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Supply chain collaboration for sustainability: A literature review and future research agenda

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ABSTRACT

New technology is altering business strategies and innovation capabilities while increasing the possibilities of production and process innovation. Supply chain collaboration undertaken for the sake of sustainability is currently speeding up this process of change; a growing pool of research is exploring the links between sustainability collaboration and company performance on economic, environmental, and social metrics. It is a good time to review the literature to reveal what has been studied and what are the gaps in the current body of knowledge, and also to comment on what the future research agenda should include. For these purposes, the authors conducted a systematic literature review and a quantitative bibliometric analysis. Results indicate that research about supply chain collaboration for the purpose of sustainability is gaining growing attention in the business field; however, environmental and economic considerations still dominate the research, while there is a lack of consideration about social concerns such as child labor and personal development. In addition, the collaboration partners under investigation have mainly been the company and its customers and suppliers, whereas competitors and other horizontal collaboration partners have received little attention.

1. Introduction

Supply chain collaboration has become a strategic issue for companies that wish to achieve their economic, social, and environmental sustainability targets. Most researchers define supply chain collaboration as a partnership process in which no less than two independent parties work hand in hand to mastermind and execute supply chain operations for the fulfillment of common goals and mutual benefits (Cao and Zhang, 2011). This collaboration process may include governments and university/research institutes, which define development policies and contribute to the relevant R&D activities, respectively (Lee et al., 2010). Meanwhile, collaboration among multiple businesses for environmental improvements should be a key issue for a sustainable supply chain management (Lu et al., 2007).

The studies on supply chain management highlight the importance of coordination among companies. Soylu et al. (2006) point out that supply chain collaboration is a common way for companies throughout the supply chain to share the information, make strategic alliances to improve performance, and reduce overall costs and inventories. The ultimate objective for supply chain collaboration is to increase a company's competitive advantage (Soylu et al., 2006; Cao and Zhang, 2011).

Nowadays, companies must address external and internal concerns to become more environmentally and socially responsible while maintaining their responsibilities toward economic sustainability. Industrial practices increasingly emphasize that collaboration is a feasible means of balancing these three priorities. Such collaborations have expanded over time to include all the relevant parties of an industrial value chain. As the academic literature examining supply chain collaboration and sustainability is still in a relatively infantile stage (Linton et al., 2007), the time to undertake an in-depth analysis of the research to date is now. Such an analysis will allow academic and industrial practices move forward in tandem.

This paper focuses on the subject of sustainability and supply chain collaboration from a broad perspective that includes economic, environmental, and social aspects. The research objectives of this paper are to summarize the current state-of-the-art in the field of sustainability and supply chain collaboration research, as well as to identify what future research would best benefit the field. Thus, the research questions in this

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paper are:

- What are the state-of-the-art and existing trends in the research on sustainability and supply chain collaboration?
- What gaps exist in the research, and what may be done to contribute to future research?

To address these questions, we scoured different databases to collect articles that fit the research objectives. Then we provided a comprehensive analysis of the current literature in supply chain cooperation and collaboration for the sake of sustainability and conducted a triangulation analysis of the literature to improve understanding of the current research situation. A systematic literature review and quantitative bibliometric analysis have been applied to improve the results of the analysis.

In this paper, we take a broad strategic perspective of sustainability and supply chain collaboration from both qualitative and quantitative views. There are some significant features in this review: i) it explicitly includes supply chain collaboration practices in terms of their ability to effect sustainability, ii) it considers sustainability from a broad viewpoint that includes not only economic aspects, but environmental and social factors as well.

Following the introduction chapter, the paper presents an overview of the review methodology. It then provides a classification scheme for the selected articles based on content analysis, and then illustrates the results of a bibliometric analysis that indicates the leading individual contributors and leading organizations in this field. We elaborated a conceptual framework that can help researchers to assess the relationship between sustainability and supply chain collaboration. From there, the paper provides a research agenda for the purpose of contributing the existing knowledge of industry and academia on the relationship between sustainability and supply chain collaboration.

2. Methodology

To address the research questions, we performed a thorough review on the literature relating to supply chain collaboration for the purpose of sustainability. The literature review team, made up of two senior researchers and two PhD students, held discussions and cooperated in all facets of this literature review. The four researchers performed independent work first, and then entered a panel discussion at every research step. This study followed the process recommended by Krippendorff (1980), which includes four steps: (i) data collection, (ii) descriptive analysis, (iii) categorization analysis, and (iv) data evaluation and interpretation.

2.1. Data collection

This study contains literature from 1987 to 2015, because 1987 was the year when the UN Brundtland Commission first officially introduced the sustainability concept (WCED, 1987). The process for data compilation followed the review methodology suggested by Andriolo et al. (2014), and is shown in Table 1. We collected articles from a selection of databases, including Scopus, Web of Science, and Business Source Premier. An expert panel discussion resulted in the creation of a table of selected keywords that would identify literature that fulfilled the requirements in the research objectives. The keywords can be divided into three categories:

1. Related words about supply chain
2. Related words about collaboration
3. Related words about sustainability

One example of a keywords combination would be “sustainability”+“supplier”+“integration”; another would be “green”+“supply chain” +“collaboration.” Table 1 shows all the selected keywords.

Table 1
Review methodology keywords and the four selection steps adopted.

		Process	Papers found
1	Year	1987–2015	
2	Keywords	Topic=“Related words about supply chain” and “related words about collaboration” and “related words about sustainability” • Related words about supply chain: supply chain, supplier • Related words about collaboration: integration, collaboration, cooperation, joint planning, joint product development, coordination, development, involvement, customer involvement • Related words about sustainability: green, sustainable*, corporate social responsibility, environment*, compliance • For example: TS = (supplier and cooperation and green)	1778
3	Exclusion criteria	• Only focus on economic performance • Has nothing to do with supply chain collaboration	1603
4	Selection criteria	• Document type: article and review • Research areas: Operations management and supply chain management • Languages: English	174 Used for descriptive analysis
5		• Read the full texts of 174 papers by all members of the research team independently to evaluate whether the paper at least answered one of the research questions • Based on the comparison of all evaluations, careful analysis and interactive team discussion, papers not really focusing on the research questions were deleted • Finally 90 papers are include for the further categorization analysis	90 Used for categorization analysis and data evaluation and interpretation

After clearly defining the research strategy, we conducted comprehensive systematic research to collect published journal articles and reviews in the operations management field from 1987 to 2015. Papers were collected from the main sources based on their appearing in the search results of various databases as the result of entering the selected keywords. To test the relevance of the collected papers, each team member performed individual abstract analysis of all 1778 papers. Those papers focusing exclusively on the economic dimensions of sustainability or that had nothing to do with supply chain were excluded in order to highlight works on collaboration and comprehensive sustainability indicators. In the end, 174 papers were considered to be valid. The inter-rater agreement of all team members was 85%. These 174 papers were used for the bibliometric analysis to explore the structures and evolution of current research in sustainability and supply chain collaboration.

After selecting relevant papers and bibliometric analysis, however, we read the full texts of all 174 papers. We found that these 174 papers provided a suitable overview of the current state-of-the-art in the field of sustainability and supply chain collaboration. Thus, we included them in the following bibliometric analysis. However, when preparing the content analysis, we had a more specified aim in mind. The papers selected for content analysis had to answer at least one of the following questions:

- What are the most important factors determining whether a supply chain collaboration achieves sustainability?
- What are the relationships among these factors?
- What combination of factors leads to improved sustainability performance by companies?

