國 立 交 通 大 學

資訊管理研究所

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應用引文分析和社群網路分析於供應鏈管理之研究

The Study of Supply Chain Management Using

Co-citation Analysis and Social Network Analysis

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中 華 民 國 九 十 七 年 六 月

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中文摘要

　　在全球競爭環境的新時代，因為現今企業最重要的典範轉移為單一企業不在被視為唯一性及不變性的，而是應該被視為供應鏈的體系，所以供應鏈管理在企業環境中扮演很重要的角色，由於供應鏈管理它是相當新且廣泛的概念，很多研究者從很多學科裡分析文獻並探討供應鏈概念是如何的演進、改變和定義。

　　在這一個研究中，藉由實證性分析研究，我們使用共引用分析及社群網路分析方法，探索供應鏈管理的主題及文件兩者之間的關係，並找出最密切相關的連結，我們希望藉由此研究的初步結果，可以幫忙專家們更容易了解供應鏈的主要趨勢、理解智慧架構和動向，以及找出供應鏈管理和其他領域之間的關係，並且快速的找出經典文獻。

關鍵字: 供應鏈管理、共引用分析、社群網路分析

The Study of Supply Chain Management Using Co-citation Analysis and Social Network Analysis

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Abstract

In this era of global competitive environment, Supply Chain Management (SCM) plays an important role in the environment of an enterprise because the most important significant paradigm shifts of modern business environment that individual business no longer consider as unique and immutable, but rather must be seen as supply chain. Due to SCM, it is a relatively new extensive concept that many researchers analyze the literature from multiple disciplines by seeing how the supply chain concept has evolved and changed and defined.

In this study, by using empirical experiment, we use co-citation method and social network analysis to discover the most closely related links between sets of subjects or documents of SCM. Based on our research results that we hope to help specialists easily realize the main trends, understand of intellectual structure and movement in the SCM and in other areas, and locate relevant papers efficiently.

Keywords**:** Supply Chain Management (SCM)、Co-Citation、Social network analysis

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　　入寶山豈可空手而歸，在這兩年的碩士生涯中，不管在專業知識的學習上、待人接物處事、自我省思及突破等等，都讓我有所增長，也讓我更認識自己。

　　首先我要感謝我的指導教授楊千老師，在自由的學術風氣下，讓我勇於嘗試不同領域的學術研究，培養了獨立思考及解決問題的能力，在老師身上不只讓我學習到做研究應具備的態度，從老師的身教、言教上，啟迪了我更多觀點及想法，在論文口試期間，感謝論文口試委員劉敦仁老師與傅振華老師撥冗閱讀本論文，給予此篇論文寶貴建議與指導，使得本研究內容更為完備，特此感謝。

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彭志祺　謹誌

國立交通大學資訊管理研究所

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Contents

List of Tables

List of Figures

1. Introduction

1.1 Research Background

In this era of global competitive environment, in order to deal with competitive pressure and market globalization, firms need to develop supply chains which can quickly respond to customer service, increasing levels of service and flexibility in terms of delivery, minimize the cost, and improve communication among supply chain companies (Lancioni, Smith, & Oliva, 2000). Over the past decade, Supply Chain Management (SCM) has played an important role in the environment of an enterprise because the most important significant paradigm shifts of modern business environment is that individual business no longer consider as unique and immutable, but rather must be seen as organic and ever changing interdependent organisms. Strictly speaking, the supply chain is not a chain of businesses with one-to-one, business-to-business relationships, but a network of multiple businesses and relationships (Bechtel & Jayaram, 1997).
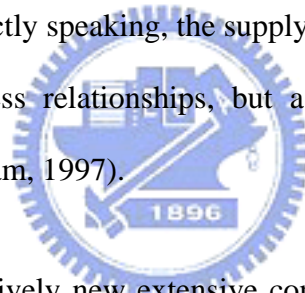
Due to SCM, it is a relatively new extensive concept that still lacks a clear definition. Many researchers analyze the literature from multiple disciplines by seeing how the supply chain concept has evolved and changed and defined (Bechtel & Jayaram, 1997; Croom, Romano, & Giannakis, 2000; Mentzer et al., 2001; Tan, 2001). However, at present, about SCM research works, there is still no systematic way to analyze the trends and relationships among papers, and help specialists realize the main trends, understand of intellectual structure and movement in the sciences and in other areas easily.

1.2 Research Purpose

The purpose of this study is to define the coupling of SCM document references cited in our research works. The analysis of the references of documents can be used to study the research fronts (Price, 1965). By using an actual example from the SCM documents, we could explore its relationship to other citation measures for identifying relationships. The more the two documents are cited together, the closer the relationship is between them, as perceived by the citing subjects, and the closer they would appear in the graphic rendering of groups of documents(White & Griffith, 1981) .

