THE INTELLECTUAL STRUCTURE OF SUPPLY CHAIN MANAGEMENT

Wen-Lung Shiau  
*Ming Chuan University, mac@mail.mcu.edu.tw*

Chia-Han Tsai  
*Ming Chuan University, jasontsai6604@gmail.com*

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THE INTELLECTUAL STRUCTURE OF SUPPLY CHAIN MANAGEMENT

Wen-Lung Shiau, Department of Information Management, Ming Chuan University, Taoyuan, Taiwan, R.O.C., mac@mail.mcu.edu.tw

Chia-Han Tsai, Department of Information Management, Ming Chuan University, Taoyuan, Taiwan, R.O.C., jasontsai6604@gmail.com

Abstract

Supply chain management (SCM) has developed more than 30 years. However, few studies explore intellectual structure of SCM. The purpose of this study is to examine the intellectual structure of SCM through co-citation method. Data was collected from Web of Science online database. A total of 4,033 articles and 117,984 references were identified. Authors’ productivity and 41 highly cited/value articles were extracted by using a citation and document co-citation analysis. Using cluster analysis and multidimensional scaling (MDS), we identified four key issues of supply chain management researches: sustainable SCM (SSCM), strategic competition, value of information, and development of SCM where SSCM is an emerging area. Results in this paper are also compared with the previous studies, to show the shift in intellectual structure of SCM. The contribution of this study is to provide core knowledge for both researchers and practitioners to understand the aspects of SCM.

Keywords: Supply chain management, Intellectual structure, Document co-citation, Classification.
1 INTRODUCTION

Supply chain management (SCM) is a well-known management strategy which attempts to add value to customer service, to enhance competitive advantage through integrating the main business process in supply chain. Since SCM has been proposed in 1980s, it is already three decades passed (Oliver & Webber 1982). During this period, SCM has become more important and achievable in business management by increased globalization and advanced information technologies (Cousins et al. 2006; Handfield & Nichols 1999). Many researchers claim that organization is on longer competing as individual but rather as supply chain (Drucker 1998; Lambert & Cooper 2000).

In early stage, SCM has once been recognized as a synonym for logistics. Until late 1990, many scholars notice that SCM has grown in its own way. Thus, research in domain and scope of SCM became an important issue in that period(Cooper et al. 1997; Harland et al. 2006; Harland 1996; Lummus & Vokurka 1999; Mentzer et al. 2001; Tan 2001). In 21st century, SCM has moved from operation oriented (sharing information) to strategy oriented (business process integration) (Lummus & Vokurka 1999; Mentzer et al. 2001), and grown as a multivariate discipline (Cousins et al. 2006). Contributed by advanced information technology, SCM becomes more powerful and practicable(Cachon & Fisher 2000). SCM’s potential benefits make it become one of the necessary components to organization’s competitiveness. Drawing more attention to researchers and practitioners, the publication of SCM increases dramatically (Charvet et al. 2007; Georgi et al. 2010; Lambert & Cooper 2000).

The nature of research on SCM has been examined in many studies (Cooper et al. 1997; Mentzer et al. 2001; Tan 2001), but there is little research in intellectual structure (Charvet et al. 2007; Georgi et al. 2010; Giannakis 2012). Studying of the intellectual structure can identify core knowledge in a field, and provide more objective scope of the structure and development (Culnan 1987; Hsiao & Yang 2011; Keen 1980; Shiau & Dwivedi 2013). Thus, the intellectual structure of SCM has become an important research issue in recent years (Georgi et al. 2010; Giannakis 2012). The purpose of this paper is to explore the intellectual structure of SCM. The research questions that we address are as follows: (1) what are the current trends in SCM? (2) what is the intellectual structure of SCM? By solving the questions above, we hope to provide more objectively view on SCM foundation to scholars and practitioners.