We found that not all papers focused on the above-mentioned issues concerning collaborations for sustainability. After much discussion, we selected 90 papers for in-depth analysis and summary. The descriptive analysis and quantitative bibliometric analysis thus includes 174 papers, while the categorization analysis uses on the 90 papers that focused on the most relevant issues.

2.2. Descriptive analysis

We began by exploring the growth in research publications over time and the distribution of the papers among the various journals. Next, we conducted a bibliometric analysis using the Citespace program to reveal what authors were contributing most frequently and the degree to which the research on this topic was undertaken by means of collaborative networks. One of the most important aspects of this analysis was the co-author analysis.

2.3. Categorization analysis

Because categorization is a crucial approach to understanding the characteristics of different groups (Cohen and Lefebvre, 2005), we next analyzed the pool of research papers according to key research issues. The analysis included three structural dimensions: theories used, methodologies used, and supply chain collaboration practices for sustainability. The theory dimension provided categorization of papers based on what theories were used by the reviewed papers. The methodology dimension provided categorization of papers based on the methodologies used by reviewed papers, including survey, case, concept, and math. The dimension of supply chain collaboration practices for sustainability provided categorization of papers based on what practices were assessed. It was structured into five categories based on how partners and firm were collaborating: internal collaboration, collaboration with supplier, collaboration with customer, collaboration with competitor, and collaboration with other organizations.

2.4. Rigor of research process

The study's reliability was assured by involving two senior researchers and two Ph.D. students in all steps of the literature review; this follows the same principle espoused by Seuring and Müller (2008). We also tried to ensure validity by following structured and systematic processes and guidelines for each step of the research process. We have presented this research at conferences in order to make use of feedback and comments from other researchers in further revisions of our paper.

3. Results

This section summarizes the trends in the literature in terms of the distribution of publications over time, the journals at which papers were published, and the kind of supply chain collaboration explored by the papers. The content analysis reveals that the most frequently discussed issues about sustainability and supply chain collaboration in the current literature can be divided into three broad aspects: internal collaboration, vertical collaboration, and horizontal collaboration. Vertical collaboration is either upstream or downstream collaboration, and usually involves suppliers. Horizontal collaboration includes external collaboration with competitors and other organizations, such as "haulage-sharing," which allows partners to share transportation modes for their materials and finished products to reduce costs and increase eco-efficiency (Andriolo et al., 2015).

3.1. Descriptive analysis

3.1.1. Literature over time

We began by plotting the number of publications in different time periods to observe the evolution of research interest. Although the first official introduction of the sustainability concept was by the UN Brundtland Commission in 1987, literature concerning supply chain collaboration for sustainability did not appear until 1998. The number of publications was rather limited prior to 2005. From 2005–2010, the number of relevant publications increased slowly. After 2010, the research on this topic has been increasingly emphasized; from 2012 on, the number of publications displays a strong positive trend, amounting to 36 articles in 2014, as Fig. 1 shows. This analysis shows that, while the research area is still in its infancy, interest in this field has grown rapidly in recent years.

3.1.2. Publications by journal

In order to assess the extent of journal influence on this field, we next calculated the number of papers published by each journal. The analysis revealed that the top three journals contributed more than half of the total number of papers reviewed. The 174 articles subject to our review were published among 36 different international scientific Operations Management journals. Of those, 19 journals account for 158 articles (see Table 2), while the remaining 17 articles come from 17 different journals. Three journals contributed more than half of the total reviewed papers; the International Journal of Production Economics had the most articles, followed by the International Journal of Production Research and the European Journal of Operational Research.

3.1.3. Co-author analysis

Co-author analysis is an efficient way to reveal who is performing research in a field and what networks exist among those researchers. Table 3 represents the most contributing authors in the field. Their number of contributions and publication dates are also illustrated in Table 3. The result shows that Joseph Sarkis and Robert D. Klassen are the most productive authors in this field. They have each contributed 9 papers. The next more prolific are Qinghua Zhu, Keehung Lai, and Stephan Vachon, each with 6 papers. It is also interesting to note that Robert D. Klassen and Stephan Vachon belong to the same organization.

The networks analysis of co-authors indicates that there are many co-author networks in this field. Most notable are the collaboration between Joseph Sarkis and Qinghua Zhu and the collaboration between Stephan Vachon and Robert D. Klassen. The results of the analysis are shown in Fig. 2.

Following the co-author analysis, we found that the largest cluster of co-authors had nine papers. This cluster is labeled: effect by LLR (log-likelihood ratio), green supply chain management by TFIDF (term frequency-inverse document frequency), and supplier by MI (mutual information). The papers in this cluster comprised internal and external sustainable supply chain practices and the researchers' findings on sustainability's effects on performance. They also investigated the antecedents of the implementation of sustainable supply chain practices, such as organizational learning and management support (Zhu et al., 2008). These provide insights on the factors contributing to or harming the development of sustainable supply chain practices.

These papers also investigate the moderators and mediators of sustainable supply chain practices. Zhu et al. (2012) investigated the mediation effects between internal and external green supply chain management practices and organizational performance. Wong et al. (2012) found that the environmental management capability of suppliers can positively moderate the relationship between process stewardship and financial performance. Lai et al. (2014) also found that customer integration had significant moderating effects between the extended producer responsibility and performance. The title "effect" captured this information.

We also found that most research on sustainable supply chain

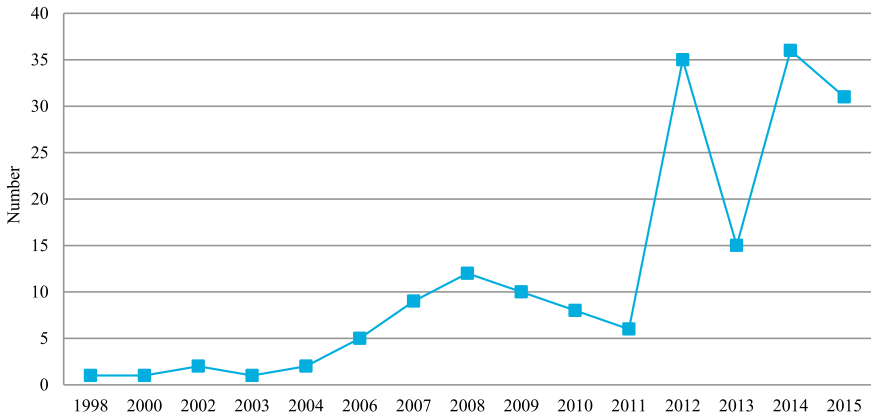

Fig. 1. Distribution of articles over time.

practices discuss the issue with a focus on green supply chain practices (Zhu et al., 2012; Fu et al., 2012; Prajogo et al., 2014; Yang et al., 2013, Lai et al., 2014). In this cluster, only one paper focuses on social issues and provides information for the title "green supply chain management" (Lu et al., 2009). In regards to performance, most papers measure financial performance, environmental performance, operational performance, and competitiveness (Wong et al., 2012; Zhu et al., 2012; Lai et al., 2014; Yang et al., 2013). The papers in this cluster tended to discuss the roles played by the supplier rather than those played by the customer (Wong et al., 2012; Fu et al., 2012). The title "supplier" captured this information.

