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Supplier Development on the Automotive Industry: A Bibliometric Study of the Scientific Production from 1993 to 2015

Bernardo KELLER RICHTER[a,1] Sergio E. GOUVEA DA COSTA[ab] and Edson PINHEIRO DE LIMA[ab]
[a]*Pontifical Catholic University of Parana*
[b]*Federal University of Technology - Parana*

Abstract. In the last decades, automobile manufacturers have been challenged with a continuous increase on global competition, customer's demands and economic instability which forced them to focus on their core competencies while having to outsource many of its operations and subcomponents. Adopting a quantitative approach on the scientific production of a specific field can be very helpful to deepen its understanding and to contribute to the forthcoming studies on the topic. The main objective of this study, therefore, is to quantitatively analyze what was published on supplier development area on the automotive context by the application of bibliometric techniques. In order to do so, the search string ((supplier development OR supplier performance OR supplier management) AND automo*) was applied on the ISI Web of Knowledge database, and the time frame was restricted to papers that were published within the years of 1993 to 2015, generating a sample of 60 papers. At the end, the results of descriptive statistics analysis identified the authors, articles, journals most referenced by scholars worldwide. This study becomes then an important contribution on the development of new ideas, concepts and approaches as well as on the consolidation of this field of research.

Keywords. Supplier development, automotive, bibliometrics

Introduction

One of the biggest paradigm shifts in modern business management is the fact that currently companies compete not individually among themselves, but in a systemic way within their respective supply chains [1]. Supply chain management (SCM) is the term used to describe the management of the flow of materials, information and resources through complete logical sequence of a production system, ranging from component suppliers, final centers until reaching the final consumer [2].

In this context, in addition to seeking a satisfactory level of efficiency and effectiveness in its internal operations, companies should improve the management of the relationship with suppliers and customers, as it may be an important source of competitive advantage. According to Germani et al. (2010) [3] and interaction styles (1) conceptual and design collaboration, (2) advanced design collaboration and finally interplay collaboration.

[1] Corresponding Author, E-Mail: bernardo.keller@pucpr.br

Suppliers are a key factor for the performance of the purchasing company; they contribute, among other factors, to the quality, flexibility and cost of their products [4].

Through a close relationship with its suppliers buying companies are reducing their cycle time, reducing costs and increasing their capacity. This is especially true in industries that have complex products with a high dependency on suppliers such as the automotive assemblers. Thus, it comes as no surprise the fact that the vast majority of automobile manufacturers have formal development programs known suppliers as Supplier Development Programs (SDPs) [5].

In this sense, the present study aims to is to analyze the scientific literature on supplier development on the automotive industry quantitatively. The specific objectives are: (1) identify the authors and more relevant articles on the subject between 1993 and 2015; (2) Identify the most referenced journals on the subject; and (3) identify the main keywords. The methodological approach used is literature review, based on bibliometric theory.

This article is structured in five parts: (1) introduction; (2) a literature review that discusses the key concepts; (3) description of the sample selection method articles and analysis techniques; (4) results found; and finally, (5) conclusions and limitations of the work.

1. Literature review

The early research on inter-firms relationships did not viewed the competitive advantage of assemblers and suppliers in an integrative manner, thus different strategies were proposed to each company in their pursue to improve their operational performance [6]. The high-degree of interdependence between the intermediate component manufacturer and final assemblers in the products with high complexity began to be pointed out around the end of 1960s and beginning of 1970s by supply chain and organizational theory researchers such as Thompson (1967) [7] and Pfeffer and Slancik (1978) [8].

During the 1980s the concepts of value-adding relationships [9] and complementarities between the stages of the supply chain [10] were starting to emerge on the literature. These ideas suggested that buyers could obtain competitive advantage from the inputs of the supply chain [11] and benefit from the investment of assets in long term links with their key suppliers [12][13][14].

