Supply Chain Integration Researches: An Overview of the Field

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Abstract **— The evolution of the logistics concept to a view of the supply chain was based on multi-organizational perception, which gave rise to the idea that a particular company depends, directly or indirectly, on other organizations. Such dependency relationship also indicates that increased competitiveness depends essentially on an integrated performance. In this context, the purpose of this study is to present an overview of the research field, its evolution over time and the main aspects discussed. This paper present a systematic mapping of publications related to the integration of supply chains, a synthesis of the same based on bibliometric indicators and, finally, the survey of the major issues discussed, based on a reference tracking.**

Keywords— *supply chain; integration; systematic literature review; overview*.

1. Introduction

The extensive development of supply chains appeared in a structured way in the 1990s. Such development took as a reference logistical issues, which were up until then deemed as part of the organizations' domestic agenda for the management, storage and transport of materials [1,2]. The evolution of the logistics concept to a view of the supply chain was based on multi-organizational perception, which gave rise to the idea that a particular company depends, directly or indirectly, on other organizations.

Such dependency relationship also indicates that increased competitiveness (based on classic competitive criteria such as cost, flexibility, speed, quality and reliability) depends essentially on an integrated performance. Thus, the degree of efficiency of an organization in terms of concrete results is directly related to the performance of its chain. There is, therefore, an indication from the literature of the direct relationship between integration and performance of the supply chain. As a result, the more integrated the chain is, the better its performance [3-8].

In this context of the relevance of the supply chain integration, as suggested by literature, the purpose of this study is to present an overview of the research field, its evolution over time and the main aspects discussed. For such reason, we present a systematic mapping of publications related to the integration of supply chains, a synthesis of the same based on bibliometric indicators and, finally, the survey of the major issues discussed, based on a reference tracking.

Thus, this paper is divided into six sections: (1) introduction, (2) review of literature on the field evolution and qualitative assessment of identified types of integration (3) methods used for bibliometric analysis and literature tracking, (4) quantitative analysis of the field; (5) bibliometric considerations on topics that relate to the study of supply chain integration, and (6) final considerations on the field.

2. Literature Review

2.1 Origin and Evolution of the Field

As a result of the need for funds during wars, Logistics was born for military purposes, but quickly reverberated in other sectors with the most diverse applications. Defining it as "the action that leads to the preparation and support of campaigns" in 1852, Antoine-Henri Jomini used the word "logistics" for the first time. Thirty-six years later, in 1888, Logistics was introduced as a discipline in the U.S. Naval War College, where theories would arise and a book would be published.

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

Released by Thorpe in 1917, the book "Pure Logistics: The Science of War Preparation" supports the idea that while Tactics and Strategy underlie the model of conducting operations, Logistics provides the means to do so. Thus, the author, a Navy First Lieutenant, gave to the incipient Logistics the same importance as the universal concepts of Strategy and Tactics in the context of wars. Twenty-eight years later, this vision would be recognized. In 1945, Admiral Henry Eccles said that the United States could have saved millions of dollars during World War II had they followed the principles preached by Thorpe in his book, again bringing to light the value of the topic.

After the reinforcement of the topic's importance, a different application possibility was noted in 1945. So far related solely with military purposes; with the end of World War II, Logistics offered a large optimization capacity to rebuild places devastated by conflicts. Thus, the topic gained notoriety at organizations that began to see it as a good knowledge base for the management of their operations. Nowadays, Logistics is deemed largely responsible for the chain of supplies and products in all companies looking to be competitive.

In view of the growing competition between companies, Logistics has assumed a key role in organizations in general. In this context of growing competitiveness, the requirements for logistics activities have also increased, and suffered much greater pressure than previously observed. Any possibility of reducing costs, deadlines and increasing control became a strategic measure for organizations. This group also includes improvements regarding flexible manufacturing, constant availability of products, compliance with deadlines, and timing of deliveries.

However, this transformation of the Logistics discipline did not take place overnight. A long time has passes since the 40s, when a few studies were published on the subject, until the introduction of concepts such as Material Requirements Planning (MRP), for example, that only began to spread after the 70s. In the meantime, there was a great concern with the satisfaction of customers, who presented a new and more demanding behavior. This new position was further strengthened in the '80s, when, in addition to an intensification of the globalization process, there also was a great increase in the use of computers.