In addition, the samples used in these papers are largely from Asia. Those from Mainland China are as follows: Zhu et al. (2012), Fu et al. (2012), and Lai et al. (2014). Those from Hong Kong include Lun et al. (2015) and Zhu et al. (2008), while those from Taiwan include Wong et al. (2012), Lu et al. (2009), and Yang et al. (2013). Some research used samples from the UK (Yakovleva et al., 2012) and Austria (Prajogo et al., 2014). Further research should accommodate multi-country samples.

The most commonly used methodology in these papers is survey (Wong et al., 2012; Zhu et al., 2012; Lu et al., 2009; Lai et al., 2014; Lun et al., 2015; Prajogo et al., 2014; Yang et al., 2013; Zhu et al., 2008), followed by literature review (Brandenburg et al., 2014; Brandenburg and Rebs, 2015; Fahimnia et al., 2015) and case study (Fu et al., 2012; Yakovleva et al., 2012).

Table 2
Distribution of articles in journals.

Journal	Number of papers	Percentage (%)	Time line
International Journal of Production Economics	47	26.8%	2012–2015
International Journal of Production Research	25	14.2%	2007–2015
European Journal of Operational Research	16	9.1%	2006–2015
Transportation Research Part E–Logistics and Transportation Review	12	6.8%	2002–2015
Journal of Operations Management	6	2.9%	2004–2010
International Journal of Operations & Production Management	5	2.9%	2000–2015
Supply Chain Management-an International Journal	5	2.9%	2009–2013
Journal of Business Ethics	5	2.9%	2009–2013
Expert Systems with Applications	5	2.9%	2010–2015
Production and Operations Management	5	2.9%	2003–2015
Production Planning & Control	5	2.9%	2012–2015
Journal of the Operational Research Society	4	2.3%	2006–2014
Flexible Services and Manufacturing Journal	4	2.3%	2010–2014
Technovation	3	1.7%	2004–2010
Annals of Operations Research	3	1.7%	2014–2015
Management Science	2	1.1%	2006–2008
OMEGA	2	1.1%	2008–2015
Computers & Operations Research	2	1.1%	2015
Decision Sciences	2	1.1%	1998–2014
Others	17	9.7%	2006–2015

Table 3
Leading authors in this field.

Author	Number of contributions	Percentage	Timeline
Joseph Sarkis	9	5.2%	2004–2015
Robert D. Klassen	9	5.2%	2003–2012
Qinghua Zhu	6	3.4%	2004–2015
Keehung Lai	6	3.4%	2008–2015
Stephan Vachon	6	3.4%	2003–2011

3.2. Categorization analysis

In this section we review the literature based on a categorization of the research papers' contents, which typically represented by collaboration partners included in the study, basis of collaboration, the performance variables investigated, the key theories applied, and the methodologies employed. This review will allow us to determine the areas of major interest to date and the areas where research gaps are evident. We derived the analytic categories from an inductive perspective based on the content analysis of the reviewed articles, as proposed by Rowley and Slack (2004), Seuring and Gold (2012), and Andriolo et al. (2014). Table 4 shows the detailed breakdown of content under the categories of Collaborators, Basis of Collaboration, and Performance Variables. Table 5 shows the breakdown by Theory applied and Table 6 shows the breakdown by Research Methods employed. We interpret and discuss these tables in the following sections.

3.2.1. Collaboration partners, basis of collaboration, and performance variables

The first notable conclusion drawn from Table 4 is that horizontal collaborations with competitors and others (such as NGOs or transportation providers) were rarely studied in the research papers included in our review. Only three papers included exploration of horizontal partners; all others focused on vertical collaborations with suppliers and customers or internal collaborations, or else investigated vertical and internal collaborations in tandem.

A second observation is that attention has shifted from a strong focus on internal collaborations to a nearly exclusive focus on external collaborations. This can be seen more clearly in Fig. 3, which charts the

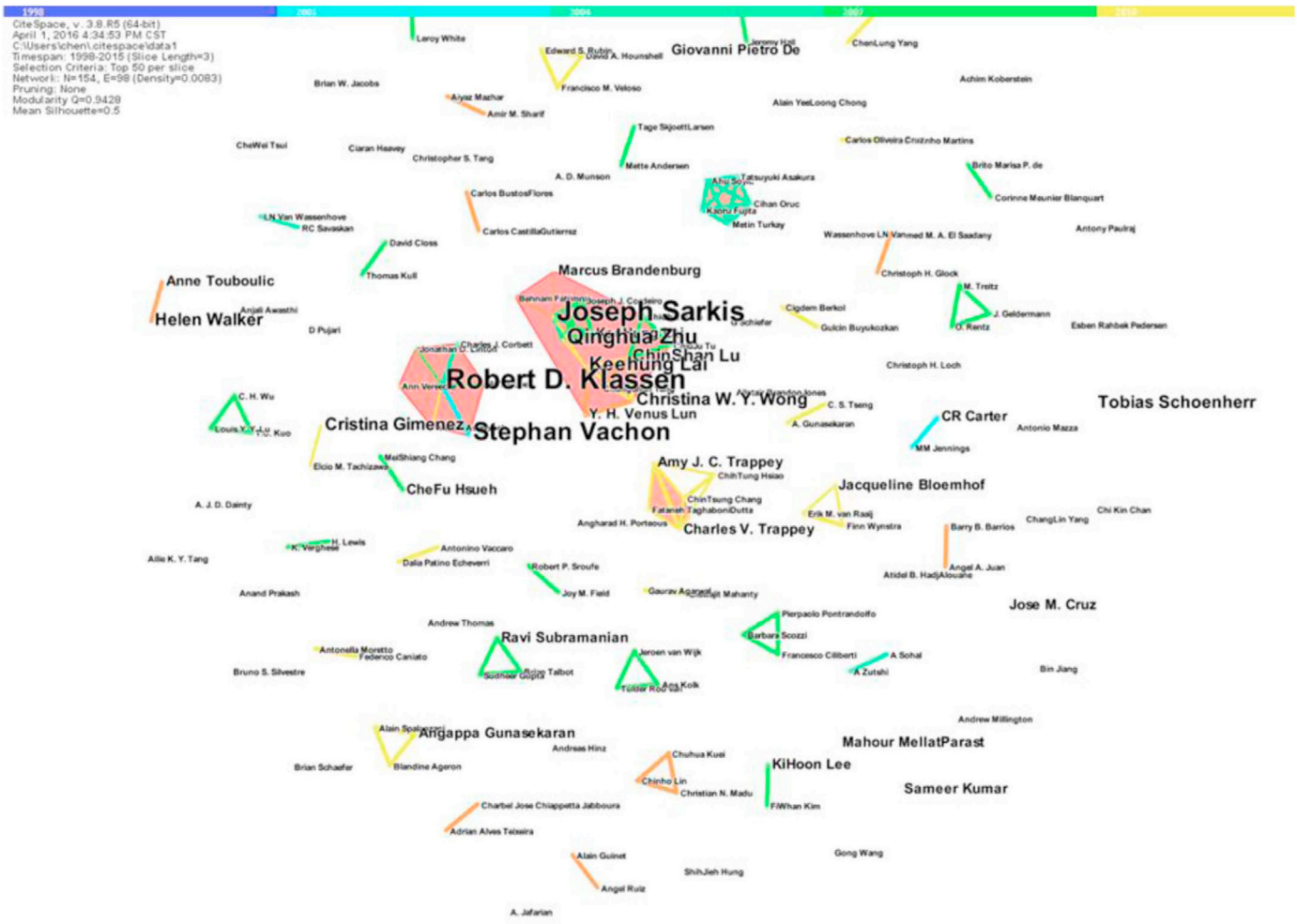

Fig. 2. Co-author analysis. Note: Circle size indicates the quantity of papers that an author or institute has published. The thickness between circles indicates the intensity of collaborations.

different partners and pairings of partners over time. Studies of 3-way collaborations among a company's internal units, its customers, and its suppliers dropped sharply after 2005, as did studies of 2-way internal-supplier collaborations and simple internal collaborations. On the other hand, studies of supplier collaboration alone have increased over time; focused studies about customer collaborations and customer and supplier collaborations are currently on the rise.