The goal of this thesis seeks to fulfill three objectives. First, we try to realize the main trends in Supply Chain Management. We apply the co-citation method to make an objective and empirical study. By using co-citation method, we can separate every sub-area in SCM topic. Second, we discuss SCM-related papers, trying to identify every sub-area and the relationships among the papers, and then recommend classic or highly influential papers in the field. We hope this work will help researchers better understand SCM issues and develop new theories and applications. Third, social network theory provides a conceptual framework and methodology for examining SCM documents group connection (Ennett & Bauman, 1993). UCINET 6.0 is a software package of social network analysis. Besides individual document network centralities provide insight into the individual's location in the network (Orgnet.com). We use it to analyze SCM core papers in order to find out the inter-relationships among the papers.

The present study uses the SCM topic as the unit of sets documents of core papers that we collect from Google scholar search engine (http://scholar.google.com). By using an empirical experiment, we would discover the most closely related links between sets of subjects or documents of SCM.

1.3 Research Process

The research process (Figure 1) has six sequent steps:

1. Topic Selection: In this work, Supply Chain Management was selected as our research topic.

2. Paper Collection: Google scholar was used as our search engine tool to collect papers from the internet.

3. Social network analysis: UCINET6.0 program was carried on Social Network analysis. From the results of running social network, we would find the strong degree papers.

4. Core papers Selection: Furthermore, the papers, which we selected as core paper, must satisfy the threshold of citation number that we defined. Then, by using our program, we would build the raw co-citation frequency matrix.

5. Statistical analysis: SPSS program was carried on Factor analysis, which permitted us to derive subfields from the co-citation matrix (McCain, 1990). And, STATISCA program was carried on Multidimensional Scaling, which was a data reduction procedure that allowed us to generate a map using similarities (or dissimilarities) between objects (Wilkinson, 1998).

6. Discussion and conclusion: According step5 experiment result, we discussed the relationships between these papers and authors. Then, base on that discussion, we would draw some conclusions.

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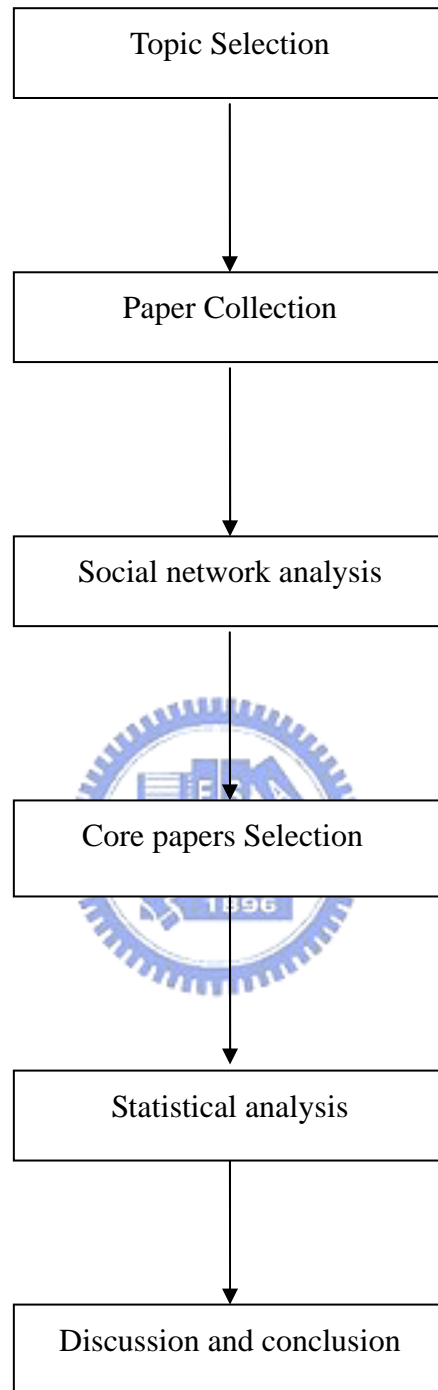
Figure 1 Research Process

2. Literature Review

2.1 Supply Chain Management

Forrester (1958) introduced a theory of distribution management that recognized the integrated nature of organizational relationships. "Management is on the verge of a major breakthrough in understanding how industrial company success depends on the interactions between the flows of information, materials, money, manpower and capital equipment. The way these five flow systems interlock to amplify one another and to cause change and fluctuation will form the basis for anticipating the effects of decisions, policies, organizational forms, and investment choices" (Forrester, 1958).

Christopher (1999) proposes a supply chain (SC) as "SC is a network of organizations that are involved, through upstream and downstream linkages in the different processes and activities that produce value in the form of products and services in the hand of the ultimate consumer".