Supply chains currently have a continuous dynamic reconfiguration in terms of interaction with partners in the search for new value creation. According to its structure, materials and products flow, representing a major logistics flow due to expectations of customers to have the delivery deadlines met. The supply chain includes information flow, such as sales, forecasts and orders, and cash flow, representing the relationship between customers and company, logistics providers and financial institutions [9]. Figure 1 represents this dynamic structure of the supply chain:

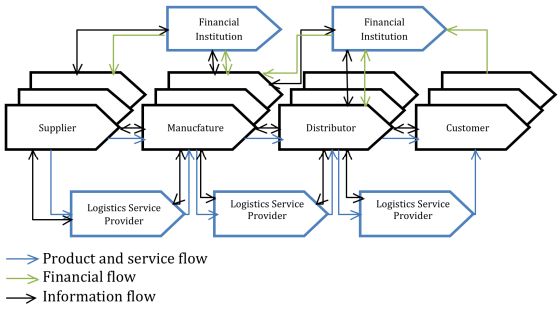


Figure 1 - Dynamic Supply Chain. Source: adapted from [9]

2.2 Qualitative Literature Review: Identified Integration Types

From a *snowball* in the texts concerning the integration of the supply chain, it was possible to find the dimensions and issues of integration as summarized below.

Table 1 - Summary of the types of integration of supply chains identified in the literature review.

Source Article	Quoted Authors	Integration dimensions	Integration issues	Integration perspectives
[10]	[12]	- Supply Chain Integration	Acquisition and use of information systems that enable the exchange of information to monitor the performance of partners such as: inventory, financial systems, etc.	Information integration technology
	[11]	- Supplier integration		
[13]	[19]	- Supplier integration		
[13]	[18]	- Supplier integration - Customer integration	Measure the impacts related to the sharing of production information on the dynamics of the supply chain appropriately.	System to measure performance in the supply chain

[21]	[10]	[10]	[10]		
[6]	[14]	[15]	[16]	[11]	[17]
- Supplier integration - Customer integration	- Supplier integration	- Internal integration - Customer integration	- Supplier integration - Customer integration - Strategic design integration - Design-process integration		
Integration of agents, internal and external to the supply chain, has different importance in GCS, but both are important for maximizing the value chain.	Integration between chains is motivated by certification institutes such as SCOR, which seeks to bring suppliers and customers closer.	Ways to measure the performance of companies regarding the quality of their services in comparison to customer satisfaction.	Production synchronized with demand and with suppliers, reduces delivery times, inventory in transit and costs. Aspects such as quality, innovation and cost reduction are important elements for maintaining a closer relationship between suppliers.		
Internal and external integration	Integration between chains-integration institutes	Analysis of the quality of goods and services	Relationship between customers and suppliers		

[26]	[20]	[13]		
[30]	[22]	[23]	[24]	[25]
- Supplier integration - Customer integration - Strategic design integration - Design-process integration	- Supplier integration	- Logistics- production integration - Logistics-marketing integration - External integration		
Integration of the purchasing function to corporate planning, integrating other key business functions, allowing a closer approach to the production process.	Production and inventory integration model that takes into account trends, scarcity and deterioration over a finite time planning with time-varying to demand and linear and finite production rate.	Chain integration from a buyer-seller production model that provides a reduction of the total annual cost.	Chain integration using coordination models between buyers and sellers, seeking to reduce costs and increase competitiveness through quantity discounts.	Harmonization through cooperation between the number of orders customer places to supplier aiming at a minimized total cost.
Internal integration	Inventory integration between buyer and seller	Coordination models focused on reducing costs between buyer-seller		

