

The Intellectual Structure of the Relationship Between Innovation and Supply Chain Management



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Abstract Innovation is recognised as an important source of competitive advantage by both academics and managers. Nowadays, supply chain partners play a crucial part in driving many aspects of innovation, from the definition of the product concept to the launch to the market. This chapter analyzes how the relationship between supply chain management and the innovation process is addressed in the literature and discuss ways to improve the performance by means of this relationship. A bibliometric analysis—including citation and co-citation analysis—is carried out to study the intellectual structure of the topic. In the end, four literature clusters were identified, and their characteristics are discussed.

1 Introduction

Innovation is a complex process that is becoming more and more important for businesses as markets are becoming more competitive than ever (Jean et al. 2012). Addressing changes in customer needs, new technologies and trends and performing proactively are all crucial. Supply chain partners play a crucial role in driving innovation forward, both downstream and upstream, from the outset of the product concept phase to the launch of the product to the market. A number of studies refer the importance of supply chains and their actors in the innovation process (Roy and Sivakumar 2010; Golgeci and Ponomarov 2013; Narasimhan and Narayanan 2013; Arlbjorn and Paulraj 2013; Zimmermann et al. 2016).

Innovation enables the development of unique products and services leveraging firms in their quest for competitive advantage (Hilletoft and Eriksson 2011; Blome et al. 2013; Bellamy et al. 2014). As firms' ability to innovate is the result of internal

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and external factors (Roy et al. 2004; Berghman et al. 2012; Fawcett et al. 2012), great innovators depend on external actors to secure most of their advantage when it comes to innovation (Fawcett et al. 2012). Many companies rely on their supply chain partners for innovative input (Koufteros et al. 2007; Zimmermann et al. 2016) and “the development of supply chain management capabilities focusing on innovation is seen as a key competitive weapon” (Blome et al. 2013, p. 60). However, integrating suppliers in product and process development involves significant risk, time, and financial resources from both parties (Koufteros et al. 2007; Silva and Moreira 2017).

A growing body of literature suggests that, to improve their performance, including innovation performance, firms need to deepen the extent of their supply chain integration, cooperation and collaboration, which involves multiple business processes upstream and downstream involving their suppliers, customers and their internal functional units (Petersen et al. 2005; Fawcett et al. 2012; Blome et al. 2013).

Taking these facts into account, this chapter analyzes how the relationship between supply chain management and the innovation process is addressed in the literature. In other words, the study has the objective of analyzing the intellectual structure of the topic by means of a bibliometric analysis. The following research questions are addressed:

- When and where were studies about the relationship between innovation and supply chain published?
- What is the intellectual structure of the literature?
- How has the diffusion of the topic through research literature taken place?
- What are the main themes addressed in the literature on the topic? Is it possible to identify different clusters? What differentiates the clusters?

2 Methodology

A bibliometric analysis was performed as a way of mapping and profiling the literature on the relationship between supply chain management and innovation. The papers were identified using the principles of the systematic literature review method, as presented by Denyer and Tranfield (2009), and were analyzed with the intention of providing useful results for researchers and practitioners. The combination of the two methods is called Systematic Literature Network Analysis (Strozzi et al. 2017). In the first phase the papers are selected and evaluated, and the output of this phase is a set of selected papers. In the second phase the articles are analyzed to answer the research questions.

The ISI Web of Science database was chosen as the source of research. This strategy is used in other reviews of literature in the area (Strozzi et al. 2017). To search for studies to be analyzed, three categories of keywords were defined: (1) Words related to innovation: innovation, innovate, innovativeness. We decided to use the term *innovat** to cover all possibilities; (2) Words related to supply chain:

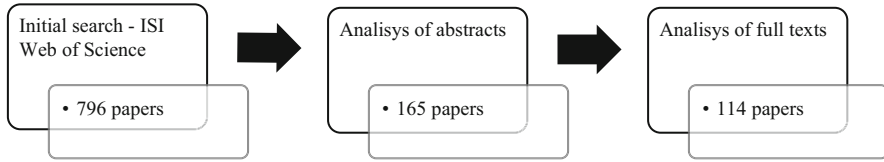


Fig. 1 Location and selection of the articles

supply chain, SCM; (3) Words related to alignment/relationship/partnership: we decided again to use the asterisk in the following terms: align*, partner*, coordinat*, collaborat*, relation*.

The search was based on all possible combinations of the three groups of keywords, using the “Topic” field to search. Only journals (articles and reviews) were searched, limited to the areas of “Business Economics”, “Engineering” and “Operations Research Management Science”. There was no restriction on the date of publication.

The abstracts and keywords of the articles were read to identify the focus on the relationship between the supply chain and the innovation process of organizations. Finally, the articles were fully read and, using the same criterion, 114 articles were selected (Appendix). The search was conducted in March 2017 (Fig. 1).

Following the suggestion of other studies, and as a way to increase the reliability of the selection, the articles were evaluated simultaneously by the three researchers and doubts and disagreements were discussed until consensus was reached. The articles were only included if all reviewers agreed.

3 Bibliometric Analysis

Gerdri et al. (2013, p. 404) define bibliometric analysis as “a method that uses statistical and mathematical methods to analyze the literature of a target discipline by investigating the pattern in its bibliographies”. In this chapter, the main idea is to get a broad and thorough view of the global context on the topic.

Bibliometrics comprises various methods, usually grouped as citation or co-citation analysis (Charvet et al. 2008). Citation analysis is based on the direct counts of references made to, or received from other documents. Co-citation analysis exploits paired citations as a measure of association between documents, or sets of documents. According to Charvet et al. (2008, p. 48), “one of its major applications is the discovery of intellectual linkages amongst (scholarly) communications and the creation of science maps”. Co-citation analysis has been widely used across disciplines, including marketing, operations management, and strategic management.

