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Analysis on Research trends and Characteristics of International Supply Chain Management Based on Mapping Knowledge Domain

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Abstract. Using the knowledge mapping method, this paper makes a visual analysis on the international *supply chain management* from the WOS database, and found out that the research perspectives of the highly cited references are divided into three distinct research direction，including theoretical model, running mode and strategy decision. The research frontier based on Citation Burst focuses on globalization, sustainability, greening and elaborating. In addition, combining with the current domestic literatures， the research limitations are studied and the future research aspects are suggested.

Introduction

In the early 1980s, Michael Porter proposed the Porter Five Force Model, in which the relationship of the firm with its suppliers, competitors, and customers presented a sort of rivalry and competition[1]. In order to win the competition, the core enterprises stepped up their control over the supply of raw materials, the manufacture and sale of products, and a vertically integrated management model emerged[2]. However, since the 1980s, the market environment has undergone tremendous changes, and the demand of customers tends to be diversified and individualized, so enterprises are faced with a rapidly changing and unpredictable market[3]. Since the 1990s, the supply chain has become a hot topic in management theory and practice because of its adaptability to the current rapidly changing market environment.

supply chain management is in line with the needs of today's development and is a hot spot in related fields such as logistics. By means of the information visualization technology in the science of metrology, the knowledge map of the dynamic and characteristic of *supply chain management* was interpreted to understand the spatiotemporal distribution, knowledge base, research trends and frontier of international *supply chain management* and to grasp the development context. The research results help to promote the rapid and healthy development of the logistics industry.

Data sources and research methods

Data collection. In the process of data collection, the completeness and accuracy of data are very important[4]. The data in this paper was from the Web of Science database published by the U.S. Science Information Service. The search query was: TS = (*supply chain management*), through a period of time from 1990 to 2017 with the document format of "Article". In order to ensure the relevance and authority of the data, 8,590 articles were selected from SCI-EXPANDED and the Social Sciences Citation Index (SSCI). The data was last updated on December 28, 2017.

Research methods and tools. Mapping Knowledge Domains is a method of visual analysis for a subject area through various means, such as scientific measurement, data mining, information analysis and graphic drawing[5]. In the knowledge map, the interaction between frontiers of disciplines is presented in a spatial form, and the visualization of "knowledge" and "relationship" can be clearly presented, thereby highlighting the knowledge with similar characteristics[6], which can be

directly displayed discipline evolution and research trends. In this paper, by using the knowledge map analysis method and information visualization software CitespaceⅢ, as well as the data collected from *Web of Science*, we do some co-citation analysis about documents to obtain the research trend and development characteristic of *supply chain management*.

Common Cited Documents Identify Knowledge Base

Atlas Analysis of Common Cited Documents. Knowledge base is trajectory of its citation and co-referencing in the scientific literature[7]. In Citespaces[8], the knowledge base is mainly reflected by the co-cited documents clustering. By analyzing clusters and key nodes in co-citation networks, we can reveal the knowledge structure of this research area. The document data was imported into CitespaceIII, time slicing was set as 1990-2017 with a Per-Slice of 2 years, the network node type selection was cited, and the data extraction object was the top 50 of the highly cited in each time zone Articles. By citing a total of citation analysis, opening the visual window after operation cluster, and selecting "timeline" as the view output, the cited knowledge map of *supply chain management* documents was gained (see Figure 1). The figure shows a total of 437 nodes, 762 connections.