	[27]	- Supplier integration - Customer integration	Relationship between logistics partners that have high levels of formalization, commitment and integration of processes, where integration of processes and information systems is used to support the evidence of the existence of partnerships.	Internal and external integration
	[28]	- Supplier integration	The decision maker is free to explore alternative configurations for integrating the supply chain, assuming there is no particular order or causality between the chain links.	Internal integration
	[29]	- Logistics-production integration - Logistics-marketing integration - External integration	The integration chain can occur between companies and within companies, aiming to maximize the initiatives of efficiency and operational effectiveness processes, examining the different companies' characteristics to implement integration.	Internal and external integration

3. Method

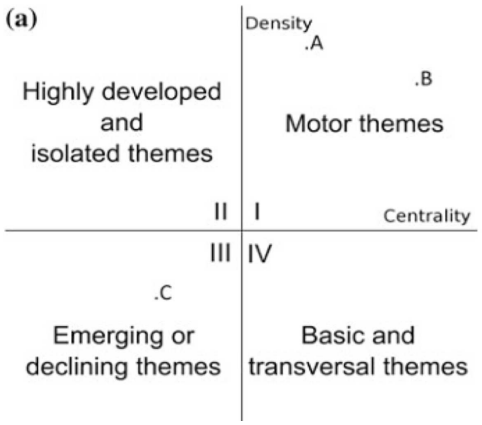
The literature review is critical, because it provides more precise contours of the subject being studied [31]. It is the literature review that provides the theoretical foundation to be adopted to address the issue and the research problem. The search strategies used that allowed a process of systematic research are described below.

3.1 Systematic Field Mapping

Mapping studies generally include broader research issues and often multiple research questions [32]. The process of extracting data for mapping studies can be more accurately seen as a classification or categorization phase, "it is unlikely to include deep analysis techniques, such as meta-analysis and narrative synthesis, but totals and summaries instead" [32]. Thus, to draw the map of researches studying the integration of supply chains, four research questions were initially made, as to know: What is the distribution of publications over time?; What are the areas of knowledge that most researched the subject?; What is the origin of the authors who write on the subject?; What periodic publications refer to this theme?

3.2 Bibliometrics

The areas of bibliometrics, text mining and visualization offer techniques and tools able to synthesize data clusters and support the identification of relevant topics and research trends [33]. The bibliometric analysis refers to the mathematical and statistical analysis of patterns appearing in publications and use of documents [34]. That is, it consists of a method to synthesize scientific research with the use of certain indicators [35]. Text mining, on the other hand, seeks to analyze and process semi-structured and unstructured data from a set of texts [33]. For the bibliographic review, a strategic diagram was used, in which the volume of the spheres is proportional to the number of published documents associated with each theme [38]. Thus, within the interconnected networks, the themes can be characterized according to two parameters [36]: the Centrality, which measures the degree of interaction of a network with other networks, and the Density, which measures the internal resistance of the network, i.e., the power of the internal links between all keywords that describe the research topic; and be mapped on a two-dimensional space and classified into four groups according to figure 2.



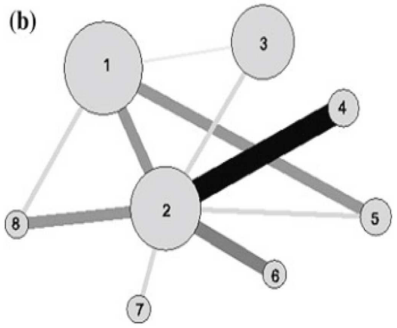


Figure 2 - (a) Quadrants in a strategic diagram. (b) An example of a thematic network. Source: [36]

The higher the centrality of the issue, the greater the relationship between it and the other topics of the research field. On the other hand, the higher the density of a theme, the stronger the relationship between the keywords that belong to the same subject. A theme in the first quadrant has high centrality and density, i.e., conceptually, it is closely related to other topics, as well as there are strong ties between its keywords. If it is in the second quadrant, it means that there is has a strong interaction between its keywords, which characterizes it as very specialized, although isolated theme. In the third quadrant, it implies that the subject has been little studied and there is no strong inter-relationship between keywords. The fourth quadrant implies that the subject has a strong interaction with others, but that there is a weak relationship between keywords, which characterizes it as important to the field, but little developed. In relation to a subject, keywords and their interconnections draw a network graph, called thematic network (Figure 2b), which is defined by the use of keywords with more importance in relation with the associated theme.