The program BibExcel was used to conduct the bibliometric and statistical analyses from the 114 articles identified. BibExcel is the software most commonly used for performing bibliometric analysis in management and organizations (Charvet et al. 2008). The data source file used as the input to BibExcel was in a

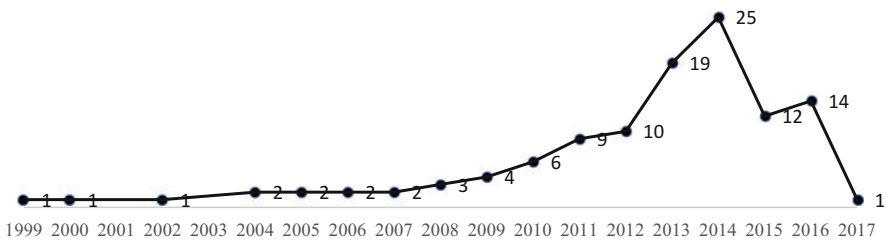


Fig. 2 Number of articles per year

plain text format and contained bibliographic information on the articles. The analysis focused on authors, titles, journals, years of publication, keywords, affiliations and references.

The open source software package Gephi was used to carry out the network analysis and graphical investigation. It uses a 3D render engine to develop illustrations of large networks in real-time and assist in speeding up the exploration process. In the graphs generated, the published papers are shown as nodes and citations are represented by the arcs and between the nodes (Fahimnia et al. 2015).

3.1 *When and Where?*

Initially, the data from the articles were used to help answering the first research question, which is “When and where were the studies about the relationship between innovation and supply chain published?” The answer to this question should clarify the breadth of interest and the potential for emerging, alternative perspectives on the topic. The aspects observed were year of publication, publication source and location of authors.

Figure 2 shows the evolution of the topic in the literature since 1999, when the first article was published. About 70% of the articles were published in the last 5 years (since 2012), which shows that the theme is relatively new in the literature.

When it comes to the journals where the papers were published, there is a clear indication of the relevance and the all-embracing character of the theme, as the articles have been published in 40 different Journals. However, it is clear that the journals in the field of operations management have paid more attention to the topic than the journals in the areas of management, innovation and strategic management. Accordingly, the journals with the largest number of articles are the International Journal of Production Economics, followed by the Journal of Supply Chain Management, and Supply Chain Management: An International Journal. Table 1 presents the main publishing journals.

Table 1 Main sources of publication

Journal	1999	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
International Journal of Production Economics									1	2	1	2	2	3		2	1	14
Journal of Supply Chain Management										1		1	5	2				9
Supply Chain Management: An International Journal				1				1		1			2	2		1	1	9
Journal of Operations Management				1	1	1	1							2				6
Research Policy			1					1					2			1		5
Production Planning & Control													1	1	2	1		5
International Journal of Production Research													1	3				4
Industrial Management & Data Systems							1											4

(continued)

Table 1 (continued)

	1999	2000	2002	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Journal of Production and Operations Management												1	1	1	1			4
Journal of Purchasing and Supply Management													1	1	2			4
Journal of Product Innovation Management								1		1				1	1			4

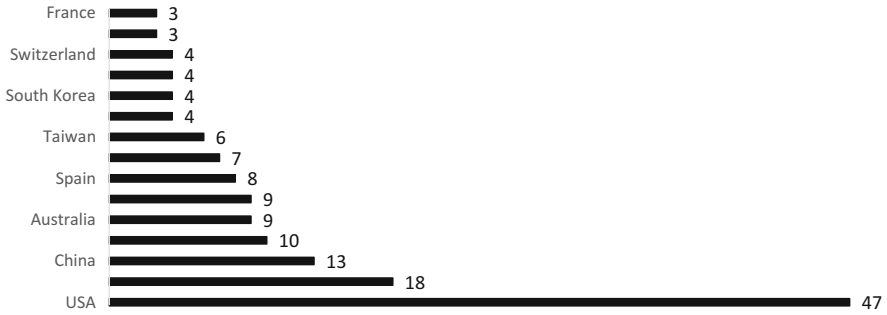


Fig. 3 Countries with the largest number of publications

Finally, the articles are also widely dispersed geographically (authors from 32 countries were identified), demonstrating that the subject is of global interest, as Fig. 3 shows.

This first analysis of the literature shows that the topic has aroused the interest of researchers from different parts of the world in recent years and that the theme has potential for continuous growth.

3.2 *Keyword Statistics*

Using the data extracted from the papers, an analysis was conducted to identify the most frequently used words and terms in article titles and keywords, respectively. The most frequently used words in paper titles were “supply”, “innovation” and “chain”. On the other hand, the most popular keywords are “innovation”, “supply chain management” and “supply chain”. Considering the search terms used to find the articles, there was no surprise in the main words used in titles and keywords.

However, it is important to highlight the use of the word “performance” among the most used words in titles. The high number of papers that uses this word in the title reveals the contribution of the topic to the improvement of firms’ performance. Concerning the keywords, it is important to highlight the word “integration”, which was used together with the terms “supplier” and “supply chain”, and “trust” (Table 2).

3.3 *Citation Analysis*

To evaluate the relevance of each publication, a citation analysis was conducted, which counts the number of times a paper is cited in other publications. Citation analysis is frequently used to evaluate or compare articles, journals, academic programs and institutions (Charvet et al. 2008). In this case, we use citation analysis to compare the papers and to identify the most influential studies in the area.

Table 2 The most frequently used words in paper titles and keywords

Word in titles	Frequency	Keyword	Frequency
Supply	62	Innovation	33
Innovation	56	Supply chain management	25
Chain	53	Supply chain	13
Product	34	New product development	8
Performance	25	Product development	8
Development	21	Supplier integration	6
Supplier	20	Innovativeness	5
New	20	Supply chain integration	5
Integration	17	China	5
Relationships	12	Product innovation	5
Role	12	Trust	5
Knowledge	11	Game theory	3
Management	11	Smes	3
Effects	10	Open innovation	3
Firm	9	Absorptive capacity	3
Empirical	8	Supply chain performance	3
Collaborative	8	Performance	3
Innovativeness	7	Collaboration	3
Industry	7	Dynamic capabilities	3
Chains	7	Structural equation modeling	3

The BibExcel citation analysis results shows that the 114 articles in the sample cited each other 134 times. The most cited papers in the core sample are shown by number of local citations in Table 3.