In the study of intellectual structure, bibliometrics is a well-known method to describe the intellectual structure in any academic field (Eom 1998; Hsiao & Yang 2011; Pratt et al. 2012; Shiau & Dwivedi 2013). Therefore, this study used the term “supply chain management” as a keyword to collect journal articles from Web of Science online database. Citation and co-citation approaches were used to map the intellectual structure. Finally, the results in this research will be compared with the previous studies (Charvet et al. 2007; Georgi et al. 2010; Giannakis 2012). The remainders of this paper are as follows, section 2 reviews the supply chain management and co-citation method. In section 3, we present the procedures of data collection and research methodologies. Section 4 shows the results of data analysis and discusses the intellectual structure of SCM. In Section 5, we conclude the results and contributions of this paper. Finally in the last section, limitations and future research are discussed.

2 LITERATURE REVIEW

2.1 Supply Chain Management

The term “Supply Chain Management” was introduced by consultants in 1982 (Oliver & Webber 1982). At that time, it was just a vague concept in business management, and even has been considered as a synonym for logistics (Cooper et al. 1997). After decades of evolution, several studies tried to examine the nature and scope of SCM. The core concept of SCM is an attempt to add value to customer service, and maintain or enhance competitive advantage by integrating and coordinating of the business processes within and across organizations. In the domain of SCM, Cooper et al. (1997) proposed that
SCM framework consists of three closely related elements, business processes, management component and the structure of the supply chain. Later, Lummus and Vokurka (1999) proposed that SCM is a seamless process of coordination and integration in activities which deliver a product from raw material to the customers. Mentzer et al. (2001) proposed that the ultimate goal of SCM is to increase the customer satisfaction and competition advantage. Recently, the Council of Supply Chain Management Professionals (CSCMP) claim that “supply chain management encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies”. Today’s SCM includes the concern of environmental and social responsibility to develop sustainable supply chain management (SSCM) or green supply chain management (GSCM) (Ageron et al. 2012; Björklund et al. 2012; Gimenez & Tachizawa 2012; Green Jr et al. 2012). The foundation of SCM is becoming stable and starting to combination with these new elements. Besides, according to Cousins et al. (2006) SCM has been recognized as a multivariate discipline, but lack of boundaries. Thus, examining the intellectual structure of SCM has become more necessary.

There have some researchers studied the intellectual structure of SCM in the past decade. For examples, Charvet et al. (2007) used Business Source Complete (BSC) scholarly business database as a data source to collect and extract the core articles which related to SCM from 1985 to 2005. Used co-citation method, cluster analysis, MDS, and factor analysis to explore four clusters of research in SCM: (1) logistics disciplines; (2) operations research; (3) inter-organizational relationships and strategic alliances, and one heterogeneous cluster. Georgi et al. (2010) collected source articles from Journal of Business Logistic (JBL) from 1987 to 2007. Used co-citation, cluster analysis, MDS, and factor analysis to reveal current state of research on logistics and SCM which divided into seven groups: (1) supply chain management; (2) inter-organizational relationships; (3) competitive strategy; (4) research methodologies; (5) textbook; (6) customer service; (7) inventory management. More over, Giannakis (2012) selected the ten journal which are important in the field of SCM. Used social network analysis, citation analysis, cluster analysis and MDS to explore that the current structure of the network of the journal is shift from operation management to more SCM phenomena.

Even though the research in intellectual structure of SCM has been done before, but the structure may change over time. Besides, only Charvet et al. (2007) combine bibliometrics analysis with keywords to explore the intellectual structure of SCM. Therefore, this paper is to explore the current characteristics and the shift of the intellectual structure of SCM.