3.3 Snowball

When performing a literature review, findings are also made by chance Relevant literature is often in a place where no one is looking for it [37]. Additionally, it should be noted that a striking feature of the research was the use of the "snowball" method, which consists of researching the literature, looking for references. A reference in a text points to other texts, references in texts point to an even larger set of texts, and so on. The set of relevant texts grows as a "snowball" [37].

4. Quantitative Field Analysis

4.1 Characterization of Researches on Supply Chain Integration

The *ISI Web of Science* was selected as it contains the production indexed and deemed of good quality by the global academic community. In this basis, a "*suppl** AND *integrat**" search was performed in the topic index of the publication with no temporal filtering. We noted: (1) a consistent growing trend of publications since the 90s, (2) a concentration of researches in the areas of technical and technological knowledge, especially in the area of Motorering, with about half of the publications in the subject; (3) predominance of U.S. and China; (4) distribution of texts among journals.

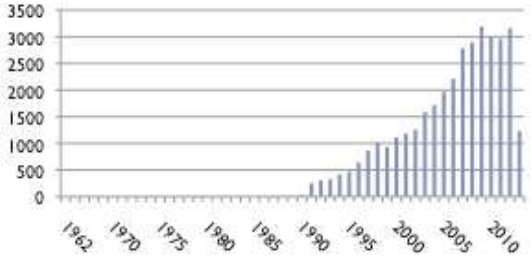


Figure 3(a) - Characterization of researches on supply chain integration: distribution of publications over time.

Field: Research Areas	Record Count	% of 35606
ENGINEERING	15557	43,69%
COMPUTER SCIENCE	6339	17,80%
BUSINESS ECONOMICS	4256	11,95%
OPERATIONS RESEARCH MANAGEMENT SCIENCE	2756	7,74%
ENVIRONMENTAL SCIENCES ECOLOGY	2305	6,47%
ENERGY FUELS	2075	5,83%
AGRICULTURE	1575	4,42%
TELECOMMUNICATIONS	1557	4,37%

Figure 3(b) - Characterization of researches on supply chain integration: areas of knowledge that most researched the subject.

Posição	Field: Countries/Territories	Record Count	% of 35606
1	USA	10108	28,39%
2	PEOPLES R CHINA	3805	10,69%
3	GERMANY	2939	8,25%
4	ENGLAND	2280	6,40%
5	CANADA	1594	4,48%
6	ITALY	1589	4,46%
7	FRANCE	1402	3,94%
17	BRAZIL	449	1,26%

Figure 3(c) - Characterization of researches on supply chain integration: the origin of the authors who write on the subject.

4.2 Bibliometric Assessment of Researches on Supply Chain Integration

For purposes of the bibliometric analysis, the ISI *Web of Science* database was searched. The result of the search with the term *suppl** and *integrat** in 07/14/2013 resulted in 35,606 publications. These were refined based on 15 refining categories, resulting in 11,361 publications, from which information from the most recent 500 ones was imported, through the *Full Record* feature.

In 2012, 148 articles were published. The themes SUPPLY-CHAIN-MANAGEMENT (with 41 items) and PERSPECTIVE (with 25 articles) stood out as motor themes of the search field for that period. Located in the upper left quadrant, COMPETITION (19) is a peripheral theme for the field in that period. Due to its location in the lower left quadrant, DECISIONS (6) is a weakly developed and marginal topic, i.e., it was deemed an emerging or declining theme in the period. MODELS (38) is a more general and basic theme, that is, it is important for the field, but did not develop, as shown in Figure 4 (a).

In 2013, on the other hand, with 352 publications, the themes FIRM (71), INVENTORY (62), SUPPLIERS (52), PERSPECTIVE (42) and INFORMATION TECHNOLOGIES (31) are in the right upper quadrant, featuring as motor themes. The topic CONTRACTS (4), in the left upper quadrant, proved to be a peripheral and marginal issue for the field. In turn, the themes GENETIC-ALGORITHM (19), PROCESS (10), BUYER-SUPPLIER-RELATIONSHIPS (5), FRAMEWORK (4), ECONOMICS (3) are emerging or declining themes, due to low centrality and density. QUALITY (27) is a more general and basic theme. MODELS (61) shows an increase in centrality and has evolved from a basic subject to a motor theme for the field, as shown in Figure 4 (b).