3.4 Co-citation Analysis

A co-citation analysis was developed to identify the intellectual structure of the theme. Co-citation analysis is used in the majority of bibliometric studies in management and organizations and citation practices to connect documents, authors, or journals (Zupic and Cater 2015). When co-citation is applied to the cited articles, it is able to identify the knowledge base of a topic and its intellectual structure. The knowledge base of a field is the set of articles most cited by the current research. These publications are the foundations on which current research is being carried out and contain fundamental theories, breakthrough early works, and the methodological canons of the field (Zupic and Cater 2015).

Based on the co-citation analysis, 39 articles emerge as the core sample, as they are the studies which have been cited by the others. However, four articles were removed as they appeared as remote nodes (Fig. 4).

Table 3 Articles from core sample with the highest number of local citations (only those articles with 3 or more)

Article	Local citations
Petersen, K., 2005, V23, P371, J OPER MANAG	21
Roy, S., 2004, V32, P61, J ACAD MARKET SCI	13
Koufteros, X., 2007, V25, P847, J OPER MANAG	10
Soosay, C., 2008, V13, P160, SUPPLY CHAIN MANAG	8
Bhaskaran, S., 2009, V55, P1152, MANAGE SCI	7
Craighead, C., 2009, V27, P405, J OPER MANAG	7
Choi, T., 2006, V24, P637, J OPER MANAG	6
Ettlie, J., 2006, V37, P117, DECISION SCI	4
Jean, R., 2012, V43, P1003, DECISION SCI	3
Kim, B., 2000, V123, P568, EUR J OPER RES	3
Chong, A., 2011, V111, P410, IND MANAGE DATA SYST	3
Narasimhan, R., 2013, V49, P27, J SUPPLY CHAIN MANAG	3
Panayides, P., 2009, V122, P35, INT J PROD ECON	3
Salvador, F., 2013, V49, P87, J SUPPLY CHAIN MANAG	3
Wynstra, F., 2010, V27, P625, J PROD INNOVAT MANAG	3

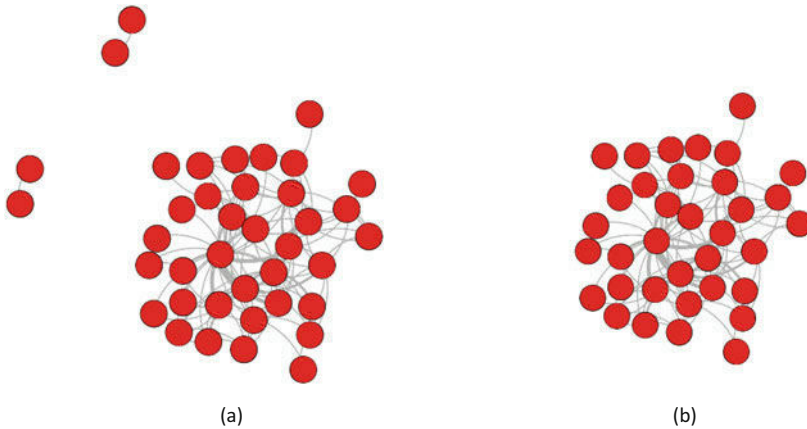


Fig. 4 Co-citation network with and without remote nodes removed. (a) The initial 39-node co-citation network. (b) The 35-node co-citation network after removing the with remote nodes remote nodes

The 35 papers remaining articles can be understood to be intellectual base of the topic (Table 4).

Table 4 Intellectual base of the topic based on the co-citation analysis

Author	Year	Vol	Journal
Koufteros XA	2007	V25	J OPER MANAG
Petersen KJ	2005	V23	J OPER MANAG
Choi TY	2006	V24	J OPER MANAG
Bhaskaran SR	2009	V55	MANAGE SCI
Ettlie JE	2006	V37	DECISION SCI
Lau AKW	2007	V107	IND MANAGE DATA SYST
McIvor R	2004	V32	OMEGA-INT J MANAGE S
Wagner SM	2014	V32	J OPER MANAG
Jayaram J	2013	V51	INT J PROD RES
Billington C	2013	V22	PROD OPER MANAG
Bellamy MA	2014	V32	J OPER MANAG
Roy S	2004	V32	J ACAD MARKET SCI
Soosay CA	2008	V13	SUPPLY CHAIN MANAG
Roy S	2010	V63	J BUS RES
Jean RJ	2012	V43	DECISION SCI
Seo Y-J	2014	V19	
Wang LW	2011	V134	INT J PROD ECON
Panayides PM	2009	V122	INT J PROD ECON
Pero M	2010	V15	SUPPLY CHAIN MANAG
Blome C	2013	V49	J SUPPLY CHAIN MANAG
Cao M	2010	V128	INT J PROD ECON
Fawcett SE	2012	V55	BUS HORIZONS
Chong AYL	2011	V111	IND MANAGE DATA SYST
Hilletoft P	2011	V111	IND MANAGE DATA SYST
Modi SB	2010	V46	J SUPPLY CHAIN MANAG
Wynstra F	2010	V27	J PROD INNOVAT MANAG
Koufteros X	2012	V48	J SUPPLY CHAIN MANAG
Caridi M	2012	V136	INT J PROD ECON
Craighead CW	2009	V27	J OPER MANAG
Narasimhan R	2013	V49	J SUPPLY CHAIN MANAG
Salvador F	2013	V49	J SUPPLY CHAIN MANAG
Oke A	2013	V49	J SUPPLY CHAIN MANAG
Kim B	2000	V123	EUR J OPER RES
Wong CWY	2013	V146	INT J PROD ECON
He YQ	2014	V147	INT J PROD ECON

3.5 Data Clustering

Finally, in order to understand how the literature deals with the different themes that are part of the main topic “supply chain management and innovation”, a data clustering analysis was conducted. Cluster analysis is a frequently used technique for finding subgroups inside a topic (Zupic and Cater 2015). The nodes of a network



Fig. 5 The position of the four literature clusters

can be divided into clusters where the density of edges is greater between the nodes of the same cluster than those of the others (Fahimnia et al. 2015). A cluster can be seen as a group of well-connected articles in a research area with limited connection to papers in another cluster or research area.

From the intellectual base of the topic, the literature mapping and network analysis identified four clusters. The papers that are part of Cluster 1 focus on the structural characteristics of the supply chain network, with a special focus on the supply base. Cluster 2 is predominately characterized by the study of supply chain trust and collaborative advantage. Authors in Cluster 3 highlight the importance of supplier and customer long term integration. Cluster 4, which was the last cluster to emerge, is composed of a set of papers which approach some trends in the topic, mainly related to strategy. Figure 5 shows the position of the four clusters.

