Lane (1993)			.704

chain management (Pagell & Shevchenko, 2014; Carter and Liane Easton, 2011; Hoejmose & Adrien-Kirby, 2012).

The second component is named "Corporate Social Responsibility" and was included in 21 articles, of which Rao and Holt (2005), Carter and Jennings (2004) and Andersen and Skjoett-Larsen (2009) are common with component 1 as they are also linked with the Supply Chain theme, but in our analysis belong conceptually to component 2.

In Carroll's study (1979), the concept of Corporate Social Responsibility (CSR) can be classified by considering four categories that make up a pyramid: (1) Economic Responsibility: the basis and is associated with the concern of organizations to make a profit; (2) Legal Responsibility: linked to the need to know and obey the law; (3) Ethical Responsibility: obligation to do what is right and fair; and (4) Philanthropic Responsibility: contributing resources to the community (corporate citizen). In addition to this study, other authors of the sample discussed the theoretical perspectives of the CSR concept (McWilliams, Siegel & Wright, 2006; Garriga & Melé, 2004; and Fombrun & Shanley, 1990).

The articles by Orlitzky, Schmidt and Rynes (2003), Margolis and Walsh (2003), Brammer and Millington (2008), Waddock and Graves (1997); Russo and Fouts (1997) relate the concept of corporate social performance to corporate financial performance that is geared to maximizing the wealth of the organizations' owners. Some studies also relate the organization's CSR practices to stakeholder theory and the impact of these practices on the company's reputation, image and financial performance [Barnett (2007), Clarkson (1995), Berman, Wicks, Kotha & Jones (1999), Buysse & Verbeke (2003) and Freeman (2010)]. Finally, the studies by Russo and Fouts (1997), Hart (1995) and Aragón-Correa and Sharma (2003) analyze Corporate Social Responsibility in the light of Resource-based View (RBV).

The third component is named "Sustainable Tourism" as the challenges associated with the environment and the concern for sustainable development and the efficient use of resources impact this sector. This component considered 10 studies. The research presents several theoretical perspectives on the subject: Hunter (1995), Clarke (1997), Liu (2003), Saarinen (2006), Okazaki (2008),

Sharpley (2000), Hunter (1997) and Bramwell and Lane (1993). Presented are priorities for academic research aimed at improving the sustainability of the tourism industry (Buckley, 2012), as well as the use of management tools such as Strategic Planning and stakeholder participation to foster sustainable tourism (Simpson, 2001).

4 BIBLIOGRAPHIC COUPLING ANALYSIS

Bibliographic Coupling began with 78 sample documents that have a minimum of 6 shared citations. The analysis was performed to achieve a solution that satisfied all the assumptions underlying a valid PCA: general and individual KMO above 0.5, *Bartlett*'s sphericity test *p-value* less than 0.05, and communalities over 0.5. After 11 interactions, we reached a final solution comprised of 18 sample documents loaded in five components that explained 80% of variance. They are represented in the following Table 3 and have been ordered from the most explained variance (or greater eigenvalue) to the lowest.

The first component we call "Classical Sustainable Supply Chain Frameworks" and consists of five sample articles dealing with research on sustainable supply chain management. Conceptually, all five articles analyze frameworks and metrics related to sustainable supply chain management performance. The first article, Stindt (2017), is a theoretical essay proposing a sustainable supply chain management planning framework. Oelze & Habisch (2018) applied a typology of Responsible Supply Chain Management in 10 cases (5 multinationals and 5 small companies) using Eisenhardt's (1989) approach with 29 interviews (Miles & Huberman, 1994) along with triangulation of data (Patton). Osiro, Lima-Junior and Carpinetti (2018) propose supply chain sustainability assessment metrics based on previous literature studies and test them using Quality Function Deployment (QFD) matrix and expert assessment. Zhou, Wang, Lim, He and Li (2018) is a background analysis of the supply chain background in selecting sustainable partners employing Multi Criteria Decision Making (MCDM) using quantitative equations with a fuzzy approach, plus 5 experts to evaluate the dashboard metrics. Finally, Touboulic and Walker (2015) assesses the Collaborative paradigm on Sustainable Supply