2.2 Co-Citation

Co-citation is one of the famous methods in bibliometrics and usually used to identify the knowledge of academic field (Hsiao & Yang 2011; Shiau & Dwivedi 2013; Small 1973). It can be divided into three levels: document co-citation, author co-citation, and journal co-citation analysis (Hsiao & Yang 2011). The main concept is to establish the correlation between documents to documents, authors to authors, or journals to journals by computing the co-cited frequencies (McCain 1991; Small 1973; White & Griffith 1981). Co-citation analysis can also provide an objectively view on intellectual structure with quantitative data (Charvet et al. 2007; Hsiao & Yang 2011; Shiau & Dwivedi 2013). In this section, we reviewed some previous studies which used co-citation method to established intellectual structure, and summarized in the Table 1. Co-citation method has some parameters needed to be confirmed, like data reference, analysis of the object, period, and visualization, which different setting may have the different meanings in the results.

<table>
<thead>
<tr>
<th>Author (year)</th>
<th>Research methods</th>
<th>Research issue</th>
<th>Data reference</th>
<th>Analysis of the object</th>
<th>Period</th>
<th>Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culnan (1987)</td>
<td>Co-citation</td>
<td>MIS</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
In order to explore the intellectual structure of the SCM, we used the keyword “supply chain management” to collect the journal articles which related to SCM in Web of Science database. After collecting the raw data, citation analysis is used to extract the highly cited articles and authors’ productivity. Then document co-citation analysis is used to build the correlation matrix between articles. Finally, the matrix is analyzed by series statistical to construct and visualize the intellectual structure of SCM.

3 METHODOLOGY

In this research, we used the Web of Science database to be our main data source, because of its high reputation (Hsiao & Yang 2011). The results in this research were compared with the results of previous studies. We used the keyword “supply chain management” which proposed by Charvet et al. (2007) in title, abstract or author-supplied keywords to collect our raw data. Because the Web of Science database only provides the citations which published after 1995, therefore, the time span is set from 1996 to 2012. We collected 4,405 articles and 181,416 references. After considering about the reliability and rigor, we excluded the articles which are books, conferences, proceeding, and letters. Finally, a total of 4,033 articles and 117,984 references are identified.

3.1 Data Collection

In this research, we used the Web of Science database to be our main data source, because of its high reputation (Hsiao & Yang 2011). The results in this research were compared with the results of previous studies. We used the keyword “supply chain management” which proposed by Charvet et al. (2007) in title, abstract or author-supplied keywords to collect our raw data. Because the Web of Science database only provides the citations which published after 1995, therefore, the time span is set from 1996 to 2012. We collected 4,405 articles and 181,416 references. After considering about the reliability and rigor, we excluded the articles which are books, conferences, proceeding, and letters. Finally, a total of 4,033 articles and 117,984 references are identified.

3.2 Citation Analysis

Citation analysis is an approach to understand the trends and growth conditions in disciplines by examining the disciplines itself on citation frequency (Córdoba et al. 2012; Ma & Yu 2010; White 1990). Highly cited articles are usually known as more influential ones (Córdoba et al. 2012; Culnan 1986). For examples, Hsiao and Yang (2011), Chen and Lien (2011), and Rorrisa and Yuan (2012) used citation analysis to obtain the highly cited articles, authors, or journals related to different disciplines like technology acceptance model, e-learning and information retrieval. Thus, citation analysis is used to rank and find the highly cited articles in this research. In addition, authors’ production was also been examined.

3.3 Co-Citation Analysis

After extracting and ranking the highly cited articles, co-citation analysis is used to build the correlation between these articles. We computed co-cited frequencies between each article to generate a correlation matrix. For example, if two articles are cited together for 70 times from the total 4,033 articles, we give these two articles 70 points. These points then form the symmetric matrix, which the main diagonal numbers are not co-cited frequency. We replace the main diagonal numbers by highest co-cited frequency in each row (White 2003). In order to make the good fit of co-citation matrix, we adopt the Kruskal (1964)’s stress measurement to identify the fit/size of co-citation matrix. Generally,
acceptable range of stress value is lower than 0.2 (Hsiao & Yang 2011; Pratt et al. 2012; Shiau & Dwivedi 2013). Finally, the matrix will be analysed by cluster analysis and multidimensional scaling.