Figure 6 shows the evolution of the clusters over time. It stands out that Cluster 1, 2 and 3 have emerged since the beginning while Cluster 4 emerged later, in 2009. Although Cluster 3 has the first article published on the theme (in 2000), the other papers were published from 2013 onwards, providing evidence of the recent interest in its approach.

Table 5 shows the number of articles published each year in each cluster and Table 6 shows the articles that belong to each cluster.

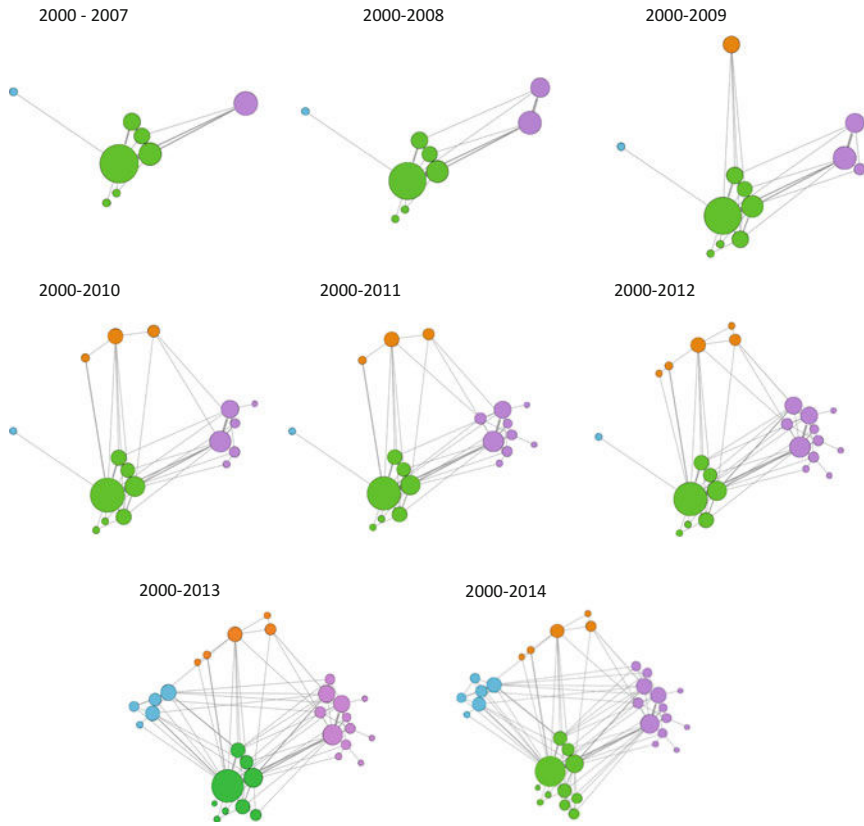


Fig. 6 Evolution of the research areas/clusters over time

Table 5 Number of published papers per cluster

Year	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total
2000			1		1
2004	1	1			2
2005	1				1
2006	2				2
2007	2				2
2008		1			1
2009	1	1		1	3
2010	1	3		1	5
2011		3			3
2012	1	2		1	4
2013	2	1	4		7
2014	2	1	1		4
Total	13	13	6	3	35

Table 6 Papers belonging to each cluster: co-citation PageRank measure

Cluster 1	Cluster 2	Cluster 3	Cluster 4
Petersen K, 2005, V23, P371, J OPER MANAG	Roy S, 2004, V32, P61, J ACAD MARKET SCI	Narasimhan R, 2013, V49, P27, J SUPPLY CHAIN MANAG	Craighead C, 2009, V27, P405, J OPER MANAG
Koufteros X, 2007, V25, P847, J OPER MANAG	Soosay C, 2008, V13, P160, SUPPLY CHAIN MANAG	Salvador F, 2013, V49, P87, J SUPPLY CHAIN MANAG	Wynstra F, 2010, V27, P625, J PROD INNOVAT MANAG
Bhaskaran S, 2009, V55, P1152, MANAGE SCI	Jean R, 2012, V43, P1003, DECISION SCI	Wong C, 2013, V146, P566, INT J PROD ECON	Koufteros X, 2012, V48, P93, J SUPPLY CHAIN MANAG
Choi T, 2006, V24, P637, J OPER MANAG	Panayides P, 2009, V122, P35, INT J PROD ECON	Oke A, 2013, V49, P43, J SUPPLY CHAIN MANAG	Caridi, M, 2012, V136, P207, INT J PROD ECON
Ettlie J, 2006, V37, P117, DECISION SCI	Wang L, 2011, V134, P114, INT J PROD ECON	He Y, 2014, V147, P260, INT J PROD ECON	Modi, S, 2010, V46, P81, J SUPPLY CHAIN MANAG
Wagner S, 2014, V32, P65, J OPER MANAG	Chong A, 2011, V111, P410, IND MANAGE DATA SYST	Kim B, 2000, V123, P568, EUR J OPER RES	
Billington C, 2013, V22, P1464, PROD OPER MANAG	Seo Y-J., 2014, V19, SUPPLY CHAIN MANAGEM		
Bellamy M, 2014, V32, P357, J OPER MANAG	Blome C, 2013, V49, P59, J SUPPLY CHAIN MANAG		
McIvor R, 2004, V32, P179, OMEGA-INT J MANAGE S	Roy S, 2010, V63, P1356, J BUS RES		
Lau A, 2007, V107, P1036, IND MANAGE DATA SYST	Cao M, 2010, V128, P358, INT J PROD ECON		
Jayaram J, 2013, V51, P1958, INT J PROD RES	Fawcett S, 2012, V55, P163, BUS HORIZONS		
	Hilletoft P, 2011, V111, P184, IND MANAGE DATA SYST		
	Pero M, 2010, V15, P115, SUPPLY CHAIN MANAG		

4 The Main Topics in the Literature and the Characteristics of the Clusters

In this section the main characteristics of the clusters are discussed. However, it is important to highlight some general features of the literature on this topic. Regarding the methodology used, there is a predominance of quantitative empirical studies and concerning the nature of the samples, there was a predominance of the use of information from industrial companies.