We next explored the basis of the collaboration efforts. Table 4 shows that the majority of studies examine collaborations in terms of their environmental dimensions, and often in combination with economic dimensions. As outlined in Fig. 4, environmental and economic dimensions were the focus of 70–80% of all papers in every period. The remaining 20–30% of the papers within each time interval included an aspect of social collaboration; the percentage of paper focusing on social collaboration slowly increased over time.

Performance metrics also emphasized environmental and economic factors relative to social factors. Of the papers that explicitly examined performance criteria, 32% focused on economic criteria, 6% on environmental criteria, and 40% on both environmental and economic performance criteria.

In total, 21% of the papers examined the company's social performance, 2% of them explored social performance, 4% explored social and environmental performance together, and 15% explored social performance in connection with economic and environmental dimensions.

Overall, the analyses show that operations research on supply chain collaboration has expanded beyond internal production and supplier control issues. The research field embraces consideration of a wider set of collaboration partners and a broader pallet of environmental and social issues that span the value chain. Most studies focus on one or two value chain partners, which can create deeper insights about particular links in the chain but might inhibit whole system understanding. Additional studies that explore a broad set of value chain partners simultaneously would help balance this tendency in the research. Furthermore, studies of social issues and non-traditional partners have only recently begun to enter the literature. There is thus a gap in understanding about the potential roles and influences of so-called secondary stakeholders.

3.2.2. *Categorization based on topic areas and theory*

The content analysis of the 90 articles reveals categories based on topic areas and the background theories that illustrate the logic supporting the research in these studies. A two-dimensional classification of articles by topic and theory is presented in Table 5.

Organizational theories were most frequently used in the research area of upstream and downstream collaboration, especially stakeholder theory (Vachon, 2007; Cruz, 2008; Zutshi and Sohal, 2004), which holds that the externalities produced when a company has weak environmental and social performance will affect all of the firm's stakeholders. In light of the growing sustainability pressures applied to companies from global NGOs, local communities, and industry trade associations, stakeholder theory is growing in prominence among management researchers. Stakeholder priorities and pressures thus increasingly influence the firm's sustainable practices, including supply chain collaboration. In total, 26.7% of the papers reviewed drew on stakeholder theory to motivate and explain their findings. For example, Vachon (2007) used

Table 4
Content categorization.

Time period	Articles	Collaborators investigated					Basis of collaboration	Sustainability Performance Variables		
		Internal collaboration	Collaboration with supplier	Collaboration with customer	Collaboration with competitor	Collaboration with other organizations		Economic	Environmental/ green	Social
Prior 2000	Carter and Carter (1998)	√	√				Environmental			
	Corbett and Cutler (2000)	√	√	√			Environmental			
2001–2005	Carter and Jennings (2002)	√	√				Environmental, social	√		
	Schiefer (2002)	√					Economic, environmental	√	√	
	Klassen and Vachon (2003)		√				Environmental			
	Zhu and Sarkis (2004)	√	√	√			Environmental	√	√	
	Zutshi and Sohal (2004)	√	√				Environmental			
2006–2010	Pujari (2006)	√	√				Economic, environmental	√	√	
	Savaskan and Van Wassenhove (2006)			√			Environmental	√		
	Soylu et al. (2006)	√					Economic, environmental	√		
	Field and Sroufe (2007)		√				Environmental			
	Geldermann et al. (2007)	√					Economic, environmental			
	Vachon (2007)		√	√			Environmental			
	Vachon and Klassen (2007)		√	√			Environmental			
	Verghese and Lewis (2007)		√	√			Economic, environmental	√	√	
	Ciliberti et al. (2008)		√				Environmental, social			
	Cruz (2008)			√			Economic, environmental, social	√	√	
	de Brito et al. (2008)	√	√	√			Economic, environmental, social	√	√	√
	Hsueh and Chang (2008)			√			Economic, social	√		
	Kumar and Putnam (2008)			√			Environmental			
	Lee and Klassen (2008)		√				Environmental			
	Vachon and Klassen (2008)		√	√			Economic, environmental	√	√	
	Zhu et al. (2008)	√	√	√			Environmental			
	Andersen and Skjoett-Larsen (2009)	√	√				Social			
	Ki-Hoon and Ji-Whan (2009)		√				Environmental, social			
	Subramanian et al. (2009)			√			Economic, environmental	√	√	
	Vaccaro and Echeverri (2010)			√			Environmental			
	Yang et al. (2010)		√				Economic, environmental	√		
2011–2015	Buyukozkan and Berkol (2011)		√				Economic, environmental, social	√	√	√
	Gavronski et al. (2011)	√	√				Environmental			
	Lee and Kim (2011)		√				Economic, environmental	√	√	
	Martins et al. (2011)					√	Environmental			
	Ates et al. (2012)	√	√				Environmental		√	
	Barari et al. (2012)			√			Economic, environmental	√	√	
	Caniato et al. (2012)		√				Environmental		√	

(*continued on next page*)

Table 4 (*continued*)

Time period	Articles	Collaborators investigated					Basis of collaboration	Sustainability Performance Variables		
		Internal collaboration	Collaboration with supplier	Collaboration with customer	Collaboration with competitor	Collaboration with other organizations		Economic	Environmental/ green	Social
	Dou (2012)		√	√			**Environmental**	√	√	
	De Giovanni and Vinzi (2012)									
	Fu et al. (2012)		√				Environmental			
	Gallear et al. (2012)		√				Social	√		
	Gimenez et al. (2012)		√	√			Economic, environmental, social	√	√	√
	Gimenez and Tachizawa (2012)		√				Economic, environmental, social	√	√	√
	Gopalakrishnan et al. (2012)		√				Economic, environmental, social			
	Jacobs and Subramanian (2012)		√				Environmental	√		
	Kim and Rhee (2012)		√	√			Economic, environmental	√	√	
	Klassen and Vereecke (2012)		√	√			Social			√
	Koh et al. (2012)						Environmental			
	Kumar et al. (2012)		√				Environmental	√		
	Lu et al. (2012)		√				Economic, environmental, social			
	Narasimhan and Schoenherr (2012)		√				Environmental	√		
	Rahman and Subramanian (2012)	√					Environmental	√		
	Walker and Brammer (2012)		√				Environmental, social			
	Wong et al. (2012)		√				Environmental	√	√	
	Wu et al. (2012)			√			Environmental			
	Zhu et al. (2012)	√	√	√			Environmental	√	√	
	Chan et al. (2013)		√				Economic, environmental	√	√	
	Garcia-Rodriguez et al. (2013)			√			Environmental			
	Gimenez and Sierra (2013)		√				Environmental		√	
	Jaber et al. (2013)			√			Environmental			
	Morali and Searcy (2013)		√	√			Economic, environmental, social			
	Swami and Shah (2013)			√			Environmental			
	Yang et al. (2013)		√	√		√	Environmental	√	√	
	Clark et al. (2014)		√				Environmental	√		
	De Giovanni (2014)			√			Environmental			
	Dou et al. (2014)		√				Environmental			
	Grekova et al. (2014)		√	√			Environmental			
	Grimm et al. (2014)		√				Environmental, social			
	Hsueh (2014)			√			Social			
	Huq et al. (2014)		√				Social			
	Lai et al. (2014)			√			Environmental	√		
	Longoni et al. (2014)	√					Environmental, social		√	√
	Lu et al. (2014)				√		Environmental			
	Mitra and Datta (2014)		√				Environmental	√		
	Pan et al. (2014)		√				Economic, environmental	√	√	
	Panda (2014)			√			Social			