Leender (1966) [15] was this first author to coin the term “supplier development” to describe any efforts of assemblers to increase their range of possible suppliers and to improve their overall performance. More recently, Krause et al. (1998) [16] defined supplier development as any effort by an industrial buying firm to improve the performance or capabilities of its suppliers. These efforts are not limited to assist suppliers to comply their manufacturing parts with technical specifications but also encompass activities such as design of parts, adjustment of the manufacturing process; and specially, knowledge and information transfer [17].

With a considerable development of the conceptual basis of supplier management literature in the early 1990s a few important empirical studies that discussed the role of supplier development as a source of competitive advantage started to arise. The articles from Womack (1990) [18] and Clarck and Fujimoto (1991) [19], both applied on the automotive industry, are examples of comprehensive empirical studies done on the supplier development practices.

In particular the ability between a buyer and supplier to achieve a high level of coordination of its operations has been widely discussed in the literature and have been referred as the relational assets or relation-specific assets [20]. The relational approach states that in order to develop idiosyncratic communication routines buyers must be willing to share information, invest directly on suppliers operations, provide trainings and technical assistance. On the other hand suppliers are requested to share information, dedicate human resources and invest in equipment [21]. The practices above-mentioned are at the core practices of supplier development itself; for that reason, the application of such measures are expected to enhance the competitive advantage for both companies.

2. Methodology

The objectives described in the introduction are issue from selected research problem. The research was conducted in four steps, illustrated in Figure 1.

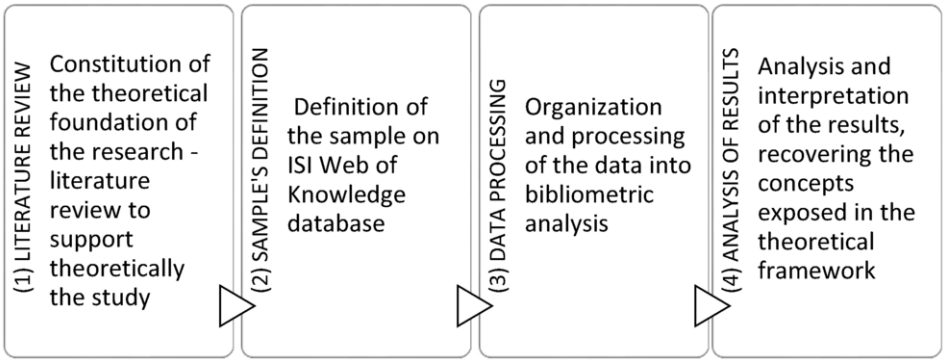

Figure 1. Research process.

2.1 *Bibliometrics*

The bibliometrics is defined as "a research technique that aims at the analysis of the size, growth and distribution of literature in a given field of knowledge." [22]. To Leite Filho (2006) [23], bibliometric performance indicators are important to evaluate academic research, guide direction and future research strategies.

Guedes and Borschiver (2005) [24] emphasize the aid of decision-making, organization and systematization of information allowed by this method. For these authors, it is a quantitative tool that minimizes the subjectivity of analysis.

Bibliometrics was developed by establishing empirical laws on the literature of behavior [25]. The bibliometric laws make use of mathematical and statistical analysis of data to investigate and quantify the scientific production on a subject.

In this scenario, it is important to know the three basic laws of bibliometrics to better understand the data: Zipf, Lotka and Bradford, the most commonly used and related scientific productivity [26].

The law of Zipf measures the number of occurrences of words in various texts, generating a list of terms in a particular subject being used to observe which scientific issue is addressed in the articles.

The law of Lotka covers the productivity (and quotes) of authors. It is based on the premise that some researchers publish a lot and that many scholars publish little.

The third law, called the Bradford law, allows to estimate the level of attraction of journals in a specific area of knowledge. In this case, since the first articles on a new subject are written and published by appropriate journals such vectors attract more articles on the topic in question; creating a feedback loop that accelerates the building of a positive image of certain journals in an area of knowledge.

The three laws are easily identified in the presentation of the results of this research. The first is associated with the main key expressions surrounding the theme of work. The second is reflected in the indication of authors with a more recognized production, measured by the number of citations and the article number. The third can be seen in the analysis of the leading journals on the topic.

