

IDENTIFYING INTER-ORGANIZATION COLLABORATION TYPES AND RESEARCH ADVANCEMENTS IN SUPPLY CHAIN CONTEXT

Ke Ma¹, Eva Gustafsson¹ and Rudrajeet Pal¹

¹Department of Business Administration and Textile Management, University of Borås, Sweden

ABSTRACT

The main purpose of this state-of-the-art paper is to make a synthesis analysis on collaboration in supply chain by literature review of all relevant articles, conceptualizing collaboration in supply chain and providing implications for future research. Based on designed material collection standard, up to year 2014, a total of 1250 papers are used for descriptive analysis and a total of 509 papers are carefully reviewed for further classification, conceptualization and comparison analysis. Research in this field is in an increasing trend in general but most of collaboration in supply chain is still in a low level in research. Another interesting finding is that logistics seems to be the most promising supply chain stage for research about collaboration in supply chain.

1. INTRODUCTION

As the development of supply chain, collaboration in supply chain is more and more common, while research regarding collaboration in supply chain keeps increasing as well. The important role of collaboration in supply chain has been demonstrated by many researches before (Ramanathan & Gunasekaran 2014, Soosay, Hyland & Ferrer 2008); therefore it is valuable and significant to identify different types of collaboration in supply chains.

This systematic literature review presents a comprehensive overview of past research on collaboration in supply chains, bringing an understanding to this field as a whole. Review papers on collaboration in supply chains are mainly about the investigation on the performance of collaboration and integration in supply chain (Adams, Richey, Autry, Morgan & Gabler 2014, Vereecke & Muylle 2006) and only seven review papers in this topic could be found on popular scientific databases, e.g. Web of Science. However, none of the existing scholarly paper constructs an overview of research on supply chain collaboration through a systematic literature review method. Besides, there are no studies conceptualizing or identifying different types of supply chain collaboration. This research, by constructing a useful framework based on past research, is valuable to researchers working on collaboration in supply chains and companies seeking supply chain collaboration in different industries.

2. RESEARCH METHODOLOGY

This survey article is based on a systematic literature review by using a meta-analysis of scholarly literature on collaborations in supply chain context. Three steps were used for a content analysis, including material collection, category selection and text-mining.

2.1 Material collection

The process of material collection is divided into two parts. Initially, two internationally well recognized scientific citation databases, Web of Science (WoS) Core Collection and Scopus, were used for searching relevant papers on collaboration in supply chain context. These papers were used for basic descriptive analysis (year distribution etc.) and basic comparison. For further analysis, e.g. categorizing and conceptualization, only articles found in WoS were included. As Table 1 indicates, a topic keywords list for searching was designed so that to include all relevant papers while several specific research areas provided by WoS and Scopus were selected respectively to restrict the subjects of the paper. Only papers written in English language were included, the year range is up to 2014 and document type was restricted to "Article". It should be mentioned here that all reviewed papers were collected by searching their topics (Title, Abstracts and Keywords)

which were all provided by authors or database. However, not always that these selected papers matched exactly to the selected research areas as required for investigation possibly due to discrepancies in the classification of the paper by the databases. Therefore we may miss some articles which correspond to our need for the analysis while some articles not pertinent enough may be included.

Keywords list	Selected research areas in WoS Core Collection	Selected research areas in Scopus
"supply chain coordination" OR "supply chain cooperation" OR "supply chain collaboration" OR "coordinati* supply chain" OR "cooperati* supply chain" OR "collaborati* supply chain"	<i>Business economics</i> OR <i>Operations research</i> <i>management science</i> OR <i>Public administration</i> OR <i>Social sciences other topics</i> OR <i>Transportation</i>	<i>Business, Management and Accounting</i> OR <i>Decision Sciences</i> OR <i>Economics, Econometrics and Finance</i> OR <i>Social Sciences</i>

Table 1: Keywords list and Research area restrictions

Finally, a total of 1250 papers in WoS and Scopus from 1995 to 2014 were collected for initial descriptive analysis. Among these papers, 509 papers from WoS are selected for further detailed analysis.

2.2 Category selection

A systematic categorization of all articles is the major topic of analysis in this study; therefore some criteria for categorization are required initially. The criteria are

- 1) Each category should be meaningful for further investigation and comparison, which means evolving patterns chosen purposefully yet systematically to meet the research objective;
- 2) Each category should contain a number of papers, at least five percent of the overall;
- 3) Each category is capable of being divided into several sub-categories, each of which should at least contain a small group/number of papers.