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Table 4 (*continued*)

Time period	Articles	Collaborators investigated						Sustainability Performance Variables		
		Internal collaboration	Collaboration with supplier	Collaboration with customer	Collaboration with competitor	Collaboration with other organizations	Basis of collaboration	Economic	Environmental/ green	Social
	Paulraj et al. (2014)		√				Environmental		√	√
	Prajogo et al. (2014)	√	√	√			Environmental			
	Schoenherr et al. (2014)		√				Environmental	√	√	
	Sharif et al. (2014)	√					Economic, environmental, social	√	√	√
	Sheu and Gao (2014)			√			Environmental			
	Treitl et al. (2014)		√				Environmental	√	√	
	Andriolo et al. (2015)					√	Economic, environmental	√	√	
	Dai et al. (2015)		√				Environmental			
	Ji et al. (2015)		√				Environmental			
	Lopes de Sousa Jabbour et al. (2015)		√	√			Environmental	√		
	Luo et al. (2015)		√				Environmental			
	Luzzini et al. (2015)	√	√				Economic, environmental, social	√	√	√
	Marshall et al. (2015)		√				Environmental, social			
	Porteous et al. (2015)		√				Environmental, social	√	√	√
	Xie (2015)			√			Environmental			
	Zhang et al. (2015)			√			Environmental			

Note: √ means that the corresponding parts are included in this paper.

stakeholder theory as a lens to investigate the relationships among environmental collaboration, monitoring the supply chain, and the different forms of environmental investment.

Researchers also frequently cited organizational theory as a resource-based theory (Mitra and Datta, 2014; Morali and Searcy, 2013). Organizational theory holds that a company's competitive advantage is closely linked to its resource base. Sustainability raises concerns about resource constraints and resource price volatility; hence, the issue is a natural focus for research in this field. In total, resource-based theory underpinned 20% of the papers.

Beyond organizational theory and sustainability, the papers exhibited little consensus about appropriate theoretical guides to sustainable supply chain research. Table 5 shows many different organizational theories, such as resource dependency theory (Sheu and Gao, 2014), transaction cost theory (Gimenez and Sierra, 2013; Jiang, 2009), and institutional theory (Glover et al., 2014), as well as operations frameworks like lean and TQM. Table 5 presents an overview for understanding the application of theories in explaining the different issues of supply chain collaboration for sustainability, and also provides a reference of what theories may be used for further investigation of supply chain collaboration with competitors and other external entities; subsequently, the table provides opportunities to develop new theories to better understand supply chain collaboration for sustainability.

3.2.3. *Categorization based on topic areas and methodology*

The content analysis related to focal areas of research also enabled us to determine the most frequently used methodologies in different topics. Thus, we categorized the research topic and most frequently applied research methodology as shown in Table 6. This categorization shows that most research focused on internal collaboration, upstream collaboration, and downstream collaboration. We found that the most applied methodologies in the research area of supply chain collaboration for sustainability are the survey methodology (Gimenez and Sierra, 2013; Vaccaro and Echeverri, 2010; Porteous et al., 2015), mathematical modeling (Chan et al., 2013; Fu et al., 2012; Hsueh, 2014; Andriolo et al., 2015), and the analytic network, process-based model (Dou et al., 2014). For example, Gimenez and Sierra (2013) implemented an online survey in Spain and Germany to investigate the effects of supplier assessment and collaboration with suppliers on a firm's environmental performance. Gimenez et al. (2012) explored the effects of internal and external environmental programs on the firm's economic, environmental, and social performance with the data collected by the fifth round of the International Manufacturing Strategy Survey project. Furthermore, Jaber et al. (2013) constructed a two-level supply chain model to test the effects of supply chain coordination between vendor and buyer. The model considered supply chain costs, emissions costs, and penalty costs. Dou et al. (2014) introduced a grey-analytical network, process-based model to evaluate green supplier development programs.

We have also found that the body of research on collaboration with competitors and other external entities, such as NGOs, is rather limited. The methodologies used in these areas mainly are usually mathematical models and case studies, which can be enriched with the integration of mixed methods. Mixed methods would generate better understanding of the enablers and barriers for collaboration with competitors and other external entities. Combining surveys, case studies, experimental methods, and mathematical evaluation can help the researcher gain wideness and depth of knowledge; it also compensates for the weaknesses intrinsic to applying each method by itself.

The methodologies applied in the current literature have advantages and disadvantages. For example, a case study often uses interview and observation methods to obtain and examine detailed understanding. It thus has the advantage of capturing the "lived reality" (Hodkinson and Hodkinson, 2001: 3). A case study can compensate for the drawbacks of a survey study but may retain more of the "noise" of the real situation of the case. Generalizations cannot be reached by case studies, which often have a limited sample size. Even multiple case studies are rarely

Table 5
Two-dimensional categorization of the relevant literature, with respect to content analysis and main theory.

Topic area	Theory	Number
	Stakeholder theory	3
	Resource-based view	3
Internal collaboration	Lean principle	1
	TQM	1
	Contingency theory	1
	Organizational climate theory	1
	Coordination theory	1
Collaboration with supplier	Stakeholder theory	14
	Resource-based view	11
	Transaction cost theory	3
	Institutional theory	3
	Contingency theory	2
	Environment management	2
	The relational view	1
	Network theory	1
	Grey system theory	1
	Sustainability theory	1
	Coordination theory	1
	Lean theory	1
	Resource dependency theory	1
	Critical success factors theory	1
	Evolutionary game theory	1
	The Schumpeterian view of competition	1
	Quality management	1
	The theory of projected dynamical systems	1
	Relational exchange theory	1
	Organizational climate theory	1
	Others	3
Collaboration with customer	Stakeholder theory	6
	Resource-based view	4
	Institutional theory	3
	Contingency theory	2
	Game theory	2
	Quality management	2
	Network theory	1
	Coordination theory	1
	Organizational climate theory	1
	Others	7
	Supply chain management	1
	environmental management	1
	The theory of projected dynamical systems	1
Collaboration with competitor	Cooperative game theory	1
Collaboration with other organizations (e.g. NGO)	Stakeholder theory	1
	Multi-objective theory	1

Table 6
Two-dimensional categorization of the relevant literature, with respect to content analysis and research methodology.

Topic area	Research methodology				
	Survey	Case	Concept building	Math	Other
Internal collaboration	13	4	1	3	
Collaboration with supplier	39	14	2	6	
Collaboration with customer	18	5	2	14	
Collaboration with competitor	0	0	0	1	
Collaboration with other organizations	1	1	0	1	
Total	71	24	5	25	0

Note: Math includes model and evaluation.

generalizable.