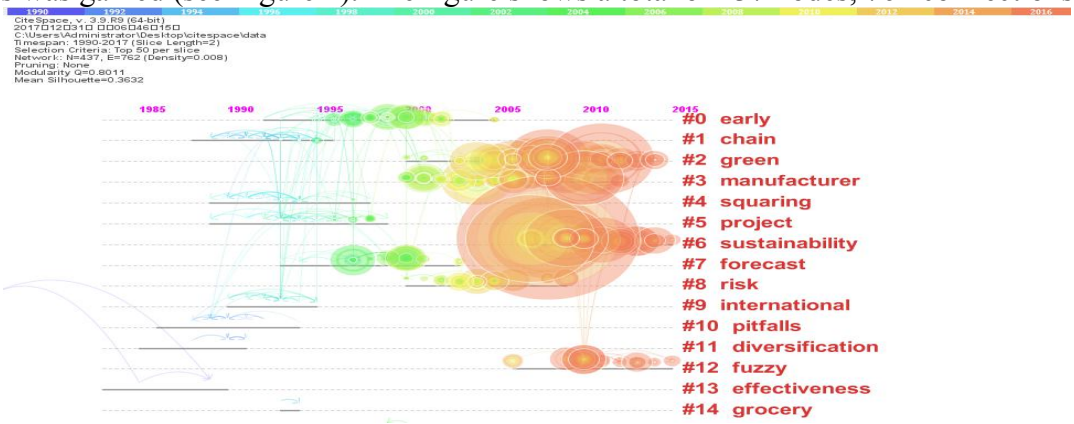

Figure 1. Map of the Research Time for *supply chain management*

Each straight line in the figure represents each clustering time axis formed with time. Each node on the time axis represents a document. The more nodes in a timeline, the more this clustering literature is, and the larger the age ring, the higher the reference frequency of the literature is[6]. By analyzing the time-series atlas of documents cited, the international *supply chain management* research process can be roughly revealed. Figure 2 shows that there was two nodes in clusters #1, #11 and #13 in 1990, indicating that the number of studies on *supply chain management* was very low. There was a slight increase in the number of citations in 1995 and a clear citation ring appeared on the #0 cluster and the #7 cluster time axis,which showed that the research on *supply chain management* was gradually increasing. After 1995, the number of the citation age ring increased significantly and the area became larger, indicating that the number of citations increased significantly. Since 2000, the citation age rings are densely arranged, showing that there has been a sharp increase in research on *supply chain management*. As can be seen from Figure 1, in the early (before 1990) the research of *supply chain management* is less, mainly about that in order to obtaining more profits, the effectiveness and diversity of the chain is studied by the enterprise.The literature of *supply chain management* in the medium-term (1990-2000) was to predict and reduce the cost by using the supply system. In the recent (2000- present), at the innovation stage,the literature is in the greening, sustainability and diversity and so on.

High frequency of literature research perspective. In order to gain a deeper understanding of the knowledge base in *supply chain management*, this article lists the top 10 high-frequency citation for further analysis (see Table 1).Table 1 lists the high-frequency citation documents published mainly in 1990-2010, *supply chain management* is an important period of development. By combining with Figure 2, Table 4 and literature analysis, classifying and summarizing the research

perspectives of high-frequency literature of *supply chain management*, three distinct and distinct research directions are obtained:

Table 1. The most influential 10 classic literature on *supply chain management* research in 1990-2017

Rank	Frequency	Year	Author	Source	Article
1	554	1997	Hau L. Lee	Management Science	Information Distortion in a Supply Chain: The Bullwhip Effect
2	374	1997	Fisher.ML	Harvard Business Review	What is the right supply chain for your product?
3	333	2001	Markham T. Frohlich	Journal of Operations Management	Arcs of integration: an international study of supply chain strategies
4	312	2000	Hau L. Lee	Management Science	The Value of Information Sharing in a Two-Level Supply Chain
5	301	2008	Stefan Seuring	Journal of Cleaner Production	From a literature review to a conceptual framework for sustainable supply chain management
6	288	1997	Hau L. Lee	Sloan Management Review	The bullwhip effect in supply chains
7	285	2007	Samir K. Srivastava	International Journal of Management Reviews	Green supply chain management: A state-ofthe-art literature review
8	282	2000	Gérard P. Cachon	Management Science	Supply Chain Inventory Management and the Value of Shared Information
9	274	2000	Douglas M. Lambert	Industrial Marketing Management	Issues in supply chain management
10	262	2004	Injazz J. Chen	Journal of Operations Management	Towards a theory of supply chain management:the constructs and measurements

(1)Theoretical model class, involves the basic theory such as the concept, characteristic and classification of *supply chain management* as well as the model research of validity and evaluation, with the most relevant literature. Hau L. Lee[9] pointed out in his article *The Information Disorder in the Supply Chain - The Bullwhip Effect* , that information should not be transmitted as an "order"， which the vendor makes the supply decision based only on the vendor's "downstream" demand information and produces a gradual zoom-in effect. It is a typical representative of *supply chain management* and an important basis for the literature, and the highest frequency of reference means that the new focus of the place, which in the later study of hot discourse confirmed. Later in his article *The Bullwhip Effect in the Supply Chain*, he argues that the "bullwhip effect" is caused by the rational decisions of members in the supply chain and proposes four solutions to the bullwhip effect: to avoid excessive demand Predict updates, change orders, stabilize prices and reduce the game in short supply[10].

(2) Operational patterns. Refer to the relevant classical basic documents are cited very frequently as a hot research topic in *supply chain management*, the . Hau L. Lee[11] studied that the value of information sharing would be great when closely studied the emergence of two non-stationary demand supply chain. Douglas M. Lambert[12] argued in the article *The Problem of supply chain management* that successful *supply chain management* proposed a *supply chain management* framework, as well as continuous analysis and improvement, the reliable, effective and linear operation measures have been formed. Markham T. Frohlich[13], in *The Integration of Arcs: A Study of International Supply Chain Strategies*, identified different "integrated arc" strategies for measuring supply chain integration, which represents the degree of direction and integration activities with suppliers or customers, and leaded to the conclusion that the greater the arc integration, the better the performance improvement.