When it comes to the theoretical perspective, the analysis of the papers showed that there was no dominant theory on the relationship between innovation and supply chains as more than 30 different theories were mentioned. The resource-based view was the theory with the largest number of articles, followed by the knowledge-based view and transaction cost economics. Moreover, there is a recent trend regarding the use of the resource-based view of the firm, which was heavily cited in recent publications. Another important factor is that there are a considerable number of papers that do not mention their theoretical basis.

4.1 Cluster 1: Supply Network Structural Characteristics

The 11 papers that are part of this cluster study, in general, the structural characteristics of the supply chain network, with special focus on the supply base. The supply base is understood as the “portion of a supply network that is actively managed by a buying company” (Choi and Krause 2006, p. 637).

The supply network of a firm, and specially the supply base, has been viewed as an important source of innovation—in addition to the operational benefits of managing it effectively—and its structural characteristics have a great influence on a firm’s innovation outputs (Bellamy et al. 2014). The supply network provides critical conduits for knowledge and information flows and the structural characteristics define the way in which firms manage knowledge and information sharing (or integration) with their partners (Billington and Davidson 2013; Jayaram and Pathak 2013; Bellamy et al. 2014).

Information and knowledge integration is an effective strategy to achieve superior innovation or new product development performance, and the context of new product development is important and promising for knowledge integration (Jayaram and Pathak 2013). As the capability share knowledge and information between firms, mainly as a result of the growth of the Internet, often makes it easier for companies to access external resources than to develop them internally (Billington and Davidson 2013), open innovation is addressed by Billington and Davidson (2013) as a network structure that can facilitate the overall relationship between firms, especially the sharing of information, knowledge and decision making and, therefore, collaboration in research and development of new products and processes. In addition, Ettlé and Pavlou (2006) argue that information and knowledge sharing makes the development of technology-based new products possible.

Although firms use many mechanisms to help preserve and stimulate the creation of knowledge, it is still difficult for many firms to transfer internal knowledge to actors that are external to the firm and vice versa. Accordingly, it is the responsibility of the firms to find the right partners and build what Jayaram and Pathak (2013) call ‘enterprise-wide knowledge architectures’. Thus, “to achieve product co-development with suppliers and customers, managers should identify, assess and qualify competent partners as a major supply base” (Lau et al. 2007, p. 1054). The importance of the supplier selection for integrating them in the new products process, considering “not only the capabilities, but also the culture of the supplier, which will have an impact on the buying firm’s ability to interact with the supplier effectively” has to be emphasised (Petersen et al. 2005). Therefore, Lau et al. (2007) discuss three types of co-development: supplier co-development (SC); customer co-development (CC); and internal co-development (IC). The type of co-development determines the main partner(s) in the innovation process.

Regarding the level of involvement of the supply chain partners, Petersen et al. (2005) suggest three basic forms of supplier involvement in product development: white-box, grey-box and black-box approaches. In summary, in the white-box approach, the suppliers are consulted about new product development and the integration is informal. In the grey-box model, the supplier and the customer work alongside each other and the supplier provides expertise, suggestions and other inputs to the product development effort but typically will not assume sole responsibility for developing parts, let alone modules, for the final product (Koufteros et al. 2007). Finally, a black-box approach implies that each company will concentrate on certain tasks and components. In this case, the supplier can be “trusted” to develop parts and components.

Besides the level of involvement, it is also important to discuss when the partners will participate in the innovation or new product development process. Several authors (McIvor and Humphreys 2004; Petersen et al. 2005; Lau et al. 2007), highlight the role of early supplier, and client, involvement in the design process as a central attribute for the success of the co-development of new products.

The management of the supply network also can be seen as a cost sharing mechanism and a way of optimizing the research and development process. Bhaskaran and Krishnan (2009) propose a model which includes the interfirm interaction, the co-development process, technological uncertainty, the information structure and decision sequence. Depending on the type of project, the investment and revenue are shared. Wagner and Bode (2014) discuss the important differences between process and product innovation sharing, and the role of supplier-relationship-specific investments and safeguards for the investments for supplier innovation sharing.

4.2 Cluster 2: Supply Chain Trust and Collaborative Advantage

The 13 articles in Cluster 2 focus on the relationships, as opposed to the structural characteristics. The two most important features for the authors in this cluster are trust between partners (Panayides and Lun 2009; Wang et al. 2011; Fawcett et al. 2012; Blome et al. 2013; Jean et al. 2014) and building alliances (Roy et al. 2004; Soosay et al. 2008; Blome et al. 2013).

For Fawcett et al. (2012, p. 163), “trust is at the heart of a collaborative innovation capability”. The objective of the relationships is to gain collaborative advantage, which is defined as “strategic benefits gained over competitors in the market place through supply chain partnering and partner enabled knowledge creation, and it relates to the desired synergistic outcome of collaborative activity that could not have been achieved by any firm acting alone”.

Trust between supply chain partners can be seen as a catalyst for collaborative innovation (Fawcett et al. 2012). It is important to search for supply chain partners with distinctive complementary capabilities and create unique collaborative relationships with them to generate unparalleled process and product innovation (Fawcett et al. 2012). In this context, trust is an essential element of relational architecture and “without a foundation of trust, collaborative alliances can neither be built nor sustained” (Fawcett et al. 2012, p. 164). Fawcett et al. (2012) identified four stages of trust: limited trust, transactional trust, relational trust, and collaborative trust. In the last stage, relationships entail a common belief leading parties to view supply chain partners’ capacity and capabilities as an extension of their own business. Soosay et al. (2008) also describe trust as one of the most important characteristics to reinforce collaboration and, as a consequence, improve innovation performance.

Trust allows supply chain partners to build collaborative relationships (Roy et al. 2004; Fawcett et al. 2008; Cao and Zhang 2010; Hilletoft and Eriksson 2011). In the supply chain context, building collaborative relationships can help firms share risks, access complementary resources, reduce transaction costs and enhance productivity, and, therefore, enhance profit performance and competitive advantage over time (Cao and Zhang 2010; Chong et al. 2011). According to Cao and Zhang (2010), by collaborating, supply chain partners can work as if they were part of a single enterprise and such collaboration can increase joint competitive advantage. Collaborating with supply chain partners can involve activities such as sharing information, synchronizing decisions, sharing complementary resources, and aligning incentives with partners’ costs and risks (Cao and Zhang 2010).