2.2 *Sample definition*

The sample of articles on Supplier Development was set upon the selection of the database, the definition of the key words and search string, selection of the language of published articles, as illustrated in the Figure 2.

Criteria	Protocol Description
Keywords	Group 1- (supplier developement; supplier performance; supplier management) Group 2- (automo*)
Bolean Operator	OR between keywords, AND between groups
Search string	((*supplier developement* OR *supplier performance* OR *supplier management*) AND *automo**)
Text location	Title; abstract; keyword
Data Base	ISI Web of Knowledge
Language	English and Portuguese
Time window	From 1993 to 2015

Figure 2. Research protocol.

As for the determination of the database, we chose to use one the most popular platform for academic research - ISI Web of Knowledge [27] as it may return a representative sample of the scientific production on the topic.

In order to define the search string the authors read some of the seminal studies on the supplier development literature, and after testing a few key words on the database chosen the search string "((supplier development OR supplier performance OR supplier management) AND automo*)" was applied. It was considered only articles published in academic journals and conferences as they generally demand less time to be published and therefore provide a more updated picture of the recent studies on the subject. On the next step, a filter was applied so that only documents in the English and Portuguese language were taken into account. Without imposing restrictions on the years of publication, it was considered the years 1993-2015 time frame. The final composition of the sample resulted in 60 articles to be analyzed.

2.3 *Bibliometric treatment of collected*

The bibliometric treatment of the collected records are presented using descriptive statistics, obtained through illustrative charts and graphs generated by Microsoft Excel® software, highlighting three areas, based on bibliometric principles:

a) Classification of the most consulted journals;

b) Classification by most cited articles;

c) Classification of key expressions most used by the authors.

For the representation of the most used key expressions, it was applied the Wordle™ tool for building clouds of words, a concept that will shortly be defined later in this article. Moreover, it was possible to obtain other relevant information from the sample such as the evolution of the sample publications over time and who are the authors with the highest number of publications.

3. Findings

The first descriptive analysis of publications sought to identify how the interest on the supplier development topic behaved along the years, classifying the sample articles according to their year of publication. From the graph below (figure 3) can be observed that the development of the subject is fairly recent. The first publication date from 1993, and in subsequent years the volume of publications has a cyclical nature with publications volume peaks in the years 2010, 2011 and 2014, interspersed with periods of lower volume of publications.

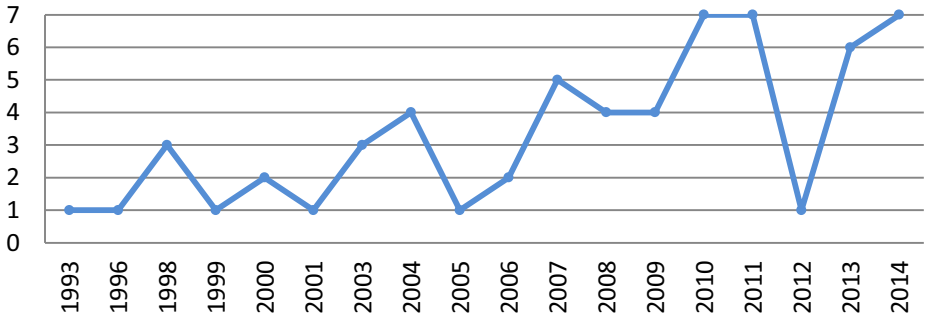

Figure3. Evolution of the sample publications over time.

A second descriptive analysis sought to evaluate the dispersion of work in order to identify the main authors, countries of origin and periodicals in volume of publications, as shown in Figures 4, 5 and 6.

With respect to the distribution of works per author (Figure 4), the analysis of the sample revealed that there are only 6 authors that published at least two articles, these authors are shown on the following figure. The author Jefrey K. Liker, from United States, stands out with the publication of four articles on the subject [28][29][30][31].