On the other hand, a survey is a technique that helps researchers gather information from a selected sample drawn from a larger population (Forza, 2002; Rossi et al., 2013). It can help researchers to gain understanding from the larger population and reach generalizations. However, it cannot effectively validate the results of complicated or detailed relationships or new perspectives (Karlsson, 2010).

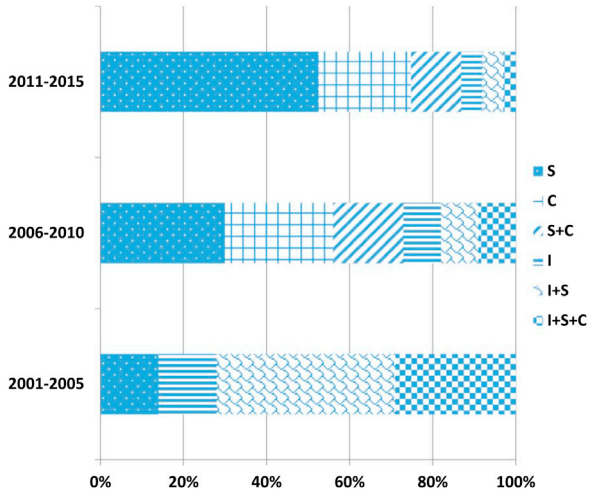

Fig. 3. Collaboration partners by time (I=Internal collaboration, S=Collaboration with supplier, C=Collaboration with customer).

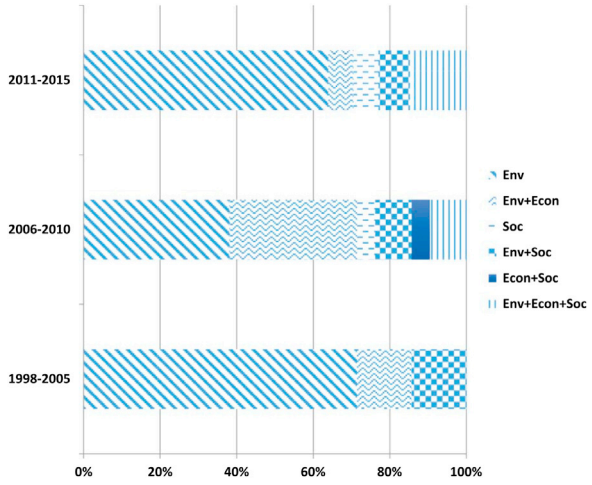

Fig. 4. Basis of collaboration by time (Env=Environmental, Soc=Social, Econ=Economic).

Mathematical modeling establishes a mathematical illustration of a targeted phenomenon to help researchers understand the phenomenon. This approach has some advantages to the case study and survey methods. It is more precise, it can be applied to a comprehensive range of topics, and it is more cost efficient than other empirical methods. However, it usually requires large amounts of data to conduct a mathematical evaluation. Moreover, this approach relies heavily on precise assumptions.

Conceptual modeling is a method that helps researchers to develop their understanding of theoretical concepts and the terminology from the literature review. It often includes simple numerical examples (Chen et al., 2014). Although conceptual modeling is suitable for exploratory investigation, it lacks universally-accepted rules for the identification of categories and lacks sufficient empirical evidence support.

Finally, we examined the emergence of key issues over time, as depicted in Fig. 5. The research interests have gradually expanded to embrace a wide variety of topics. Early studies were limited to coordination and process integration between internal collaborators and suppliers, replicating the conclusions presented in Section 3.2.1. From 2006–2010, discussions broadened to include closer forms of stakeholder

integration concerning decision making and capacity sharing. Communication emerged as an element of the collaboration process, but research continued to stress controlling mechanisms such as monitoring and governance. During 2011–2015, discussions broadened even more to include mechanisms of trust and the sharing of responsibility. The focus of collaborations were manifold, and included infrastructure integration and collaborative planning. As mentioned in Section 3.2, the trend of the research is toward assessing wider collaborations that require effort to build in terms of relationships, process linking, and technology building. Most research explores suppliers and customers for collaboration potential, while very few explore horizontal collaboration partners and other secondary stakeholders.

4. Synthesizing the framework

The results of the content and bibliometric analyses indicate the practices of supply chain collaboration for sustainability, as well their effects on a company's sustainability performance. In order to fulfill our research purpose, we further identified and categorized the important factors of supply chain collaboration for sustainability. Based on the topic areas discussed previously in this paper, Table 7 describes in further detail the sub-dimensions of supply chain collaboration for sustainability.

Based on prior analysis, we have proposed a conceptual model (shown in Fig. 6) that describes the practices and performance of supply chain collaboration for sustainability. It recommends that firms should first evaluate the performance of sustainability based on all three aspects of sustainability, including economic, environmental, and social performance. Economic and environmental performance are more highly emphasized in the current body of research, while social performance has not been sufficiently investigated.

The second step for firms is to perform supply chain collaboration for sustainability with an integrated perspective. Supply chain collaboration, including collaborations with suppliers, customers, competitors, and other organizations, should be integrated into sustainability activities. This will enrich the firms' resources and enhance their capability for improved sustainable performance. Although collaboration with suppliers and customers are the most frequently used approaches to facilitate sustainability, collaboration with competitors and other organizations also need to be considered.

The model includes two levels of synthesis. The first level is a synthesis of economic, environmental, and social points of view to accomplish sustainability, which requires the integration of social and environmental systems as well as maximization of financial performance. According to the breakdown of literature shown in Table 4, only six papers included all three aspects of sustainability. Luzzini et al. (2015) investigated the effects of intra and inter firm collaborative capabilities on sustainability in terms of cost, environmental, and social performance. As mentioned in the previous section, very little of the prior literature focused on the social aspect of sustainability compared to the amount of research that focused on the other two aspects of sustainability. This synthesis reveals the need to gain a comprehensive perspective of social sustainability in the supply chain collaboration literature in order for the body of literature to provide a thorough assessment of all angles of sustainability.

The second level synthesizes internal collaboration and collaboration with external parties such as suppliers, customers, competitors, and other organizations. The roles played by each supply chain partner vary according to the different positions of each partner in the supply chain. Thus, firms should emphasize their varied importance in facilitating sustainability. Sustainability can be realized in part through the use of internal collaborative practices for sustainability, such as performing internal process integration, adopting environmental systems, and implementing functional coordination. Collaboration with supply chain partners like suppliers and customers will help to enrich the firm's resources and capabilities for sustainable development. Internal collaboration can also improve a firm's external collaboration capabilities, and vice versa. Therefore, the firm should consider and analyze all the possibilities for different supply chain collaborations in order to achieve sustainability.

Fig. 5. Key issue by period.

Firms should utilize integrative perspectives when considering supply chain collaboration for sustainability and sustainability performance. The dimensions of supply chain collaboration for sustainability, such as supplier collaboration and developing trust, can be used to facilitate improved sustainability performance. Other aspects of performance should be considered in addition to economic performance, including marketing performance and operational performance. Environmental and social impacts should also be included when evaluating a firm's performance, in order to assist the firm's long-term survival.

5. Future research agenda

Based on the qualitative and quantitative analyses provided in the study, this section identifies areas that deserve further research attention and build the future research agenda for sustainability and supply chain collaboration. In particular, we focus on what research questions need to be answered concerning how firms can develop more economically, environmentally, and socially sustainable business practices through supply chain collaboration.