It would be defined as integrated process of a supply chain, wherein a number of various business entities such as suppliers, manufacturers, distributors, and retailers…. They work together in an effort to (1) acquire raw materials, (2) extract raw materials or minerals from the earth, through the manufacturers, wholesalers, retailers, and the end user (see Figure 1), and (3) deliver these final products to retailers. Traditionally, this supply chain can be characterized by a forward flow of materials and a backward flow of information (Beamon, 1998; New & Payne, 1995).
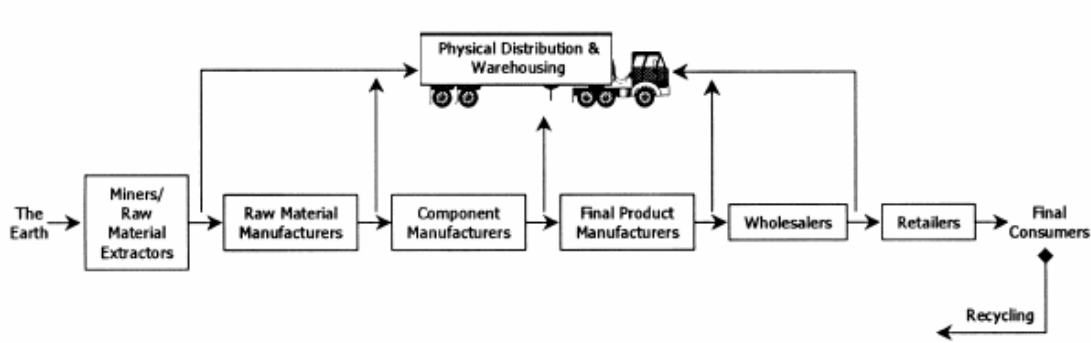
Figure 2 Activities and firms in a supply chain.
Source: New & Payne (1995)

The term "Supply Chain Management (SCM)", which makes it began in 1982, is relative new in the literature. It is defined as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user" (Oliver & Webber, 1992), and is an entire process that must be viewed as one system (Lummus & Vokurka, 1999). Many researchers analyze the literature from multiple disciplines and try to define the supply chain management such as Bechtel & Jayaram (1997) emerges Supply Chain Schools of Thought (see Table 1), and Mentzer et al. (2001) classify three categories: a management philosophy, implementation of a management philosophy, and a set of management processes (see Table 2). Besides, the Global Supply Chain Forum (ref. GSCF) defines the SCM as "Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services, and information that adds value for customers and other stakeholders".

Table 1 Supply Chain Schools of Thought

Author(s)	Definition
	Chain Awareness School
Jones and Riley (1985)	"Supply chain management deals with the total flow of materials from suppliers through end users."(p.19)
Houlihan (1988)	"Supply chain management covers the flow of goods from supplier through manufacturer and distributor to the end user."(p.14)
Langley and Holcomb (1991)	"Supply chain management focuses attention on the interactions of channel members to produce an end product/service that will provide best comparative value for the end user."(p.14)
Cavinato (1991)	"…the entire sourcing, value-added, and marketing activities of the overall link of firm up to final customers."(p.32)
Novack and Simco (1991)	"Supply chain management covers the flow of goods from the supplier through the manufacturer and distributor to the end user."(p.32)
Stevens (1990)	"Control the flow of material from suppliers, through the value adding (production) processes and distribution channels, to customers."
Lee and Billington (1992)	"Networks of manufacturing and distribution sites that procure raw materials, transform them into intermediate and finished products, and distribute the finished products to customers."(p.65)
	Linkage/Logistics School
Scott and Westbrook (1992)	"…supply chain is used to refer to the chain linking each element of the production and supply process from raw materials through to the end customer."(p.23)
Turner (1993)	"**…**technique that looks at all the links in the chain from raw materials suppliers through various levels of manufacturing to warehousing and distribution to the final customer."(p.52)
	Information School
Johannson (1994)	"SCM is really an operations approach to procurement. It requires all participants of the supply chain to be properly informed. With SCM, the linkage and information flow between various members of the supply chain are critical to overall performance."
Towill, Naim and Wikner (1992)	"A supply chain is a system, the constituent parts of which include material suppliers, production facilities, distribution services, customers linked together via the feed forward of materials and the feedback flow of information."(p.3)
	Integration School
Cooper and Ellram (1990)	"An integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user."(p.1)
Ellram and Cooper (1993)	"Supply chain management is an approach whereby the entire network from which suppliers through the ultimate customer, is analyzed and managed in order to achieve the 'best' outcome for the whole system."(p.1)
Hewitt (1992)	"Supply chain integration is only a natural result of redesigned business processes not realignment of exiting functional organizations."(p.340)
	Future
Cavinato (1992)	"The supply chain concept consists of actively managed channels of procurement and distribution. It is the group of firms that add value along product flow from original raw materials to final customer. It concentrates on relational factors rather than transactional ones."(p.285)
Farmer (1995)	"Instead of using the term supply chain management, we should use the idea of a seamless demand pipeline."