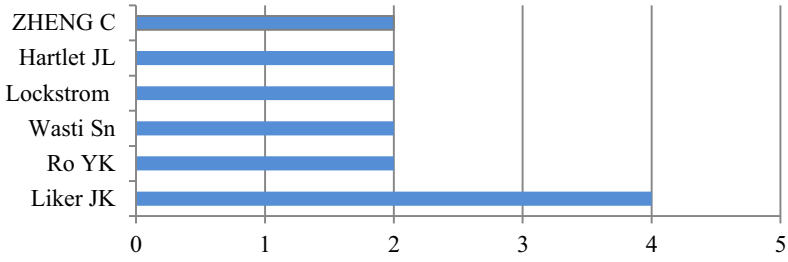

Figure 4. Authors with more publications.

The next analysis sought to identify the main centers of research that the authors are affiliated. Universities that stand out with more research on the subject are the University of Michigan, University of Cincinnati, both from the United States; Shanghai Jiao Tong University and Tongji University, both from China.

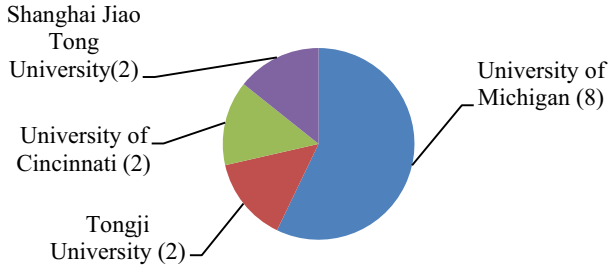

Figure 5. Universities with more publications.

Stratification of publications by country of origin of coauthors (Figure 6) shows a clear predominance of coauthors from USA. It is important to note that some papers have authors from different nationalities that's the reason one article could account to more than one country. Stratification contemplated all the countries of the sample, and Brazil had three publications.

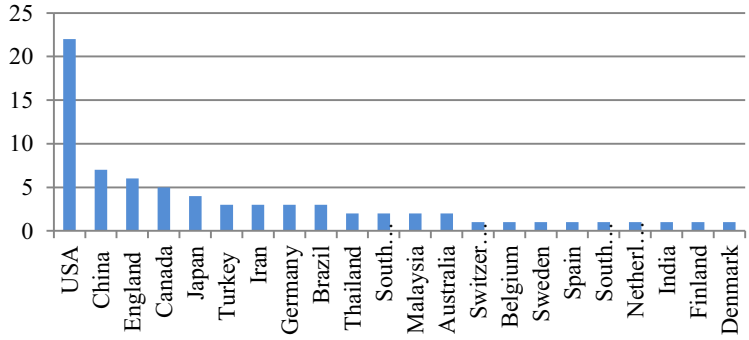

Figure 6. Distribution of the sample publications by country of origin.

Regarding the distribution of the sample articles per journal or conferences, the following graph (Figure 7) shows the journals or conferences with at least three publications. The International Journal of Production Economics had six publications on the topic followed by the Journal of operations management with five articles.

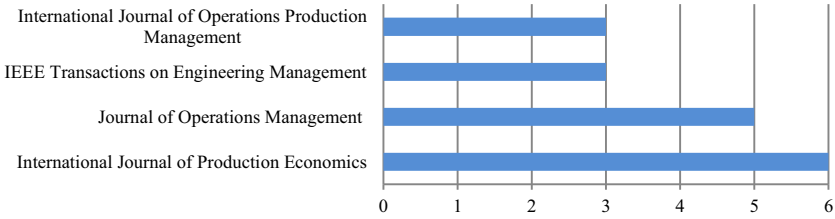

Figure 7. Distribution of publications by leading journals.

The 20 most cited articles of the sample are shown in Table 1. It is important to note that the data were collected on the ISI Web of knowledge database.

Table 1. The 20 most cited publications of the sample.