The content analysis of papers according to the most contributive authors' clusters indicates that the most highly used definition of sustainability is the one provided by the UN Brundtland. It's also widely accepted that there are three dimensions of sustainability. Even so, research regarding the environmental and green issues remain in the center of the network. Studies considering social responsibility are on the outskirts of the network. Currently, there is no research exploring how supply chain collaboration frameworks can improve social sustainability. Future directions for research thus include how to improve employee health and working environments, how to decrease child labor usage in developing countries, and how to protect female workers' benefits. Although the current incentives to implement supply chain collaboration do not focus on the social dimension of such practices, investigations that consider the social sustainability of supply chain collaboration will provide new insights to facilitate the development of social sustainability.

Table 7
Practices in the supply collaboration process that contribute to sustainability.

Topic areas	Key issues	Source (s)
Internal collaboration	Process integration/ process management	Geldermann et al. (2007), Soylu et al. (2006),Gavronski et al. (2011), Rahman and Subramanian (2012), Longoni et al. (2014), Sharif et al. (2014), Schiefer (2002), Zhu and Sarkis (2004), Andersen and Skjoett-Larsen (2009), Luzzini et al. (2015)
	Cross-functional coordination	Pujari (2006), Carter and Carter (1998), Carter and Jennings (2002), de Brito et al. (2008), Zhu et al. (2008), Ates et al. (2012), Zhu et al. (2012)
	Process integration/ process management	Zutshi and Sohal (2004), Prajogo et al. (2014), Corbett and Cutler (2000)
Collaboration with supplier	Supplier collaboration	Mitra and Datta (2014), Carter and Carter (1998), Carter and Jennings (2002), Zhu et al. (2008), Gavronski et al. (2011), Yang et al. (2013), Luo et al. (2015), Ates et al. (2012), Kim and Rhee (2012), Paulraj et al. (2014), Klassen and Vachon (2003),Treitl et al. (2014), Morali and Searcy (2013), Gimenez and Sierra (2013), Lu et al. (2012), Yang et al. (2010), Vachon and Klassen (2008), Corbett and Cutler (2000), Zhu and Sarkis (2004), Buyukozkan and Berkol (2011), Caniato et al. (2012), De Giovanni and Vinzi (2012), Grekova et al. (2014), Schoenherr et al. (2014), Prajogo et al. (2014), Chan et al. (2013), Wong et al. (2012)
	Supplier development (e.g. training, support)	Kumar et al. (2012), Dou et al. (2014), Lee and Klassen (2008), Andersen and Skjoett-Larsen (2009), Yang et al. (2010), Fu et al. (2012), Gallear et al. (2012), Gimenez et al. (2012), Klassen and Vereecke (2012), Lu et al. (2012), Grimm et al. (2014), Ji et al. (2015), Luzzini et al. (2015), Wong et al. (2012), Marshall et al. (2015), Huq et al. (2014)
	Supplier integration	Fu et al. (2012), Pan et al. (2014), Luzzini et al. (2015), de Brito et al. (2008), Lee and Kim (2011), Gopalakrishnan et al. (2012), Gimenez and Tachizawa (2012)
	Supplier relationship governance	Field and Sroufe (2007), Paulraj et al. (2014)
	Communication with supply chain partners	Verghese and Lewis (2007), Ciliberti et al. (2008), Walker and Brammer (2012)
	Supplier monitoring	Vachon (2007), Gavronski et al. (2011), Dai et al. (2015), Ki-Hoon and Ji-Whan (2009), Marshall et al. (2015)
	Logistical and technological integration	Vachon and Klassen (2007)
	Supplier involvement (e.g. product development)	Dai et al. (2015), Zutshi and Sohal (2004), Pujari (2006), Clark et al. (2014)
	Collaborative planning	Dai et al. (2015)
	Green purchasing	Lopes de Sousa Jabbour et al. (2015), Zhu et al. (2012)
	Trust	Kim and Rhee (2012)
	Infrastructure integration	Kim and Rhee (2012)
	Integrated supply chain management practices	Narasimhan and Schoenherr (2012)
	Sharing responsibility for product recovery	Jacobs and Subramanian (2012)
	Penalties and incentives	Porteous et al. (2015)
Collaboration with customer	Collaboration/ coordination with customer	Savaskan and Van Wassenhove (2006), Vachon (2007), Zhu et al. (2008), Barari et al. (2012), Swami and Shah (2013), Yang et al. (2013), Panda (2014), Lopes de Sousa Jabbour et al. (2015), Xie (2015), Kim and Rhee (2012), Zhu et al. (2012), Hsueh and Chang (2008), Zhang et al. (2015), Gimenez and Tachizawa (2012), Subramanian et al. (2009), Das (2012), Gimenez et al. (2012), Zhu and Sarkis (2004), Vachon and Klassen (2008), Corbett and Cutler (2000), de Brito et al. (2008), Kumar and Putnam (2008), Wu et al. (2012), Grekova et al. (2014), Klassen and Vereecke (2012), Jaber et al. (2013), Morali and Searcy (2013), De Giovanni (2014), Hsueh (2014), Prajogo et al. (2014), Sheu and Gao (2014)
	Communication with supply chain partners	Verghese and Lewis (2007), Garcia-Rodriguez et al. (2013)
	Customer integration	Lai et al. (2014)
	Trust	Kim and Rhee (2012)
	Infrastructure integration	Kim and Rhee (2012)
	Monitoring by customer	Vachon (2007)
	Logistical and technological integration	Vachon and Klassen (2007)
	Integrated decision making	Cruz (2008)
Collaboration with competitor	Collaborative capacity sharing	Lu et al. (2014)
	Joint production	Lu et al. (2014)
Collaboration with other organizations		Martins et al. (2011), Yang et al. (2013), Andriolo et al. (2015)

The content analysis of the entities in supply chain collaboration for sustainability indicated that the majority of research focuses on the upstream entities, especially the suppliers. Although it is difficult to compare the impacts of normal upstream and downstream entities in a supply chain, customers, universities, research institutes, and competitors also play critical roles in facilitating the development of sustainable practices. The body of literature could therefore benefit from studies that examine the input-output sequence from raw materials to final products used by customers in terms of the upstream supply chain collaboration with suppliers, universities, and research institutes. Such research can contribute to firms' development of sustainability via supplier collaboration from the input perspective. Studying collaborations with customers and competitors in the down supply chain, meanwhile can provide necessary support for the output perspective (Un and Asakawa, 2015). For example, the competition will enable and excite sustainable outputs such as eco-innovation products, sustainable business models, and innovative, environmentally friendly services.

NGOs and local communities play an important role in prompting focal firms to extend sustainability to suppliers. Only a small amount of prior research considers the impact of these actors in the supply chain collaboration process. Thus, future research should consider whether different configurations of internal collaboration, upstream collaboration, and downstream collaboration can create different sustainable outcomes. Research focusing on the collaborations among different stakeholders such as academic scholars and practitioners should help to improve our understanding of these effects.