Roy et al. (2004) propose a framework in which the link between interactions and innovation generation is moderated by several factors, which can be grouped as internal or external. In the set of internal and dyadic buyer/supplier relationship factors, they highlight IT adoption, commitment and trust. The authors focused on the upstream supply chain relationships. Roy and Sivakumar (2010) studied innovation generation considering upstream and downstream relationships. In this study, the authors highlight the importance of complexity and globalization as moderator effects for the relationship between interaction and innovation generation. Chong

et al. (2011) emphasizes that through strategic supplier partnerships, organizations can work closely with suppliers who can share responsibility for the success of products, in a relationship characterised by trust.

In addition to the partnership with suppliers and clients in the new product development process, it is important to coordinate the different functions inside the company. Hilletoft and Eriksson (2011) defend the involvement of members of the main functions of the company in the design stage of new products and single out the role of the supply chain in the success of the products and the improvement of performance. The model presupposes a strong view on the demand side and a consumer-oriented perspective.

Finally, Jean et al. (2012) discuss the role of power-dependence and study the supplier dependence on the buyer as a moderator of the effects of supplier market knowledge acquisition, relationship learning, systems collaboration, and technological uncertainty on supplier innovation generation. The authors claim to provide “a strong theoretical and empirical foundation for understanding how suppliers can augment their innovation capabilities by working with their customers in cross-border exchange relationships, and thus improve performance outcomes” (Jean et al. 2012, p. 1030).

4.3 Cluster 3: Supplier and Customer Long Term Integration

The six papers which compose Cluster 3 highlight the importance of supplier and customer long term integration. Topics such as partnership, strategic alignment and strategic relationships are discussed by the authors. According to Wong et al. (2013, p. 567), “external integration involves the strategic alignment of business processes, information sharing and joint collaboration with suppliers and customers” and helps firms to establish mutual understanding and gain information through network relationships.

Strategic relationships with supply chain partners, are defined by Oke et al. (2013, p. 44) “in terms of the extent to which the relationship is enduring and on a long-term basis”. Considering the risks involved in the innovation process, suppliers are more likely to align with customers for innovation if there is a long-term relationship in place (Oke et al. 2013). In addition to the importance of building long-term relationships with partners, the authors highlight the need to create strategic collaboration with the most important partners, which creates mutual benefits. For Lee et al. (2014) integration with other supply chain actors presupposes partnership, which is characterized by a long-term commitment between the collaborators. The authors emphasize that integration in the context of NPD has different forms, internal or external to the firm boundaries, such as cross-functional team integration, intra-process or concurrent integration, resource integration, supply chain or external integration. For the authors, supplier integration has a positive effect on customer integration and they recommend that managers adopt the practice of supplier integration first. According to Salvador and Villena (2013), integrating suppliers into NPD projects

offers manufacturers the potential for substantial improvements in the new product being designed.

Kim (2000) approaches coordination of the innovation process as a way to manage supplier innovation, considering that the innovation generated by the client company can lead to reduced costs for the supplier and, consequently, a reduction in the prices of their products. The coordination of innovation, for Kim (2000), is based on the long term relationship between client and supplier, which is characterised by trust and shared information and decision making.

Finally, for Narasimhan and Narayanan (2013) it is crucial that companies align their internal research and development strategies with the knowledge available in the supply chain in order to achieve better performance with regard to innovation (Narasimhan and Narayanan 2013). The authors define innovation as the process of generating changes in products, processes and services that result in the creation of value for the firm and its customers, through the knowledge generated by the company and/or its supply chain partners. Thus, the main reason to collaborate with other companies is to share and leverage resources unavailable internally.

4.4 Cluster 4: Emergent Topics

Cluster 4, which was the last cluster to emerge and is composed of five articles, is a set of papers that approach some trends in the topic. However, it is important to highlight that, considering that the analysis is based in the co-citation of papers, the newest studies in the area are not included in any cluster because they were not co-cited at the time the analysis was carried out.

The papers in this cluster mainly deal with topics related to strategy, such as knowledge management and supply chain knowledge, strategic supplier selection, supplier strategic focus on innovation, supply chain efficiency and product modularity. Supply chain strategy, knowledge, and action are key antecedents to firm performance (Craighead et al. 2009; Wynstra et al. 2010). Supply chain knowledge, in turn, can be understood in terms of three constructs: learning progression, use of existing knowledge, and organizational memory (Craighead et al. 2009). Companies “need to fit a supply chain’s innovation–cost strategy to knowledge elements in a way that enhances action and creates superior firm performance” (Craighead et al. 2009, p. 418).

Efficiency is a core concept for operations management that influences firms’ success in a general way and a central facet of supply chain management is the efficient flow of materials within the organization and across the firm’s boundaries (Modi and Mabert 2010). Modi and Mabert (2010) study the relationship between efficient supply chain management and innovation and conclude that over time a firm’s supply chain performance and supply chain stability positively influence the volume of its innovations.

Supply chain efficiency is also related to supplier selection. As firms become more dependent on their suppliers, the capabilities of those suppliers serve as key

resources in the development of the buyer's own capabilities and performance (Koufteros et al. 2012). Strategic supplier selection has a positive effect on firm performance, including innovation performance (Wynstra et al. 2010; Koufteros et al. 2012). Moreover, supplier product development activity is directly affected by the supplier's position in the supply chain, by an explicit strategic focus on innovation and by commitment to customer development (Wynstra et al. 2010). The selection and the position in the supply chain will affect supplier innovation and, consequently, the customer innovation process and performance.

Finally, the product characteristics also influence the way that suppliers and clients participate in the innovation process (Caridi et al. 2012). The level of modularity, for example, is significantly related to new product performance (Caridi et al. 2012). Thus, identifying and qualifying the appropriate partners as a supply base for module design and production enhances the firm's capability to modularize products successfully, by leveraging the technological resources from the supply base.