Articles	Number of citations
Kotabe, M; Martin, X; Domoto, H (2003)	286
Krause, Daniel R.; Handfield, Robert B.; Tyler, Beverly B. (2007)	203
Prahinski, C; Benton, WC (2004)	177
Liker, JK; Kamath, RR; Wasti, SN; Nagamachi, M (1996)	92
Richardson, J (1993)	87
Curkovic, S; Vickery, S; Droge, C (2000)	75
Schmitz, J; Platts, KW (2004)	57
Wasti, SN; Liker, JK (1999)	56
Wagner, SM (2006)	38
Stuart, I; Deckert, P; McCutcheon, D; Kunst, R (1998)	33
Rogers, Keith W.; Purdy, Lyn; Safayeni, Frank; Duimering, P. Robert (2007)	32
Zhang, Chun; Henke, John W., Jr.; Griffith, David A. (2009)	24
Ghijsen, Paul W. Th.; Semeijn, Janjaap; Ernstson, Saskia (2010)	23
Aksoy, Asli; Ozturk, Nursel (2011)	21
Ho, William; Dey, Prasanta K.; Lockstrom, Martin (2011)	21
Ro, Young K.; Liker, Jeffrey K.; Fixson, Sebastian K. (2008)	20
Tang, Dunbing; Qian, Xiaoming (2008)	20
Oh, Joongsan; Rhee, Seung-Kyu (2008)	20
Park, S; Hartley, JL; Wilson, D (2001)	19
Dyer, Jeff; Chu, Wujin (2011)	13

The citation analysis in general is based on the idea that authors cite documents they consider to be important for your own research. An article quoted many times can

be a thought-provoking article, prominent, while it can be as Pilkington and Meredith (2009) [22], a negative quotation (quoting a reference as a bad example). However, the same authors claim that this is a problem that can be ignored.

The article of higher notoriety for the high number of citations is the Kotabe, M; Martin, X; Domoto, H (2003) [6]. This article examines links between knowledge transfer and relationship duration inter-firms, and more fundamentally what are the practices that buying firms adopts that enhance indeed the operational performance of supplier. This endeavor was conducted firms from both U.S. and Japan.

Another distinguish article from the sample is the Krause, Daniel R.; Handfield, Robert B.; Tyler, Beverly B. (2007) [16] work entitled "the relationships between supplier development, commitment, social capital accumulation and performance improvement". With more than 200 citations, in this paper the authors sought to understand how buying firm commitment to a long-term relationship, sharing goals and values, supplier development programs and supplier dependency are related to buying firm operational performance improvements. The analysis was conducted on buying firms in the automotive and electronics industries on the U.S.

The word cloud, which are pictures made from words, is a form of linguistic data visualization that shows the frequency that words appear in a particular context [32-37]. In order to provide a clearer view of the words, the cloud of words (Figure 8) was limited to show the 50 most frequent words in the title, abstract and keywords.

Figure 8. Word cloud of the most cited words of the sample articles.

This analysis contributes to a clearer identification of the interrelatedness of the main themes. For example, the appearance of words such as "automotive", "Japanese", are a evidence that a large number of works are related to the supplier management practices adopted by Japanese automobile firms such as Kotabe, Martin and Domoto, (2003) [6]; Liker, Kamath, Wasti, SN and Nagamachi (1996) [28] and Richardson (1993) [38]. Another word that can be highlighted is "relationship(s)" showing that are several studies focused on how the relationship between the buying companies and supplier impact the overall performance of both or one of the firms.

4. Conclusion

To goal of this study was to characterize the state of the art of the research conducted in supplier development area applied in the automotive industry. The analysis and results described on this work constitute an important contribution to this field of research and practice. Above all, the main purpose of this research was to identify the main concepts that are being studied, as this is, normally, a starting point for scholars who aim to undertake studies on any field.

It is necessary also to point out some limitations of this study. The major limitation identified by the authors is the adoption of only one database for this bibliometric review. The ISI Web of knowledge database has a predominance of publications issued from north American journals written predominantly in English language, in this way not including the academic production of many countries, especially developing ones. Thus, many relevant papers may not integrate the sample of this study.

Finally, it was possible to identify in recent years an increased interest by scholars on the practices carried out by the buying companies for the development of its suppliers and how the application of these practices can contribute to the firm's competitive advantage. However, supplier development remains a young field of research that needs to be matured by practitioners and researchers on the years to come.

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