Table 3: Bibliographic Pairing Analysis

ARTICLES	SUSTAINABLE CLASSIC SUPPLY CHAIN STRUCTURES	GLOBAL AND EMERGING ECONOMIES IN SUSTAINABLE SUPPLY CHAINS	PROVIDER SELECTION AND FUZZY TECHNIQUES	NEW SUSTAINABLE SUPPLY CHAIN STRUCTURES	ENVIRONMENTAL RESPONSIBILITY
Coup 1 – Stindt (2017)	.992				
Coup 2 – Oelze & Habisch(2018)	.992				
Coup 3 – Osiro, Lima-Junior & Carpinetti (2018)	.992				
Coup 4 - Zhou, Wang, Lim, He & Li (2018)	.992				
Coup 5 - Touboulic & Walker (2015)	.784				
Coup 6 - Ehrgott, Reimann, Kaufmann & Carter (2013)		.972			
Coup 7 - Chacón Vargas, Mantilla & Eduardo (2016)		.972			
Coup 8 - Ortas, E., M. Moneva, J. & Álvarez, I. (2014)		.827			
Coup 16 - Wu, Liao, Tseng & Chiu (2016)		.613			
Coup 9 - Sen, Datta, Patel & Mahapatra (2017)			.768		
Coup 10 - Taticchi, Garengo, Nudurupati, Tonelli & Pasqualino (2015)			.768		
Coup 11 - Kähkönen, Lintukangas, Hallikas & Evangelista (2016)			.768		
Coup 12 - Raj & Srivastava (2018)			.768		
Coup 13 - Pandey, Shah & Gajjar (2017)			.768		
Coup 14 - Comas Martí & Seifert (2013)				.935	
Coup 15 - Kähkönen, Lintukangas & Hallikas (2018)				.876	
Coup 17 - Fabbe-Costes, Roussat, Taylor & Taylor (2014)					1.000
Coup 18 - Eriksson, & Svensson (2016)					1.000

Chain Management through action research on a network of 11 small agricultural suppliers from a large food multinational, with 37 interviews, data triangulation (Patton) and single case study approach (Yin).

The second component was named "Global and Emergent Economies Sustainable Supply Chain" and has four sample articles. From a theoretical point of view, it is very similar to the first component of classic Sustainable Supply Chain frameworks, but its entire context is global or immersed in emerging economies. Ehrgott, Reimann, Kaufmann and Carter (2013) analyze how pressures act as antecedents in developing suppliers' environmental capacities in emerging economies from stakeholder theory and the benefits that companies derive from this effort. It is a comparative study between the United States and Germany, with 244 purchasing managers employing Structural Equation Modeling. Chacón Vargas, Mantilla and Eduardo (2016) study organizational background and implementation of Sustainable Supply Chain Management practices employing a qualitative approach (Creswell / Yin), with a case study of 4 companies from different sectors in Colombia. The analysis and data collection are based on semi-structured interviews of 7 executives, in which content analysis was applied. Ortas, Moneva and Álvarez (2014) investigate the relationship between a sustainable supply chain and companies' financial performance through the Granger Causality Test (an econometric technique). The sample is substantial with 3,900 companies and the eight-year data collection period (2004-2011). Wu, Liao, Tseng and Chiu (2016) propose a sustainable supply chain management evaluation model using Multi Criteria Decision Making (MCDM). It is a case study with four experts at a Taiwanese semiconductor company.

The third component, "Supplier Selection and Fuzzy Techniques", has five sample articles and theoretically addresses supplier selection issues using the fuzzy approach. Sen, Datta, Patel & Mahapatra (2017) analyze how to select sustainable suppliers in Supply Management using quantitative methods under fuzzy approach and recruited four experts to evaluate the panel approach. Taticchi, Garengo, Nudurupati, Tonelli and Pasqualino (2015) is a narrative literature review on state-of-the-art tools

and performance measurement in sustainable supply management that employs bibliometric techniques similar to this article. Kähkönen, Lintukangas, Hallikas and Evangelista (2016) is a definition of supplier risk management principles and practices from a sustainable perspective by surveying 99 Finnish companies. Raj and Srivastava (2018) employ a fuzzy approach to assessing sustainable performance in a supply chain and is a unique case study with an Indian airline. Pandey, Shah and Gajjar (2017) develop a sustainable supplier selection framework using a fuzzy approach and also a unique case study with an Indian automotive industry.