5 Conclusions

Innovation is a complex process which is becoming more and more important for companies as markets become more competitive. This chapter has described and discussed how the relationship between innovation and supply chain management is addressed in the literature, identifying the intellectual structure of the topic. The analysis of the literature shows that the topic has aroused the interest of researchers from different parts of the world in recent years and that the theme has the potential for continuous growth. The dispersed character of the publications that are sources of information and the theoretical perspectives used also reinforce the broader character of the theme.

Different ways of addressing the topic were found in different journals and in different contexts. The importance of strong collaboration among supply chain partners for innovation performance is clear, even though that collaboration is seen and discussed in different ways in the literature.

After a bibliometric analysis of 114 studies, the intellectual base of the field was identified, composed by 35 studies. From this intellectual base, four main clusters were identified: the papers which are part of Cluster 1 focus on the structural characteristics of the supply chain network. Cluster 2 is predominately characterized by the study of supply chain trust and collaborative advantage. Authors in Cluster 3 highlight the importance of supplier and customer long term integration. And Cluster 4 is composed of a set of papers that explore some new trends on the topic.

However, in addition to identifying particular features of each cluster, it is also possible to find great similarities between the four groups of studies. As common characteristics, we can highlight the willingness to collaborate and the importance of communication between firms.

This chapter contributes to theory by identifying the different approaches that address the relationship between innovation and supply chains in the literature, and it contributes to practice by providing some ideas to stimulate this relationship and improve performance.

As a recommendation for future research, we highlight the emergence of new topics which can be explored in the future, such as the importance of new technologies for the relationship between innovation and supply chain, the study of the fit between innovation capabilities and strategies and supply chain strategies, and the effects of supply chains on the different types of innovation (for example, product or process, radical or incremental).

Finally, as a limitation, the study is based on the analysis of published papers available in the ISI Web of Science database. Accordingly, themes which are in vogue at the moment, such as new technologies—the Internet of Things, virtual reality, autonomous vehicles and drones—and their importance for supply chains and innovation, were not considered in this study. Moreover, considering that the cluster analysis is based on the co-citation of the papers, the newest studies in the area are not included in any cluster because they were yet to be co-cited at the time the analysis was conducted.

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Appendix: Studies About the Relationship Between Supply Chain and Innovation

Paper	Year	Journal
Bruce, M; Moger ST	1999	Technology Analysis & Strategic Management
Kim, B	2000	European Journal of Operational Research
Sobrero, M; Roberts EB	2002	Research Policy
Roy S; Sivakumar K; Wilkinson IF	2004	Journal of the Academy of Marketing Science
McIvor R, Humphreys P	2004	Omega
Kim B, Oh H	2005	Supply Chain Management: An International Journal
Petersen KJ, Handfield RB, Ragatz GL	2005	Journal of Operations Management
Ettlie JE, Pavlou PA	2006	Decision Sciences
Choi TY, Krause DR	2006	Journal of Operations Management

(continued)

Paper	Year	Journal
Lau AKW, Yam RCM, Tang EPY	2007	Industrial Management & Data Systems
Koufteros XA, Cheng TCE, Lai KH	2007	Journal of Operations Management
Soosay CA, Hyland PW, Ferrer M	2008	Supply Chain Management: An International Journal
Tether BS, Tajar A	2008	Research Policy
Lee J, Veloso FM	2008	Journal of Product Innovation Management
Craighead CW, Hult GTM, Ketchen Jr DJ	2009	Journal of Operations Management
Bhaskaran RS, Krishnan V	2009	Management Science
Bakhshi H, McVittie E	2009	Innovation: Management, Policy & Practice
Panayides PM, Lun YHV	2009	International Journal of Production Economics
Modi SB, Mabert VA	2010	Journal of Supply Chain Management
Pero M, Abdelkafi N, Sianesi A, Blecker T	2010	Supply Chain Management: An International Journal
Wynstra F, von Corswant F, Wetzels M	2010	Journal of Product Innovation Management
Lin YC, Wang YC, Yu CH	2010	International Journal of Production Economics
Roy S, Sivakumar K	2010	Journal of Business Research
Cao M, Zhang Q	2010	International Journal of Production Economics
Hilletoft P, Eriksson D	2011	Industrial Management & Data Systems
Chong AYL, Chan FTS, Ooi KB, Sim JJ	2011	Industrial Management & Data Systems
Lau AKW	2011	Industrial Management & Data Systems
Johnsen TE	2011	International Journal of Operations & Production Management
Zolghadri M, Amrani A, Zouggar S, Girard P	2011	International Journal of Computer Integrated Manufacturing
Wang LW, Yeung JHY, Zhang M	2011	International Journal of Production Economics
Bouncken RB	2011	Engineering Management Journal
Hernández-Espallardo M, Sánchez-Pérez M, Segovia-López C	2011	Technovation
Lee KH, Kim JW	2011	Business Strategy and the Environment
Koufteros X, Vickery SK, Droge C	2012	Journal of Supply Chain Management
Berghman L, Matthyssens P, Vandenbempt K	2012	Industrial Marketing Management

(continued)

Paper	Year	Journal
Fawcett SE, Jones SL, Fawcett AM	2012	Business Horizons
Caridi M, Pero M, Sianesi A	2012	International Journal of Production Economics
Hsieh KN, Tidd J	2012	Technovation
Jean RJ, Kim D, Sinkovics RR	2012	Decision Sciences
Langenberg KU, Seifert RW, Tranchez JS	2012	International Journal of Production Economics
Hazen BT, Overstreet RE, Cegielski CG	2012	The International Journal of Logistics Management
Machikita T, Ueki Y	2012	Asian Journal of Technology Innovation
Bendoly E, Bharadwaj A	2012	Production and Operations Management
Salvador F, Villena VH	2013	Journal of Supply Chain Management
Kuhne B, Gellynck X, Weaver RD	2013	Supply Chain Management: An International Journal
Golgeci I, Ponomarov SY	2013	Supply Chain Management: An International Journal
Tomlinson PR, Fai FM	2013	International Journal of Production Economics
Peitz M, Shin D	2013	Journal of Economic Behavior & Organization
Fitjar RD, Rodriguez-Pose A	2013	Research Policy
Cabigiosu A, Zirpoli F, Camuffo A	2013	Research Policy
Jayaram J, Pathak S	2013	International Journal of Production Research
Tracey M, Neuhaus R	2013	Journal of Purchasing & Supply Management
Peng DX, Verghese A, Shah R, Schroeder RG	2013	Journal of Supply Chain Management
Narasimhan R, Narayanan S	2013	Journal of Supply Chain Management
Oke A, Prajogo DI, Jayaram J	2013	Journal of Supply Chain Management
Blome C, Schoenherr T, Kaesser M	2013	Journal of Supply Chain Management
Vickery SK, Koufteros X, Droge C	2013	IEEE Transactions on Engineering Management
Wong CWY, Wong CY, Boon-itt S	2013	International Journal of Production Economics
Billington C, Davidson R	2013	Production and Operations Management
Fox GL, Smith J, Cronin Jr JJ, Brusco M	2013	International Journal of Operations & Production Management
Ganotakis P, Hsieh WL, Love JH	2013	Production Planning & Control