Based on the criteria and an initial analysis of different aspects of all reviewed papers, a structural literature categorization and corresponding sub-categories are indicated as Category 1: Stages in supply chain, viz. *Manufacturing, Logistics and Retailing*; Category 2: Types of collaboration, viz. *Coordination, Cooperation, Collaboration, Strategic alliance and Joint venture*; Category 3: Industries, viz. *Textile and apparel industry, High-technology industry, Food industry, Chemical industry and Biology and pharmacy industry*; Category 4: Company scales, viz. *SMEs and Large enterprises*.

Considering the focus of this study to be exploration of different types of collaboration along different stages in the supply chain, a comparison between these two categories was carried out. Further a calculation of the proportion of articles employing different collaboration types along these three stages was obtained in the end. Manufacturing, logistics and retailing are the three most common stages in supply chain, and almost every paper on supply chain collaboration involves at least one of these three stages. According to Forest (2003), Mowery, Oxley and Silverman (1996), from "coordination" (sub-category 1 of different types of collaboration) to "joint venture" (sub-category 5 of different types of collaboration), the level of inter-organizational collaboration is interpreted to be increasing gradually. In this context, "coordination" is defined as "harmonious functioning of different parts for effective results. It includes helping each other but not changing the basic way of doing business"; "cooperation" is referred as "common efforts and association for the purpose of common benefit to help each other in specific ways"; "collaboration" is "to work jointly with others on a common goal that is beyond what any one person or group can accomplish alone"; "strategic alliance" is defined as "an agreement between two or more parties to pursue a set of agreed upon

objectives needed while remaining independent organizations”, and “joint venture” is “A business agreement in which the parties agree to develop, for a finite time, a new entity and new assets by contributing equity”.

2.3 Text-mining

To extract papers from the corpus into different categories mentioned in section 2.2, text-mining technology was used. 509 papers were imported into NVivo, qualitative analysis software, for building the literature database and for further analysis, including data mining.

Categories	Sub-categories	Keywords for text search query
Category 1: Stages in supply chain	logistics	logistics OR transport* OR shipment OR shipping OR inventory
	manufacturing	manufactur* OR produce OR producing OR production* OR fabricat*
	selling	sell* OR sale* OR wholesale* OR retail*
Category 2: Types of collaboration	coordination	"supply coordination"~2 OR "business coordination"~2
	cooperation	"supply cooperation"~2 OR "business cooperation"~2
	collaboration	"supply collaboration"~2 OR "business collaboration"~2
	alliance	alliance*
	joint venture	"joint venture*"
Category 3: Industries	Biology and Pharmaceutical industry	biology OR pharma* OR medicine* OR drug*
	Chemical industry	chemical OR chemistry
	Food industry	food
	High-tech industry	"high tech" OR "high technology" OR "high technologies"
	Textile and apparel industry	textile* OR weav* OR yarn* OR sew* OR cloth* OR garment* OR apparel* OR wearing OR costum*
Category 4: Company scales	Large enterprises	"big company"~2 OR "big companies"~2 OR " large company"~2 OR "large companies"~2 OR "big enterprise"~2 OR "big enterprises"~2 OR "large enterprise"~2 OR "large enterprises"~2 OR "big firm"~2 OR "big firms"~2 OR "large firm"~2 OR "large firms"~2
	SMEs	"small enterprise"~2 OR "small enterprises"~2 OR "small company"~2 OR "small companies"~2 OR "medium enterprise"~2 OR "medium enterprises"~2 OR "medium company"~2 OR "medium companies"~2 OR SME?

Table 2: Keywords list for text searching queries in NVivo

One of the main functions in NVivo is text-searching query; this query could find all documents contained a specific word, phrase or concept from all documents imported into NVivo based on a designed text search criteria. This function was used as the first step of text mining. A list of keywords including wildcard characters were constructed for text search query, which all are special term and synonyms may be employed in different sub-categories, was designed as Table 2, so that all papers contain certain keywords

would be coded into corresponding word node in NVivo after every text search query. Each word node represents a corpus of papers containing keywords belonging to a sub-category in Table 2. In each word node, number of references for every article, which equals the term frequency - how many times certain keywords appearing in an article, can be calculated in NVivo. Articles in each word node could be sorted by the number of references as well, which is useful for the next step in text-mining. It should be pointed out that a lot of references are coding in the reference part and header or footer part of the paper, the accuracy of term frequency is influenced by them, therefore they needed to be decoded manually.