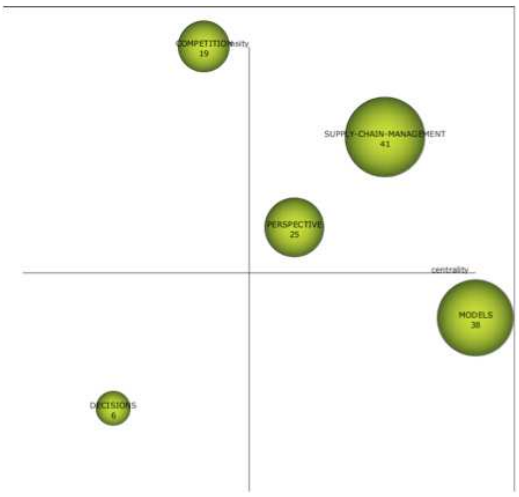


Figure 4(a) - Strategic diagrams for the Period 2012 based on the number of documents.

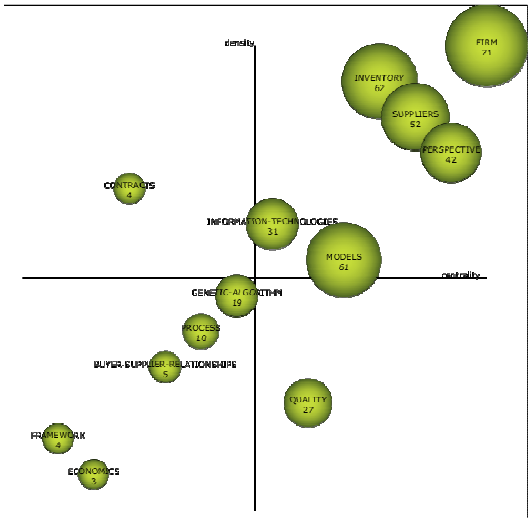


Figure 4(b) - Strategic diagrams for the Period 2013 based on the number of documents.

5. Bibliometric considerations on the topics that relate to the study of supply chain integration

The term *integration* showed a relationship with the themes FIRM and PERSPECTIVE, motor themes for the periods of 2012 and 2013, respectively. Figure 3 shows the thematic networks formed from these relationships. From these networks, it is possible to identify term subgroups with a stronger relationship, based on the thickness of interconnections.

The theme PERSPECTIVE (Figure 5a) is correlated with the terms: *suppliers*, *impact*, *innovation*, *integration*, *chain-management*, *customer*, *information-technologies*, *management*, *market*, *policy* and *strategy*. On the other hand, *integration* forms subgroups with the terms: *perspective*, *strategy*, *impact* and *chain-management; perspective*, *strategy*, *market;* and *perspective*, *strategy*, *management* and *impact*.

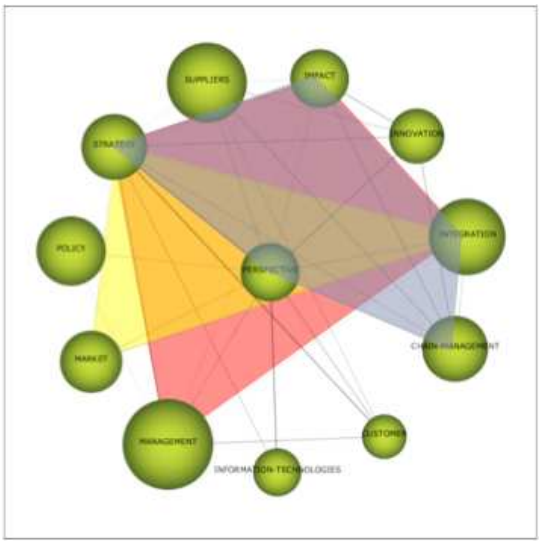


Figure 5(a) – Themes that showed some connection with the term *integration*: PERSPECTIVE – 2012