The fourth component was named "New Sustainable Supply Chain Frameworks" and consists of 2 articles that differ conceptually from the first component, even though they both have Sustainable Supply Chain frameworks as their theme. Comas Martí and Seifert (2013) analyze the consistency of companies' sustainable supply chain strategies through Content Analysis and Grounded Theory (Glaser-Strauss). Kähkönen, Lintukangas and Hallikas (2018) analyze the role of sustainable management of Supply Management in Sustainable Performance of companies from the perspective of Dynamic Capabilities. The study employed Focus Group with 9 supply chain management professionals and a survey of 111 companies.

Finally, the fifth component, Environmental Responsibility, consisting of 2 articles, deals with moral and ethical issues of Sustainable Supply Chain management. Fabbe-Costes, Roussat, Taylor and Taylor (2014) is an analysis of environmental scanning (ES) practices for sustainable supply chain management (SSCM) and was prepared with 45 semi-structured interviews with professionals along with validation of results with a focus group of supply chain specialists. Eriksson and Svensson (2016) analyze moral disengagement in sustainable business supply chains (Business Sustainability - Bsus) based on qualitative multi-case research (Eisenhardt, 1989).

The five components, derived from principal component factor analysis, to explain quantity of variance (or higher eigenvalue) show not only a trend of relevant emerging themes in sustainability research, but also demonstrate that there is no favoring of quantitative or qualitative

methodological approaches. The first component "Classical Sustainable Supply Chain Frameworks" has five articles, being a theoretical essay, therefore, without defined methodological approach. Of the remaining four articles, two are quantitative and two qualitative. In the four articles in the second component, "Global and Emergent Economies Sustainable Supply Chain", consists of two articles that are quantitative studies and one is qualitative, and one is a mixed study that employs both approaches. This demonstrates that this component slightly favors quantitative approaches. This can be explained by the global character of the component in which they generally adopt international business traditions and biases whose approaches are typically quantitative. The third component (Supplier Selection and Fuzzy Techniques) is entirely quantitative with its

in the qualitative research. Finally, the fifth component, "Environmental Responsibility"), is predominantly qualitative because it addresses moral and ethical issues that are difficult to measure quantitatively (Randall & Gibson 1990).

5 DISCUSSION

The results of this research corroborate the growth of the theme of sustainability in the scientific scope at the world level according to Figure 1 (Annual Scientific Production). The sample with 1,292 documents revealed that the scientific production in sustainability: (1) has studies in several areas of knowledge; and (2) presents a variety of methods in the publications without endorsing a preference towards qualitative or quantitative approach.