### 3.4 Cluster Analysis

Cluster analysis is used to classify the variables/articles by testing the similarity. The variables within the group have high similarity and obvious dissimilarity with the other groups (Hsiao & Yang 2011; McCain 1990; Shiau & Dwivedi 2013). In this study, co-citation matrix is normalized by z-score, and analysis by cluster analysis. The ward’s method and squared Euclidean distance are used to run the cluster analysis to classify the articles into groups. Thereby, we can explain the knowledge structure by groups of articles which have similarity in research (Hsiao & Yang 2011; Shiau & Dwivedi 2013; White 2003).

### 3.5 Multidimensional Scaling

Multidimensional scaling (MDS) is an approach to map the variables into graphic by analysing the distance between articles. The closer the distance between two points/articles, the more similar the two articles is (Hsiao & Yang 2011; Leydesdorff & Vaughan 2006; McCain 1990; Pratt et al. 2012; Shiau & Dwivedi 2013). Stress value (lower than 0.2) is also used as a threshold to identify the goodness of fit of the MDS. In this study, the co-citation matrix will be analysed by MDS after normalizing. The squared Euclidean distance is adapted to calculate the distance between each variable/article. Co-citation analysis is usually mapping into two-dimensional scaling, and this visualization can help understand the relationship between the articles, and the intellectual structure of SCM.

### 4 RESULTS AND DISCUSSION

#### 4.1 Result of Citation Analysis & Co-Citation Matrix

In order to view the trends of SCM, we arranged the articles which collected from Web of Science database. As shown in figure 1, we discover that the research in SCM receives wide attention by researchers, which led the publication of SCM to increase year by year. We ranked the authors by the amount of research articles they published, and provided the adjust count more precisely. The adjust count is to solve the bias in number of authors in one article. For example, if an article were written by two authors, then we give only 0.5 point to each author. In table 2, we list the top 20 authors which their count number are greater than or equal 9. We found that the most authors are mainly from the universities in western countries, but it is also worth noting that many productive authors are from Hong Kong Polytechnic University. Even though the researchers of SCM are mainly from the western countries, the Hong Kong Polytechnic University is to have the potential in this discipline.

![Figure 1. Articles of Supply Chain Management yearly](image-url)
<table>
<thead>
<tr>
<th>Author</th>
<th>Count</th>
<th>Adjust Count</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sarkis, Joseph</td>
<td>33</td>
<td>14.44</td>
<td>Clark University</td>
</tr>
<tr>
<td>Chan, Felix T. S.</td>
<td>29</td>
<td>11.63</td>
<td>Hong Kong Polytechnic University</td>
</tr>
<tr>
<td>Lai, Kee-hung</td>
<td>24</td>
<td>7.61</td>
<td>Hong Kong Polytechnic University</td>
</tr>
<tr>
<td>Zhu, Qinghua</td>
<td>19</td>
<td>6.12</td>
<td>Dalian University of Technology</td>
</tr>
<tr>
<td>Carter, Craig R.</td>
<td>16</td>
<td>6.73</td>
<td>Arizona State University</td>
</tr>
<tr>
<td>Choi, Thomas Y.</td>
<td>13</td>
<td>4.86</td>
<td>Arizona State University</td>
</tr>
<tr>
<td>Kumar, Sameer</td>
<td>13</td>
<td>5.98</td>
<td>University of St Thomas Minnesota</td>
</tr>
<tr>
<td>Seuring, Stefan</td>
<td>12</td>
<td>6.15</td>
<td>University of Kassel</td>
</tr>
<tr>
<td>Wagner, Stephan M.</td>
<td>12</td>
<td>4.98</td>
<td>Swiss Federal Institute of Technology Zurich</td>
</tr>
<tr>
<td>Choi, Tsan-Ming</td>
<td>12</td>
<td>6.24</td>
<td>Hong Kong Polytechnic University</td>
</tr>
<tr>
<td>Koh, S. C. Lenny</td>
<td>11</td>
<td>2.29</td>
<td>University of Sheffield</td>
</tr>
<tr>
<td>Cheng, T. C. E.</td>
<td>11</td>
<td>3</td>
<td>Hong Kong Polytechnic University</td>
</tr>
<tr>
<td>Gunasekaran, Angappa</td>
<td>11</td>
<td>3.82</td>
<td>University of Massachusetts Dartmouth</td>
</tr>
<tr>
<td>Green, Kenneth W., Jr.</td>
<td>11</td>
<td>3.32</td>
<td>Southern Arkansas University</td>
</tr>
<tr>
<td>Richey, R. Glenn, Jr.</td>
<td>11</td>
<td>3.81</td>
<td>University of Alabama</td>
</tr>
<tr>
<td>Trkman, Peter</td>
<td>10</td>
<td>3.69</td>
<td>University of Ljubljana</td>
</tr>
<tr>
<td>Autry, Chad W.</td>
<td>10</td>
<td>3.49</td>
<td>University of Tennessee</td>
</tr>
<tr>
<td>Mentzer, John T.</td>
<td>10</td>
<td>3.73</td>
<td>University of Tennessee</td>
</tr>
<tr>
<td>Wang, Shouyang</td>
<td>9</td>
<td>2.55</td>
<td>Chinese Academy of Sciences</td>
</tr>
<tr>
<td>Ketchen, David J., Jr.</td>
<td>9</td>
<td>3.11</td>
<td>Auburn University</td>
</tr>
</tbody>
</table>