Topic determining by term frequency is a simple but important method in information retrieval from a corpus of documents and it is easy to select papers from a node in NVivo by using this method, e.g. sorting the papers by term frequency and select all papers with term frequency over ten, etc. However, if one term appears in almost every paper of a corpus, although it has a very high term frequency in an article, this term can hardly determine the topic of the paper. Each term may have different significance of determining the topic of a document, therefore, another algorithm in text mining, term frequency-inverse document frequency (TF-IDF), is used in this study. TF-IDF can return (identify) documents that are highly relevant to a particular query. If a user was to input a query for a particular topic, TF-IDF method can find documents that contain relevant information on the query (Ramos 2003). Given a corpus of documents D , a term t , and one document $d \in D$, TF-IDF is calculated as:

$$\text{TF-IDF} = \text{TF}_{t,d} * \log (|D|/\text{DF}_{t,D})$$

where $\text{TF}_{t,d}$ is term frequency of t in d , equalling the number of times t appears in d ; $|D|$ is the size of the corpus, and $\text{DF}_{t,D}$ is document frequency, equalling the number of documents in which t appears in D (Sparck Jones 1972, Salton & Buckley 1988).

Based on the formula and corresponding data, TF-IDF value of each article classified to a specific word node is calculated. Then articles are sorted by TF-IDF value in each sub-category. After examination of each node of papers, according to different categories, papers belonging to word node of category 1: Stages of supply chain and category 2: Types of collaboration and with TF-IDF value over 1 were selected into corresponding source node which contains all papers with corresponding sub-category topic, while papers belonging to word node of category 3: Industry and category 4: Company scales and with TF-IDF value over 2 were selected to corresponding source node. In the end, the selection result was validated by a random reading of papers in each source node of sub-category topic.

3. RESULTS

3.1 Descriptive analysis

Besides the search by a list of keywords together mentioned in section 2.1, articles were searched by different single keywords separately in both WoS and Scopus. The number of hits is shown in table 3, which could reflect an initial categorization and topic distribution of research on collaboration in supply chains. Coordination is the topic with most hits (802), while collaboration is the second (383) and cooperation comes to the third (78).

As figure 1 indicates, publications are shown an increasing trend in general with a period of sharp increase in the number of publications between 2005 and 2007. Further, it is clear in table 3 and figure 1, that the trend of distribution of articles either by keywords or by year of publication on Web of Science and Scopus is similar. This suggests that the further detailed analysis based on articles found on Web of Science could possibly reflect current research pattern on collaboration in supply chains.

Keywords	Number of articles		
	WoS	Scopus	Total
<i>supply chain coordination</i>	346	400	746
<i>supply chain cooperation</i>	22	26	46
<i>supply chain collaboration</i>	104	159	263
<i>coordinati* supply chain</i>	15	41	56
<i>cooperati* supply chain</i>	10	22	32
<i>collaborati* supply chain</i>	41	79	120
Total	526	724	1250