Figure 2: Scientific Production by Country
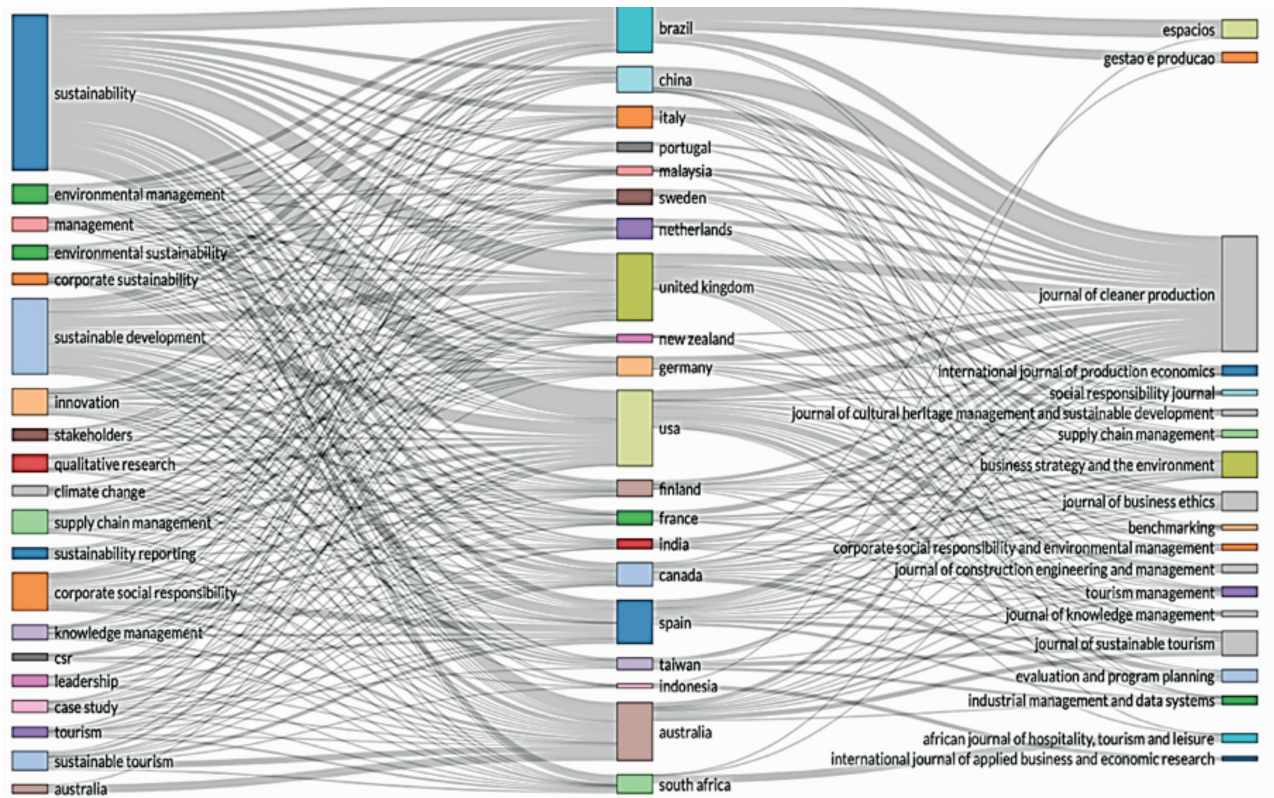
five articles using strictly fuzzy quantitative techniques. The fourth component, "New Sustainable Supply Chain Frameworks", involves the proposition of new sustainable supply chain management frameworks and tend to be more exploratory than descriptive. Therefore, its methodological approach is qualitative, and one article is strictly qualitative. There is an article from a study of mixed methods, which confirms quantitatively the results obtained

Despite this diversity, the articles in the sample converge and point to the researchers' concern to promote discussions and reflections, together with the development of strategies, actions and solutions that promote sustainability on a local, regional and global scale.

With this article we contribute to the identification of patterns and trends of sustainability research. We associate the word "management"

with the theme of "sustainability" and with the use of statistical techniques and bibliometric method we determine the main authors, journals, methodological approaches and research topics. According to Figure 2 (Scientific Production by Country), we can identify: (1) the most researched themes; (2) the countries; and (3) the main journals. It is also possible to distinguish by the thickness of the lines which countries and themes are most published. In this context, the most important are the developed countries: United States, United Kingdom, Australia and Spain for the variety of content and publications. However, in emerging countries such as Brazil and China, it is observed that they have a variety of themes, however, published in a smaller number of journals.

In the continuity of the study, when conducting the analysis of co-citation and bibliographic pairing, there is a predominance of contents related to the Sustainable Supply Chain. In the most representative articles in this sample, the authors discuss their considerations and conclusions on the implementation, efficiency and management of the Sustainable Supply Chain. Some examples are: coc 1 - Hassini, Surti and Searcy (2012), coc 2 - Ahi and Searcy (2013) with conceptual proposals on the subject. Other articles limit the research question to a traditional setting, such as: coup 1 - Stindt (2017) and coup 2 - Oelze and Habisch (2018). Other articles in the sample broaden the discussions to a global context, including economic, social and environmental issues in developed and emerging markets, as follows: coup 6 - Ehrgott, Reimann, Kaufmann and Carter (2013), coup 7 - Chacón Vargas, Mantilla and Eduardo (2016).