Table 2. Authors’ productivity of Supply Chain Management

We ranked the articles by times cited and used this sequence of articles to generate the co-citation matrix. We used time cited as a threshold to reduce the size of matrix and test the stress value progressively. Finally, we identified the 41x41 matrix as the size of research correlation matrix where stress value is 0.19706, lower than 0.2 (see figure 2), and the 41 highly cited articles which times cited is equal or more than 71 (see table 3).

![Co-citation matrix](image)

Figure 2. Co-citation matrix
### Table 3. Highly cited articles of Supply Chain Management

4.2 Intellectual Structure of Supply Chain Management

After extracting the co-citation matrix, cluster analysis and MDS are used to identify the intellectual structure of SCM. The 41 highly cited articles have divided into four main clusters which consist of...
eight cluster parts, and mapped on perceptual map (see Figure3). The stress value is 0.19706 which lower than 0.2 showed the good fit for the data. We named the clusters after carefully study every article. The four main groups and eight subgroups are discussed as follow.

From the result of cluster analysis, cluster 1 is named Sustainable Supply Chain Management. The articles in this cluster focused on sustainable in SCM. For example, Seuring and Müller (2008) proposed a conceptual framework for sustainable SCM, and other studies are focusing on green supply chain management which related to application of sustainability (Srivastava 2007; Zhu & Sarkis 2004)

Cluster 2 is comprised of SCM articles which can be divided into three subgroups. Cluster 2-1 is named Strategy of Measurement. The articles in this cluster focused on approaches in quantitative research. Such as Fornell and Larcker (1981) proposed an approach for assessing the discriminant validity of two or more factors. Armstrong and Overton (1977) studied the extrapolation methods for estimating nonresponse bias in mail surveys. Anderson and Gerbing (1988) proposed two-step approach for assessing the discriminant validity. Churchill (1979) suggested eight steps for developing measures of marketing constructs. Podsakoff and Organ (1986) suggested using Harman’s one-factor test to test common methods variance. Podsakoff et al. (2003) studied the causes of common method biases in behavioural research. Besides, the researches in this group which related to SCM are typically using the mail survey as research strategy (Carr & Pearson 1999; Chen & Paulraj 2004; Frohlich & Westbrook 2001).

Cluster 2-2 is named Competitive Advantage. The articles in this cluster focused on competitiveness of firm. For example, Barney (1991) and Wernerfelt (1984) studied the resources in firms for sustained competitive advantage. Prahalad and Hamel (1990) studied the resources within the firms, and proposed the theory of core competence.