Table 3: Hits by different keywords in WoS and Scopus

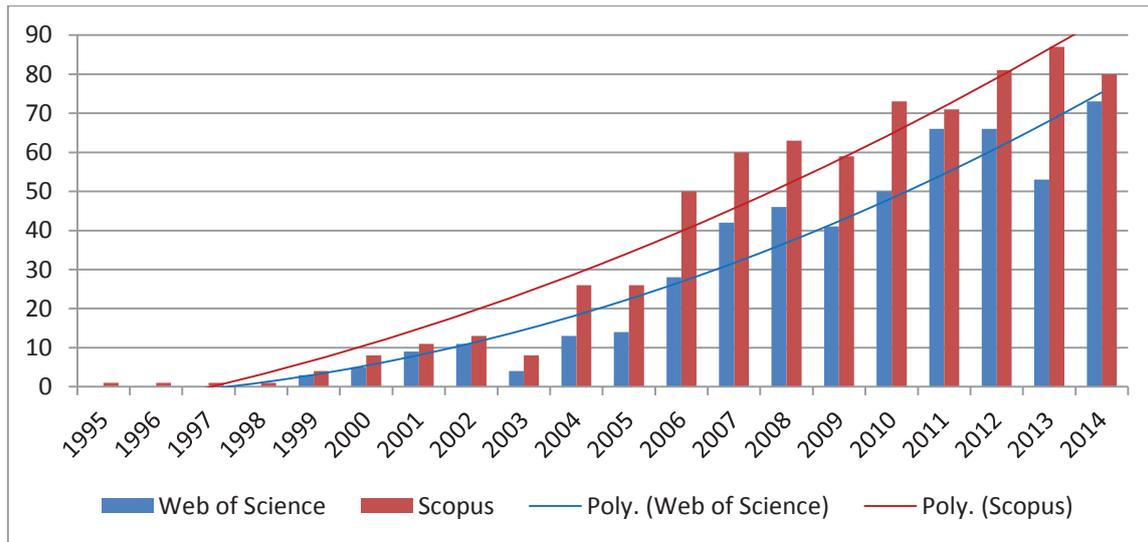


Fig. 1. Distribution of articles by year of publication

3.2 Results of literature extraction

Categories	Number of articles	Sub-categories (topics)	Number of articles
Category 1: Stages in supply chain	407	logistics	225 (55%)
		manufacturing	212 (52%)
		Selling*	295 (72%)
Category 2: Types of collaboration	257	Coordination*	142 (55%)
		cooperation	39 (15%)
		collaboration	78 (30%)
		alliance	38 (15%)
		joint venture	12 (5%)
Category 3: Industries	70	biology and pharmaceutical industry	6 (9%)
		chemical industry	7 (10%)
		food industry	17 (24%)
		high-tech industry	14 (20%)
		textile and apparel industry*	31 (44%)
Category 4: Company scales	22	large enterprises	14 (64%)
		SMEs	14 (64%)

Table 4: Distribution of literature based on the categories (*The most common topic in each category)

Based on the method described in section 2.3 for topic extraction according the TF-IDF value of each article, articles were extracted into different categories and different sub-categories. Then, the statistics on the number of articles with focus on different sub-categories was obtained, as shown in table 4. The percentage of papers under each sub-category topic to that under the main category was calculated as well, which makes it clear to see the extent of scholarly discussion on each topic in each category. Selling in category 1, coordination in category 2 and textile and apparel industry in category 3 are the three most common topics in their corresponding category, while in category 4: company scales, the research articles focussing on large enterprise and SMEs are evenly distributed.

3.3 Results of comparison

By analysing papers appearing simultaneously in categories 1 and 2, a comparison matrix is generated, as shown in table 5. It shows the proportion of articles, in past research, employing different collaboration types or levels along the three stages of supply chain. Based on the literature extraction in section 3.2, coordination is the most frequent type of collaboration addressed in extant research. Coordination is also a leading topic of research respectively along the three different stages of supply chain alongside collaboration. However, if we analyse the matrix in an another way, selling evolved as the most common stage in extant research on supply chain collaboration, however it has not been the most common topic along different types of collaboration. Selling, for example, has gained most attention in articles focussed on coordination though it has a slight edge over number of articles on cooperation in manufacturing; whereas, logistics takes over the lead position in type of collaboration, type of alliance and type of joint venture.

	Coordination	Cooperation	Collaboration	Alliance	Joint Venture
Manufacturing	74	19	28	15	4
Logistics	55	15	45	21	5
Selling	108	24	38	20	5

Table 5: Comparison matrix between stages in supply chain and types of collaboration

A further analysis of the year-wise distribution of each cell of comparison in the matrix is shown in figure 2. Figures 2a, 2b, 2c, 2d represents the year-wise distribution of extant literature on different types of collaboration, viz. coordination, cooperation, collaboration and alliance along various supply chain stages. Due to the low number of publications on joint venture, it is removed from further year distribution analysis. In general, publications on coordination and collaboration are on an increasing trend, as demonstrated by the higher slop in figure 2a compared to that in figure 2c. However, publications on cooperation and alliance remain at the same level and have a low production from 2000 to 2014. Further, articles on coordination in the supply chain stage of selling have the highest number of publications almost at all time, except in 2007 when articles on coordination in the manufacturing stage is the highest. Yet another interesting pattern observed in figure 2a is in terms of drop in number of publications from 2010 to 2013 whereas a sharp increase from 2013 to 2014. Another interesting pattern is observed in publications on coordination, collaboration and alliance in logistics (lines B, H and K respectively) – being the top three most common types of collaboration researched in logistics. All these lines show a drop from 2011 to 2013, even though lines B and H later on show a rise from 2013 to 2014, line I cease to descent in its slope and remains at the same level in 2014.