The issue of sustainability management is on the rise, which generates a positive expectation about further research over the next few years. However, we have identified the absence of important themes that should be developed and explored with the aim of boosting and expanding the world scientific literature, such as: (1) development of green technologies; (2) sustainable innovations in a broader context that are not just limited to innovations in supply chain processes; and (3) public policies and environmental certifications.

6 FINAL CONSIDERATIONS

6.1 CONCLUSIONS

Co-citation analysis identified three components. The first component was called "Sustainable Supply Chain Management" and encompassed theoretical studies on the topic, as well as research relating this concept to organizational performance, supplier selection and future research agendas. The second was called "Corporate Social Responsibility" with studies that addressed various theoretical perspectives in the light of stakeholder theory, Resource-based View and analysis of the relationship between corporate social performance and financial performance. Finally, the last component was named "Sustainable Tourism" with a mainstream of theoretical studies.

Bibliographic matching analysis emerged with five components. Regarding its theoretical framework, the first component, Sustainable Classic Supply Chain Structures, has studies that deal with frameworks and metrics related to sustainable supply chain performance. In the second component, Global and Emerging Economies in Sustainable Supply Chains, the theme is very similar to the first component, but its whole context is global or immersed in emerging economies. The third component, named Vendor Selection and Fuzzy Techniques, discuss vendor selection issues using the fuzzy approach. The fourth component, New Sustainable Supply Chain Structures, proposes new sustainable supply chain management frameworks. Finally, the fifth component, Environmental Responsibility, addresses the moral and ethical issues of sustainable supply chain management.

The components of bibliographic matching, analyzing under the methodological framework, demonstrate that there is no favoring of quantitative or qualitative methodological approaches. In general, more unison themes demand quantitative studies and more diverse themes, emerging or dealing with difficult to measure phenomena, are addressed qualitatively. Such a relationship between methodological approaches and maturity of research topics is already evident in the literature. Souza and Ribeiro (2013) show this trend in the Brazilian sustainability literature.

6.2 LIMITATIONS AND SUGGESTIONS FOR FUTURE STUDIES

Bibliometrics has some limitations in its applications. The first concerns the assumption that document citations are made to indicate there is a synergistic theoretical connection. In this sense, one document cites another as there is an intention to add the contributions of the cited document. Therefore, citations in a bibliometric study cannot be interpreted as a manifestation of conflict or disagreement. However, authors often cite documents to oppose the premises or contributions of such documents, generating a citation that, through bibliometric eyes, will be misinterpreted as alignment and consent. This limitation of bibliometrics means that bibliometric studies have to pay greater attention to their citation and co-citation analyzes. This does not occur in bibliometric pairing analysis, as a minimum cut is usually made on the number of common nodes (cited documents) that paired documents must have to join the pairing analysis sample.

The second limitation is that bibliometrics is no substitute for extensive and deep readings and syntheses. Bibliometric studies can accurately: 1) quantitatively connect themes, journals and authors; 2) identify research themes and subthemes; and 3) produce representations of published research (Zupic & Čater, 2015). Every bibliometrics has a human intervention in the sense of the researcher deciding, based on his knowledge of the theoretical field in question, what will be the interpretation of these bibliometrics results.

As future studies, we believe that methodological innovations in bibliometrics can be applied. These innovations can have a hybrid character, joining with semantic approaches that can detect new emerging topics in scientific research through bibliographic pairing with latent semantic indexing (Glänzel & Thijs, 2012). There is also the possibility of linking bibliometrics with machine learning approaches, the most prominent being topic modeling (Blei, 2012). These two methods have great potential for expanding the domain mapping scope of a desired theoretical field.

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