Cluster 2-3 is named Relationship Marketing. The articles in this cluster focused on relationship between organisations. For example, Dyer and Singh (1998) studied the competitive advantage in inter-organizational cooperation. Morgan and Hunt (1994) studied the relationship marketing and suggested that successful relationship marketing requires trust and commitment. Ganesan (1994) and Dwyer et al. (1987) studied the relationship between buyer and seller. Anderson and Narus (1990) studied the relationship between distributor and manufacturer.

Cluster 3 is named Value of Information. The articles in this cluster can divide into two parts, sharing and distorsion of information in supply chain. For example, Lee et al. (2000), Cachon and Fisher (2000), and Gavirneni et al. (1999) studied the issue on information sharing. Other studies such as Chen et al. (2000), Lee et al. (1997a), Lee et al. (1997b), and Sterman (1989) paid more attention to the bullwhip effect.

Cluster 4 can also be divided into three subgroups. Cluster 4-1 is named Model Design of Supply Chain Management. The articles in this cluster focused on model design, but emphasized in performance measurement. For example, Beamon (1998) arranged the models of supply chain and provided a research agenda for supply chain area. Thomas and Griffin (1996) studied the modelsin the area of coordinated SCM. Both studies mention about the performance measurement, which is one of a goal in supply chain modeler. In addition, other articles like Gunasekaran et al. (2004), Gunasekaran et al. (2001), and Beamon (1999) studied the issue on performance measurements in SCM.

Cluster 4-2 is named Strategy of Case Study. The articles in this cluster focused on the method of case study. For example, Eisenhardt (1989) studied the method of case study, and proposed the eight steps to build the theory from case study research. Voss et al. (2002) reviewed the use of case study research in operations management (OM), and provided guidelines for research in OM by using case study.

Cluster 4-3 is named Issues and Standards in Supply Chain Management. The articles in this cluster focused on definitions, frameworks, and issues of SCM. For example, Mentzer et al. (2001) and Cooper et al. (1997) studied the nature of SCM, and provided the definitions and framework of SCM. Other articles like Lambert and Cooper (2000), Lambert et al. (1998), Fisher (1997), and Christopher (2000) studied the issues and components in SCM, in order to provide frameworks as well as how to successfully implement SCM and the trends for future research.
From the results of MDS, we noted that the distribution of four main groups shows clearly (see Figure 3). The similar results represent the results in this study are consistent. The four main groups are discussed as follow. The first group (cluster 1) is named “Sustainable Supply Chain Management.” Because of the rise of environmental awareness, business organizations start to face new pressure on environmental policy and the changing of customer awareness. The environmental concept has been gradually added into SCM to address the problems between SCM and the natural environment (Seuring & Müller 2008; Srivastava 2007). Thus, many research are now focusing on the frameworks, issues or implement on sustainable SCM, such as the green supply chain is a well-known strategy in sustainability (Zhu & Sarkis 2004). The core concept in this issue is trying to dispose the waste more thoughtfully during the whole processes in supply chain which include developing, manufacturing, storing, transporting, and even using and recycling a product (Seuring & Müller 2008; Srivastava 2007; Zhu & Sarkis 2004). This also motivates companies to adopt sustainable SCM. Furthermore, by comparing with other highly cited articles, the articles in this group were published more recently.