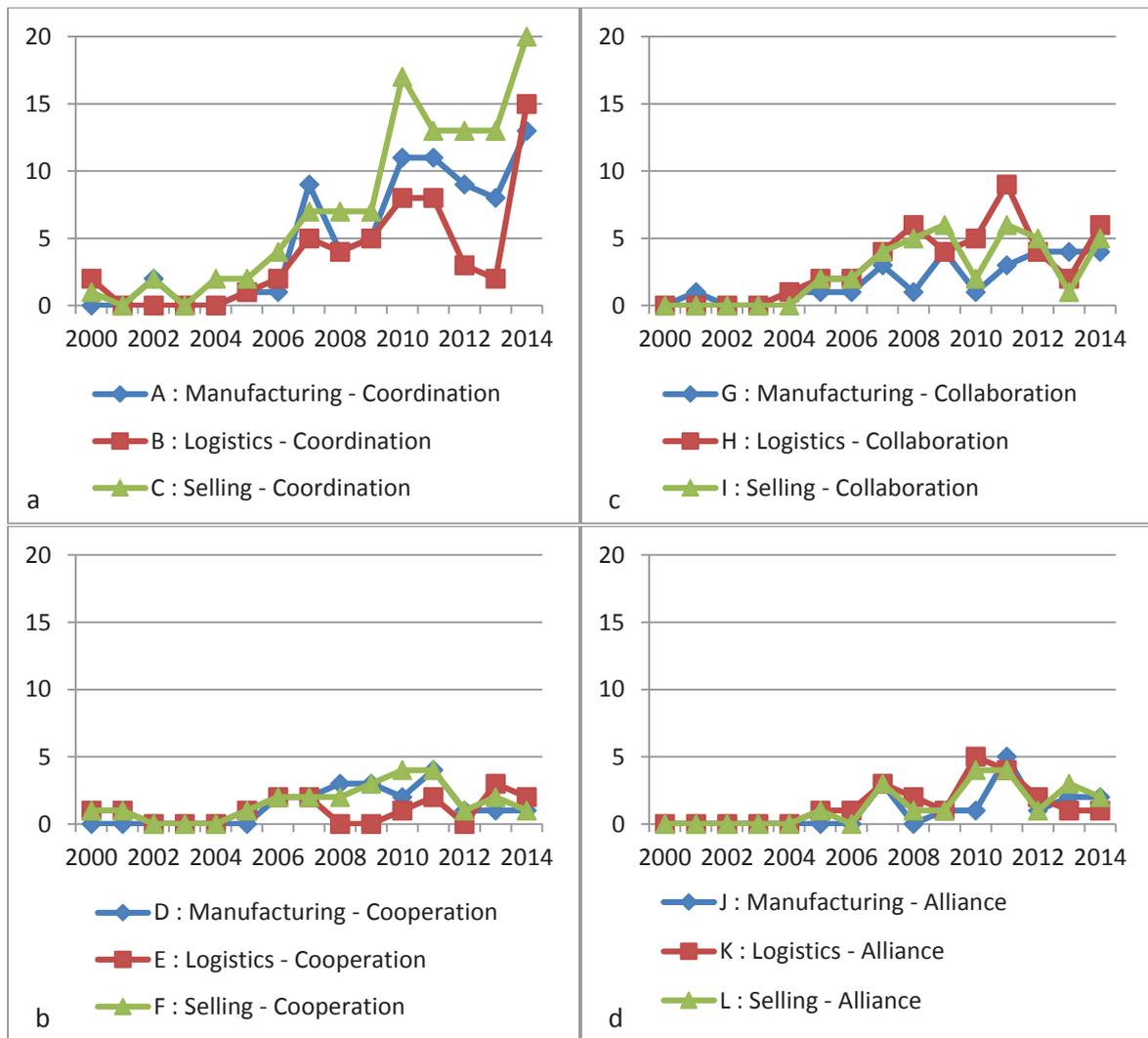


Fig. 2. Distribution of comparison between each type of stages in supply chain and types of collaboration

4. DISCUSSIONS AND CONCLUSIONS

In this study, a total of 1250 papers on different types of collaboration in supply chains are reviewed for descriptive analysis which shows a general increase in trend of research on this topic. A further analysis is undertaken based on 509 papers, extracted and classified along different categories and sub-categories.