(continued)

Paper	Year	Journal
Germani M, Mandolini M, Mengoni M, Peruzzini M	2013	International Journal of Computer Integrated Manufacturing
Cheng JH, Chen MC, Huang CM	2014	Supply Chain Management: An International Journal
He YQ, Lai KK, Sun HY, Chen Y	2014	International Journal of Production Economics
Jean RJ, Sinkovics RR, Hiebaum TP	2014	Journal of Product Innovation Management
Wagner SM, Bode C	2014	Journal of Operations Management
Yeniurt S, Henke Jr. JW, Yalcinkaya G	2014	Journal of the Academy of Marketing Science
Ge ZH, Hu QY, Xia YS	2014	Production and Operations Management
Schoenherr T, Griffith DA, Chandra A	2014	International Journal of Production Research
Tan YC, Ndubisi NO	2014	Journal of Business & Industrial Marketing
Seo YJ, Dinwoodie J, Kwak DW	2014	Supply Chain Management: An International Journal
Storer M, Hyland P, Ferrer M, Santa R, Griffiths A	2014	The International Journal of Logistics Management
Wu GD	2014	International Journal of Simulation Model
Jafarian M, Bashiri M	2014	Applied Mathematical Modelling
Saenz MJ, Revilla M, Knoppen D	2014	Journal of Supply Chain Management
von Massow M, Canbolat M	2014	International Journal of Production Research
Gualandris J, Kalchschmidt M	2014	Journal of Purchasing & Supply Management
Ma XF, Kaldenbach M, Katzy B	2014	Technology Analysis & Strategic Management
Pulles NJ, Veldmann J, Schielle H, Sierksma H	2014	Journal of Supply Chain Management
Hernández JE, Lyons AC, Mula J, Poler R, Ismail H	2014	Production Planning & Control: The Management of Operations
Chong AYL, Zhou L	2014	International Journal of Production Economics
Bellamy MA, Ghosh S, Hora M	2014	Journal of Operations Management
Liao SH, Kuo FI	2014	International Journal of Production Economics
Singh PJ, Power D	2014	International Journal of Production Research
Lee VH, Ooi KB, Chong AYL, Seow C	2014	Expert Systems with Applications

(continued)

Paper	Year	Journal
Lefebvre VM, Raggi M, Viaggi D, Sia-Ljungström C, Minarelli F, Kühne B, Gellynck X	2014	Creativity and Innovation Management
Manasakis C, Pretrakis E, Zikos V	2014	Southern Economic Journal
Piening EP, Salge TO	2015	Journal of Product Innovation Management
Ren S, Eisingerich AB, Tsai H	2015	Journal of Business Research
Wang J, Shin H	2015	Production and Operations Management
Golgeci I, Ponomarov SY	2015	Technology Analysis & Strategic Management
Arsenyan J, Büyüközkan G, Feyzioglu O	2015	Expert Systems with Applications
Zhang, H. P.	2015	International Journal of Simulation Model
Steven Jifan Ren, Caihong Hu, E.W.T. Ngai and Mingjian Zhou	2015	Production Planning and Control
Stefanie Herrmann, Helen Rogers, Marina Gebhard and Evi Hartmann	2015	Production Planning and Control
Janice E. Carrillo, Cheryl Druehl	2015	Decision Sciences
Maarten Sjoerdsma, Arjan J.van Weele	2015	Journal of Purchasing & Supply Management
Eman S. Nasr, Marc D. Kilgour, Hamid Noori	2015	European Journal of Operational Research
Erica Mazzola, Manfredi Bruccoleri, Giovanni Perrone	2015	Journal of Purchasing & Supply Management
David Elvers and Chie Hoon Song	2016	Journal of Business & Industrial Marketing
Wu, S. B; Gu, X; Wu, G. D. and Zhou, Q	2016	International Journal of Simulation Model
Seong No Yoon, DonHee Lee, Marc Schniederjans	2016	Technological Forecasting & Social Change
Ricarda B. Bouncken, Boris D. Pluschke, Robin Pesch, Sascha Kraus	2016	Review of Management Science
Rosanna Fornasiero, Andrea Zangiacomi, Valentina Franchini, João Bastos, Americo Azevedo and Andrea Vinelli	2016	Production Planning & Control
Min Zhang, Xiande Zhao, Chris Voss, Guilong Zhu	2016	International Journal of Production Economics
Olov H.D. Isakssona, Markus Simeth, Ralf W. Seifert	2016	Research Policy
Graciela Corral de Zubielqui, Janice Jones and Larissa Statsenko	2016	Entrepreneurship Research Journal
I. Robert Chiang and S. Jinhui Wu	2016	IEEE Transactions on Engineering Management
Divesh Ojha, Jeff Shockley, Chandan Achary	2016	International Journal of Production Economics

(continued)

Paper	Year	Journal
María Isabel Roldán Bravo, Antonia Ruiz Moreno and Francisco Javier Llorens-Montes	2016	Supply Chain Management: An International Journal
Giovanna Lo Nigro	2016	Journal of Business Research
Edward C. S. Ku, Wu-Chung Wu, Yan Ju Chen	2016	Information Systems and e-Business Management
Ricardo Zimmermann, Luís M.D. Ferreira, António C. Moreira	2016	Supply Chain Management: An International Journal
Tingting Yana, Arash Azadegan	2017	International Journal of Production Economics

The papers that are part of the intellectual base of the topic are presented in bold

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