The second group (cluster 2) is named as “Strategic Competition,” this group is composed of three subgroups: strategy of measurement, competitive advantage, and relationship marketing. By increasing globalization, the competitive units are no longer just connecting to an organization itself, but to the stakeholders across the whole supply chain. In other words, organizations will lose competitive advantage in the future without coordinating more with members in supply chain. Competitive advantage usually focused on two key elements, resource and product (Wernerfelt 1984). The resource represents the information, knowledge, or process. Product is the outcome by using the resource effective, thus the relationship between these two elements are mutual benefits (Barney 1991; Prahalad & Hamel 1990). Nowdays, in order to meet the current global trends, these two elements are not only belonging to organizations but also the whole supply chain. To implement this idea, the relationship between organizations becomes an important issue in SCM. Therefore, many researchers worked at designing models to build a relationship between manufacturers and distributors, or buyers and sellers (Anderson & Narus 1990; Dwyer et al. 1987; Dyer & Singh 1998; Ganesan 1994). Commitment and trust have been confirmed as two key elements in building relationship (Christopher 2000; Morgan & Hunt 1994). In addition, there are a lot of papers discussed the solutions in different situations of quantitative research, like common methods bias, nonresponse bias, measures of marketing constructs, or the evaluating in structural equation models in this group (Anderson & Gerbing 1988; Armstrong & Overton 1977; Churchill 1979; Fornell & Larcker 1981; Podsakoff et al. 2003; Podsakoff & Organ 1986). This phenomenon shows that the research strategy in this group often uses quantitative methods to solve the problems (Carr & Pearson 1999; Chen & Paulraj 2004; Frohlich & Westbrook 2001). Perhaps, it can be explained by the type of studies in this group, which is usually related to psychology or behaviour.

![Figure 3. Results of multidimensional scaling (MDS)](image-url)
The third group (cluster 3) is named “Value of Information”. One important issue in SCM is called “Bullwhip Effect.” This phenomenon can be illustrated and tested by the well-known “Beer game” (Chen et al. 2000; Lee et al. 1997a; Sterman 1989). According to Lee et al. (1997a), there are four major causes of the bullwhip effect: demand forecast updating, order batching, price fluctuation, and rationing and shortage gaming. They also provided some appropriate approaches to counteract this effect, like sharing information (demand information), channel alignment, and operational efficiency (reduces cost or lead time). In which, sharing demand information is a major strategy to address bullwhip effect problem (Cachon & Fisher 2000; Chen et al. 2000; Lee et al. 2000). Recently, many researchers have tried to quantify the bullwhip effect in different levels of supply chain, in order to present more objective illustration in this issue (Chen et al. 2000; Lee et al. 2000). According to Chen et al. (2000), bullwhip effect can be mitigated but still exist. Overall, sharing information in supply chain has become an important issue in recent years, and also known as a core strategy for addressing bullwhip effect.

The fourth group (cluster 4) is named “Development of supply chain management”. This group is composed of three subgroups: model design of SCM, strategy of case study, and issues and standards in SCM. The studies in this group focused on exploring the definition, framework, implementation, or models of SCM (Beamon 1998; Christopher 2000; Cooper et al. 1997; Lambert & Cooper 2000; Lambert et al. 1998; Mentzer et al. 2001; Thomas & Griffin 1996). By studying these articles, we found that SCM continues to grow in the changing market environment. For example, lean approach for SCM is useful in the past business environment because of the predictable demands, less variety, and large quantity of products. Today’s situation is just the opposite, organizations need to consider the “agility” within supply chain to face the challenge in the 21st century, which demand becomes volatility and plenty variety (Christopher 2000). Because of the scarcity of resources and market globalization, organizations are forced to develop the supply chain to quickly respond to demand, which lead to increased attention to performance, design, and analysis of SCM (Beamon 1998; Thomas & Griffin 1996). In which, performance measurement in SCM is the primary issue in model of SCM (Beamon 1999; Gunasekaran et al. 2004; Gunasekaran et al. 2001; Thomas & Griffin 1996). In addition, the research strategy in this area uses case study more due to the research questions in this group which to explore some present circumstances (Eisenhardt 1989; Fisher 1997; Voss et al. 2002).