According to section 3.2, coordination, which is the lowest level of collaboration, is the most common research topic among different types of collaboration claiming almost 50% of its share of total number of publications – same to the other four types thus showing its dominance. Furthermore, the decreasing trend of publication percentage distribution in different types of collaboration is same as the decreasing level of collaboration from coordination to joint venture, except the percentage rank of publications in cooperation which is not corresponding to its rank in collaboration level. Although this could possibly be explained by the use of some specific terms in supply chain literature, a more probable reason explaining this phenomenon is that today's research still concentrates on a lower levels of collaboration in supply chain. Based on section 3.3, the largest number of publications discussing different collaboration types in selling, the majority of them are focussed towards coordination. However, logistics, which has least publications in type of coordination, has more publications in the high levels of collaboration. Compared to

manufacturing and selling, research dealing with logistics is apt to take advantage of higher level of collaboration probably due to its intermediary role in supply chain under most circumstances. Moreover, from figure 2, coordination is the most popular type of collaboration all along the supply chain in all time and there is not any trend that other types of collaboration will replace its dominant position in relevant research. However, although selling is still the most common supply chain stage topic in research, articles with logistics as the topic have shown a sharp increase in number from 2013 to 2014. Besides the increasing trend from 2013 to 2014 in figure 2a is probably due to the increasing number of articles on modelling in coordination and a wider variety of journals available for publishing papers on coordination in supply chains.

In conclusion, collaboration in supply chain in current research is still at a relatively low level, and there are still a lot of potential for investigating higher level of collaboration in future research. Along various supply chain stages, logistics is the most promising direction for future research considering it as a still under-explored area of research compared to manufacturing and selling. We can also see a closer collaborative relationship if the collaboration involves logistics partner in supply chain. Further, as papers employing mathematical modelling or other modelling methods are increasingly given more attention in the recent years, this research field could be more attractive to researchers within operational research with relevant modelling background. There are still several interesting questions to be explored for future research based on the data of this study, e.g. which two stages in supply chain shows more collaboration in research, what is the difference between collaboration in supply chain context and in business context, what methods are used most frequently and so on. They are expected to be discussed in future study.

REFERENCES*

- Adams, F. G., Richey, R. G., Jr., Autry, C. W., Morgan, T. R. & Gabler, C. B. (2014). Supply Chain Collaboration, Integration, and Relational Technology: How Complex Operant Resources Increase Performance Outcomes. *Journal of Business Logistics*, 35(4), pp. 299-317.
- Forest, C. (2003). Empowerment skills for family workers: A worker handbook. Ithaca, NY: Cornell Family Development Press (distributed by Cornell University Press).
- Mowery, D. C., Oxley, J. E. & Silverman, B. S. (1996). Strategic alliances and interfirm knowledge transfer. *Strategic management journal*, 17(S2), pp. 77-91.
- Ramanathan, U. & Gunasekaran, A. (2014). Supply chain collaboration: Impact of success in long-term partnerships. *International Journal of Production Economics*, 147, pp. 252-259.
- Ramos, J. (2003). Using tf-idf to determine word relevance in document queries. *Proceedings of the first instructional conference on machine learning*.
- Salton, G. & Buckley, C. (1988). Term-weighting approaches in automatic text retrieval. *Information processing & management*, 24(5), pp. 513-523.
- Soosay, C. A., Hyland, P. W. & Ferrer, M. (2008). Supply chain collaboration: capabilities for continuous innovation. *Supply Chain Management-an International Journal*, 13(2), pp. 160-169.
- Sparck Jones, K. (1972). A statistical interpretation of term specificity and its application in retrieval. *Journal of documentation*, 28(1), pp. 11-21.
- Vereecke, A. & Muylle, S. (2006). Performance improvement through supply chain collaboration in Europe. *International Journal of Operations & Production Management*, 26(11-12), pp. 1176-1198.

*A full list of all references for the literature database of this study could be requested directly to the corresponding author.