(3) Strategic decision study. This kind of research belongs to the macroscopical research. Many documents are referenced by multiple clusters as the basis of knowledge at the same time. Gerard P. Cachon and Martin A. Lariviere[14], in *The Merits and Limitations of Supply Chain Coordination Revenue Sharing Contracts*, systematically studied the revenue sharing contracts described by

wholesale prices and the revenue sharing coefficients and pointed out their merits limitation. Injazz J. Chen[15] identified and reinforced the key elements of various supply chain planning and development of SCM structures in the article *Theory of supply chain management: structure and measurement.* In *What is the supply chain for your product?* by Fisher.ML[16], the following framework has been introduced: the supply chain is divided into physical efficient chains, which is plan to do some supply predictable requirements and at the lowest possible cost to minimize inventories through the supply chain, and market-responsive supply chains, in which the goal is to minimize inventory and respond quickly to unforeseen needs. Therefore, the ideal supply chain is to match the two together together.

the Frontier Literature Exported from the Citation Burst

The first person put forward the concept of research front is the foundation of scientometrics -Price. By statistical observation,Price[17] found that scholars tend to refer to the latest literature published in recent 10 years, so he named it the Immediacy Factor, and measured it. The results show that the research frontier is reflected by these frequent references. A sudden rise in attention is often a sign of a shift in the research field. With the imported datum from 2007 to 2017, setting the Per Slice to 2 years, clustering cited literature, and using the function of "Citation Burst" to detect the literature with higher frequency of reference,we get 10 articles, as shown in the Table 2.

Table 2. Exploding citation from 2007 to 2017

Rank	Year	Author	Source	Title
1	2004	Zhu QH	Journal of Operations Management	Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises
2	2007	Chen IJ	Journal of Operations Management	Towards a theory of supply chain management: the constructs and measurements
3	2008	Rao P	International Journal of Operations & Production Management	Do green supply chains lead to competitiveness and economic performance?
4	2003	Podsakoff PM	Journal of Applied Psychology	Common method biases in behavioral research: A critical review of the literature and recommended remedies
5	2005	Zhu QH	International Journal of Operations & Production Management	Green supply chain management in China: Pressures, practices and performance
6	2004	Lee HL	Harvard Business Review	The triple-A supply chain
7	2011	Ahi P	Journal of Cleaner Production	A comparative literature analysis of definitions for green and sustainable supply chain management
8	2008	Hervani AA	Benchmarking	Performance measurement for green supply chain management
9	2007	Vachon S	International Journal of Operations & Production Management	Extending green practices across the supply chain: The impact of upstream and downstream integration
10	2014	Brandenburg M	European Journal of Operational Research	Quantitative models for sustainable supply chain management: Developments and directions

Through the interpretation of the citation literature from 2007 to 2017, it can be found that the frontier of *supply chain management* in 10 years mainly focuses on the following aspects:

(1) Greening and sustainability.In *Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises*, Zhu QH[18] proposed that quality management and just-in-time (or lean) manufacturing principles have a great impact on the relationship between GSCM practices and performance. Rao P[19] put forward that,in *Do green supply chains lead to competitiveness and economic performance?*,the greening the different phases of the supply chain leaded to an integrated green supply chain, which ultimately leads to competitiveness and economic performance. Zhu QH[20] indicted ,in *Green supply chain management in China: Pressures, practices and performance,* that

Chinese enterprises had increased their environmental awareness due to regulatory, competitive, and marketing pressures and drivers. However, this awareness has not been translated into strong GSCM practice adoption, let alone into improvements in some areas of performance, where it was expected. Ahi P[21] proposed, in *A comparative literature analysis of definitions for green and sustainable supply chain management,* that the definitions for GSCM were generally more narrowly focused than those for SSCM and had an emphasis on the characteristics of environmental, flow, and coordination focuses. In *Extending green practices across the supply chain: The impact of upstream and downstream integration,*Vachon S[22] came up with that using the method of hierarchical linear regression can test the hypotheses for the antecedents of GSCP.

(2) Electronic informatization and refinement.In *Towards a theory of supply chain management: the constructs and measurements*, Chen IJ[23]identifies and consolidates various supply chain initiatives and factors to develop key SCM constructs conducive to advancing the field. Lee HL[24] indicted, in *The triple-A supply chain*, that only companies that build supply chains are agile, adaptable, and aligned getting ahead of their rivals.

(3) Modeling.In *Performance measurement for green supply chain management*,Hervani AA[25] provided an integrative framework for study, design and evaluation of green *supply chain management* performance tools. The findings also identified a number of issues that need to still be addressed. In *Quantitative models for sustainable supply chain management: Developments and directions,* Brandenburg M[26] showed that numerous possibilities and insights can be gained from expanding the types of tools and factors considered in formal modeling efforts.

Conclusion

In this paper, with the help of the knowledge mapping method, using the datum about the topic of international *supply chain management* research downloaded from WOS database, we have traced back to the *supply chain management*'s research hotspots and frontier, and revealed the generalization and review. The conclusion is that the international *supply chain management* research shows the trend of accelerated growth year by year, and the trend of "J" trend is presented in the last 10 years. The number of citations has proliferated, so it is obvious that *supply chain management* has been paid more and more attention by experts and scholars of various countries, and has gradually become a new hotspot research issue. The research perspective of high cited literature is divided into three distinct research directions: theoretical model, operation mode and strategic decision. The frontier literature mainly studies the contents of globalization, sustainability, greening, refinement and modeling.

As the rapid developing industry of the 21st century, *supply chain management* research is still exists optimizing space to develop. This paper argues that, in order to the evolution of the international *supply chain management*, there still needs the method of citation analysis and the theory of system dynamics carried on the thorough analysis, to study at a deeper level of the international *supply chain management* .

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