According to the study by Charvet et al. (2007), the intellectual structure of SCM in 1985 to 2005 can be divided into four groups. The first group has strong ties to the logistic discipline. This group focuses on defining and clarifying SCM. It can be similar to the forth group in our study, development of SCM. For example, there are some articles which researched on nature of SCM are appeared both on Charvet et al. (2007) and this study (Cooper et al. 1997; Lambert & Cooper 2000; Lambert et al. 1998; Mentzer et al. 2001). Our finding shows that the growing of this area is steady, such as many researchers are not only studied in defining and clarifying but also modelling and implementation of SCM. Besides, another target is to aim at performance measurement in SCM. Second group is based on operation research area. This group is focus on information sharing. It is the same as our third group, value of information. The main issue in this area is aiming at the bullwhip effect(Lee et al. 1997b; Lee et al. 2000). It conveys that the phenomenon of bullwhip effect is one of the main risks of supply chain, and needs to have more attention on this issue. Third group focused on the supply chain linkages and mentions inter-organizational relationship and strategic alliances. It is similar to our second group, strategic competition. Our finding emphasizes on competitive advantage. Relationship is still showed important in SCM, but other elements like resource and product are also need to be concerned. Fourth group is heterogeneous. It is difficult to compare with our results. Besides, the group of sustainable SCM is not appearing in previous study. We than defined this group is an emerging issue for SCM.

There are other researchers which researched are related to intellectual structure of SCM, like Georgi et al. (2010) and Giannakis (2012). One study examines the intellectual foundation of the Journal of Business Logistic(Georgi et al. 2010), and the other mapped the intellectual structure of SCM by journal co-citation analysis(Giannakis 2012). Due to the different approaches, results may show different meanings, comparing different may cause the inconsistency and bias. Thus, we do not compare our results with these studies.
By comparing with the previous studies, we found that SCM is more robust and keeps developing. Core issues are more clearly, and extended concept show up such as sustainable SCM. Nowadays, SCM is still focusing on the issues of information sharing and relationship within the whole supply chain. But other issues like Environmental and performance measurement have also aroused extensive discussion. We note that SCM has now composed of many fields like management, marketing, logistic, operation and even psychology. This phenomenon shows that the scope of the field of SCM is wide, and maybe this scope will continue to expand.

5 CONCLUSION

The purpose of the study is to explore the intellectual structure of SCM. Our data sources collected from the Web of Science are 4,033 journal articles and 117,984 references. We used citation and document co-citation to extract the 41 highly cited articles, and generated these articles into correlation matrix. Furthermore, authors’ productivity has been discussed. We discover that SCM still receives wide attention by researchers, and the Hong Kong Polytechnic University may have the potential in SCM, even though the researches of SCM are mainly from the western countries. Series statistics include cluster analysis and multidimensional scaling, which used to explore the intellectual structure of SCM. Through a comparison of the previous study, this study identifies four core issues of SCM researches: sustainable SCM, strategic competition, value of information, and development of SCM, where sustainable SCM is an emerging issue. For researchers, the contributions of this study are to show the shift in the intellectual structure of SCM to provide research priorities, such as sustainability in SCM, relationship between organizations, bullwhip effect within the supply chain, and performance measurement in SCM. But the intellectual structure of SCM may change over time. Thus, future research can expand the time period to explore the change of SCM. For practitioners, our study suggests that managers should put more effort on formulate a better performance measurement in SCM and share more information within the supply chain to reduce the bullwhip effect.

6 LIMITATIONS AND FUTURE RESEARCH

There are some limitations in this study. The data source we collected in this study is from the Web of Science database. Thus, some of the important journals and articles in SCM may not be included in this study. For example, Production and Inventory Management Journal, Purchasing and Supply Management, SCM Review, and Supply Management are not included in Web of Science database. Future studies may consider other journal databases. Moreover, the method of co-citation has time lag problem. Some of the new publish papers, which are important may be excluded because of the insufficient cited number. Thus, future research may try to include the journals we mentioned above, and draw attention to some new publish papers to make the core knowledge completely.
References


American Society for Information Science, 41(6), 433-443.
Shiau, W.-L. and Dwivedi, Y. K. (2013). Citation and co-citation analysis to identify core and emerging knowledge in electronic commerce research. Scientometrics, 94(3), 1317-1337.