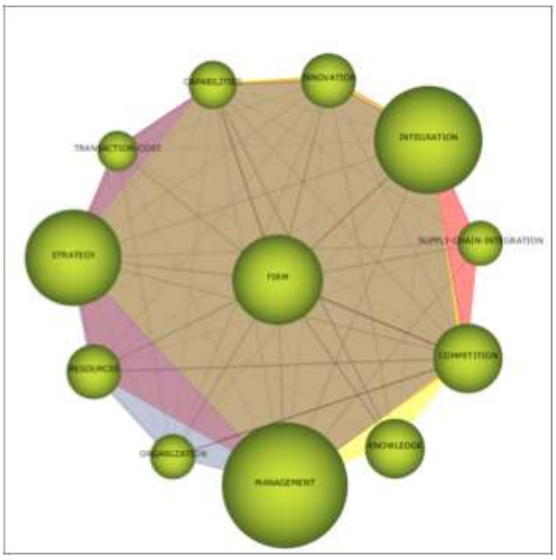


Figure 5(b) – Themes that showed some connection with the term *integration*: FIRM – 2013.

In the 2013 period, as shown in Figure 5b, the theme FIRM presents a relationship with: *integration, supply-chain-integration, competition, knowledge, management, organization, resources, strategy, transaction-cost, capabilities* and *innovation.* However, despite FIRM being the central theme in the thematic network, *integration* showed connections, in the form of subgroups, involving all keywords of the network at stake: *firm, competition, knowledge, management, strategy, capabilities* and *innovation; firm, supply-chain-integration, management, resources, strategy, transaction-cost, capabilities* and *innovation;* e *firm, competition, management, organization, resources, strategy, transaction-cost, capabilities* and *innovation*

6. Concluding Remarks on the Field

Logistics was born for military purposes but quickly spread to other organizations, to which any possibility of reducing costs, deadlines and increase control became a strategic measure. The management of the supply chain, in turn, goes beyond the logic of integrated logistics as it highlights logistics interactions between marketing, logistics and production functions, within the company, as well as those same interactions between companies that are located along the product flow channel [38].

The indication of a direct relationship between the supply chain integration and the improvement of the performance of organizations that are part of it lead to a reconfiguration of relations between partners in the quest for value creation. This is reflected in the steady growth of the number publications on the topic since the 90's.

Regarding the research field, it was noted that, from a bibliometric analysis, the supply chain integration was associated with motor themes, i.e., that have a strong conceptual link with the other themes of the thematic network. However, it ceases to be positioned next to issues related to market strategies and starts dealing with organizational issues. The *snowball* method allowed us to identify the main integration prospects discussed in the mapped publications. Among them, we highlight the integration between suppliers and customers [6, 11, 14, 16-19, 22, 30], addressing issues such as exchange of information, synchronization with demand and monitoring of performance between partners, their impacts on organizations and maximization of value chain.

Figure 6 shows the relationship between motor themes (quadrant I), well-developed and isolated themes (quadrant II), emerging or declining themes (quadrant III), basic and transversal themes (quadrant IV), found in 2013, with integration issues raised in the publications covered by the *snowball*. We noted that the relationship between customers and suppliers falls between the emerging themes of the research field, while internal and external integration relates to motor themes.

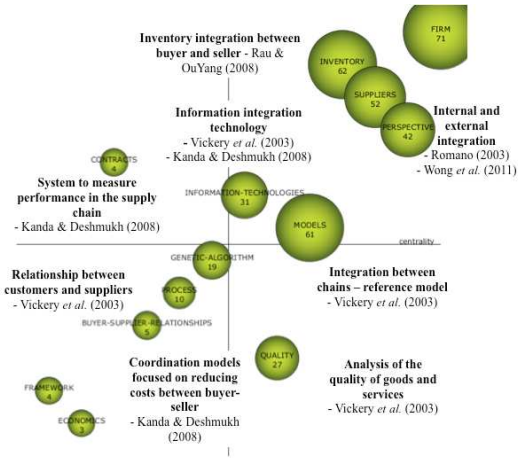


Figure 6 – Comparison between the bibliometric map and integration issues.

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