The literature review revealed that stakeholder theory and resource-

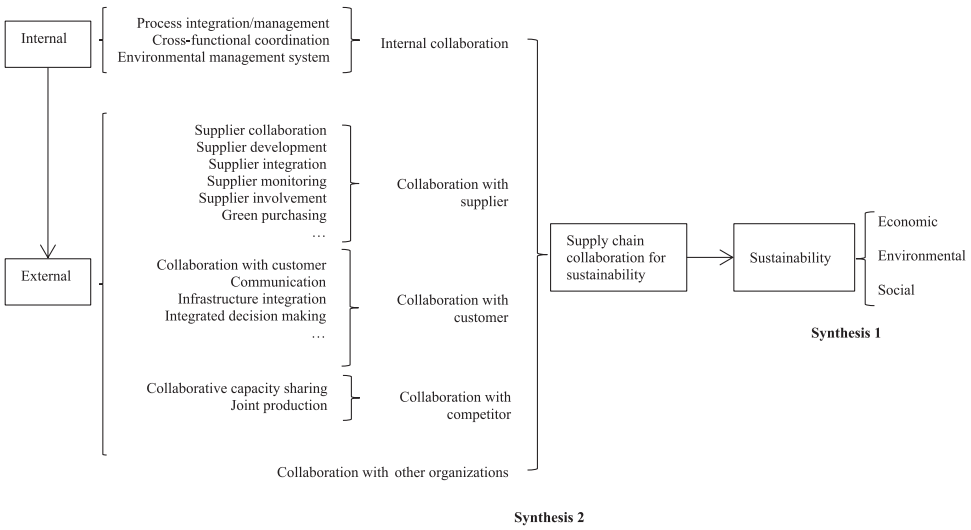

Fig. 6. Conceptual framework for supply chain collaboration for sustainability.

based view are the most frequently used theories. These theories provide appropriate lenses to explain the importance of supply chain collaboration for sustainability. The literature also identified some less used theories, such as contingency theory and diffusion of innovation theory. These theories provide better understanding of how supply chain collaboration for sustainability operates to make a difference. For example, based on the main argument of contingency theory, both the internal and external contexts should be emphasized, since the best actions depend on context. In this way, supply chain collaboration for sustainability can be affected or moderated by contextual variables that enrich our understanding of the circumstances under which a certain practice of supply chain collaboration for sustainability matters.

However, facilitating sustainability through supply chain collaboration is a complex process. Contingency theory can help to reveal the context in which supply chain collaboration for sustainability matters. Sustainability also can be viewed as an innovation that involves a lot of stages and sub-processes. Diffusion of innovation theory can help us extend current research by studying supply chain collaboration for sustainability in its different stages and the effects of each stage on sustainability.

The analysis of methodologies prevalent in this field found that survey and mathematical modeling are by far the most frequently used, while case studies and concept research are less used. Therefore, we suggest that more diversified research methodologies should be introduced to obtain a better understanding of the practices and performance of supply chain collaboration for sustainability. Because the opinions of respondents in most survey studies are subjective, rigorous statistic strategies such as Q-sort strategy, reliability, validation, and confirmatory factor analysis should be used to test all measurement scales. Meanwhile, since mathematical modeling is a more theoretical method, we would encourage researchers to supplement their use of this method through the addition of case studies and concept analysis. These latter methodologies have the advantage of analyzing more details on relative practices and performance or the context of supply chain management for sustainability. Such studies can be achieved through collaboration with practitioners in this field. Triangulation methods should also be encouraged in this field. In this case, research should involve close-ended information (quantitative methods) and open-ended information (qualitative methods) to investigate the same phenomenon from different perspectives. Triangulation studies can integrate different data sources and methods in order to help researchers more carefully examine aspects of supply chain collaboration for sustainability.

6. Conclusions

This paper applied a triangulation research method to explore the current body of literature on supply chain collaboration for the purpose of sustainability. We found that most articles in this special field emerged in the 21st century. Using content analysis, we categorized the existing literature on the diversified topics, methods, and changing research focuses over time in this research area. The field contains several influential and closely collaborating authors. Prior research has provided some insights for better understanding the practices of supply chain collaboration for sustainability and the effects of these practices on the performance of sustainability.

We have also developed a research framework to guide future studies in this field. We proposed potential future research directions that would further enrich the field, such as the following: integrating all three dimensions of sustainability; considering other supply chain entities, like competitors and NGOs; using other theories; and adopting and combining diversified methodologies, like survey, case studies, and mathematical modeling, in order to provide a more comprehensive understanding of the findings. This paper can serve as a foundation for those seeking and developing constructs and measurements for the topic of supply chain collaboration for sustainability.

Our review reveals several evolutionary trends in the research on supply chain collaboration. First, the locus of investigation has moved from primarily internal to primarily external perspectives, and from upstream-only to combined upstream-and-downstream collaborations. The role of the customer has received more attention over time. The second trend is that, while early studies focused on efficiency, technical alignment, and supplier control, the research has broadened to include “softer” elements of collaborations, such as relationships, education, communication, and shared responsibilities. Correspondingly, stakeholder theory—which advocates a holistic, multi-party view of the organization—has been referenced with greater frequency in recent years. The third trend is that the performance outcomes of collaboration considered by research have expanded from primarily economic or financial impacts to also embrace environmental effects. The social impacts of supply chain collaboration, however, are still largely neglected in the research, despite the growing emphasis on the interpersonal features of collaborations.

These trends in research mirror the development of supply chain collaboration in business and society. Early business practices emerged in response to mounting government pressures for improved environmental performance. As companies looked inward and toward their immediate suppliers, their key priorities were to find operational efficiencies and

boost compliance with procurement codes of conduct. Researchers directed their attention inward and to suppliers, as well. Broader policy and regulatory changes, such as Europe's 2012 WEEE Directive, drew attention among practitioners and researchers to a broader set of value chain partners and a more complex set of system dynamics. More recent drives for companies and entire countries to embrace concepts such as the Circular Economy have continued this trend.

As we develop our understanding of whole-systems effects, new parties engage in the effort to enhance supply chain sustainability. Pre-competitive partnerships among companies, competitors, and NGOs, for example, hold the promise of driving large scale changes in the near future based on the sharing of standardized supplier compliance data and sustainability ratings within a given industrial sector (Chouinard, Ellison, and Ridgeway, 2011). The trend will be fueled by pressures from the following: procurement officers, who will be able to see their entire supply chains; and the financial sector, where analysts will begin to embed the standardized data in their assessments of company risks and growth opportunities. Most of the recently formed pre-competitive alliances include competitors and NGOs, for example the Sustainable Apparel Coalition (SAC) was formed in 2009 by Walmart and Patagonia working together with other apparel makers and NGOs; similarly, Together for Sustainability (TfS) was formed in 2011 by six multinational chemical companies. Even though we have yet to see those secondary stakeholders included in the operations research on sustainable supply chain collaborations. Our expectation is that future research will embrace these new trends as their visibility and impact grows.

7. Limitations

There are still some limitations in this study. First, we have not discussed the various effects of each practice of supply chain collaboration on the performance of sustainability, since the different measurement systems adopted by each article would have resulted in inconsistent findings. Another limitation of this review is that this paper focuses on literature related to the limited keywords in the operations management field. Given the complexity of supply chain collaboration for sustainability, expanding the research based on a broader range of keywords and beyond operations management would be a promising step forward in the study of the body of research around supply chain collaboration for sustainability. Therefore, we call for more collaborative research among researchers from diversified fields in order to create a deeper understanding of how supply chain collaboration can create sustainability.

In order to understand more specific issues in sustainability, this study can also be extended to include more specific keywords, such as carbon dioxide reduction and green emissions. Such a study would yield a larger number of papers, which add difficulty to the researcher's ability to provide in-depth content analysis. Such studies should utilize a research team that is capable of processing and analyzing a large, data based review. Finally, system thinking should be a future trend in this area of research, since many stakeholders are studying sustainability and supply chain collaboration. Cross-functional teams should work together to investigate this issue from dynamic perspectives.

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