Source: Bechtel & Jayaram (1997)

Table 2 Definitions of Supply Chain Management

Monczka, Trent, and Handfield (1998)	SCM requires traditionally separate materials functions to report to an executive responsible for coordinating the entire materials process, and also requires joint relationships with suppliers across multiple tiers. SCM is a concept, "whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers."
La Londe and Masters (1994)	Supply chain strategy includes:"… two or more firms in a supply chain entering into a long-term agreement; … the development of trust and commitment to the relationship; … the integration of logistics activities involving the sharing of demand and sales data; … the potential for a shift in the locus of control of the logistics process."
Stevens (1989)	"The objective of managing the supply chain is to synchronize the requirements of the customer with the flow of materials from suppliers in order to effect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost."
Houlihan (1988)	Differences between supply chain management and classical materials and manufacturing control: (1) The supply chain is viewed as a single process. Responsibility for the various segments in the chain is not fragmented and relegated to functional areas such as manufacturing, purchasing, distribution, and sales. (2) Supply chain management calls for, and in the end depends on, strategic decision making. "Supply" is a shared objective of practically every function in the chain and is of particular strategic significance because of its impact on overall costs and market share. (3) Supply chain management calls for a different perspective on inventories which are used as a balancing mechanism of last, not first, resort. (4) A new approach to systems is required-integration rather than interfacing."
Jones and Riley (1985)	"Supply chain management deals with the total flow of materials from suppliers through end users…"
Cooper et al. (1997)	Supply chain management is "… an integrative philosophy to manage the total flow of distribution channel from supplier to the ultimate user."

Source: Mentzer et al. (2001)

2.2 Conceptual Framework of SCM

Cooper et al. (1997) depicts a simplified supply chain network structure, the information and product flows. Each firm in the supply chain will have its own set of functional silos that must be related to each key supply chain process (see Figure 3). As described in Figure3, the Global Supply Chain Forum (ref. GSCF) identifies eight key processes that make up the core of supply chain management: (1) Customer Relationship Management, (2) Customer Service Management, (3) Demand Management, (4) Order Fulfillment, (5) Manufacturing Flow Management, (6) Procurement, (7) Product Development and Commercialization and (8) Returns.
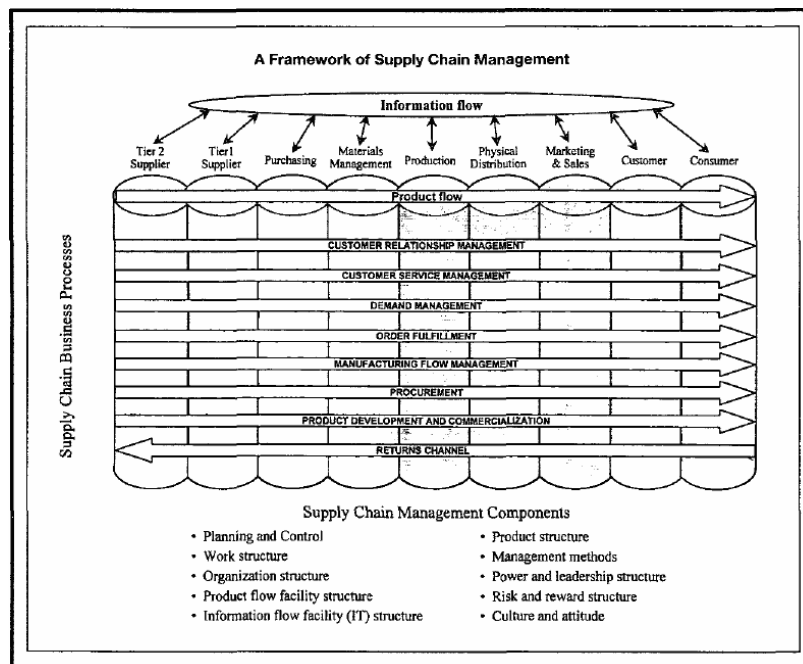
Figure 3 A Framework of Supply Chain Management
Source: Cooper et al., 1997

Cooper et al. (1997) proposed a conceptual SCM framework, which encompasses three major and closely inter-related elements, which are business process, management components, and supply chain structure (Figure 3). (1) Business processes are the activities that produce a specific output of value to the customer. (2) The management components are the managerial variables by which the business processes are integrated and managed across the supply chain. (3) The supply chain structure is the network of members and the links

between members of the supply chain. They believe that these common management components play critical and fundamental roles for successful SCM because management components are to be integrated and managed for each process link (Cooper, Lambert, & Pagh, 1997; Lambert, Cooper, & Pagh, 1998).
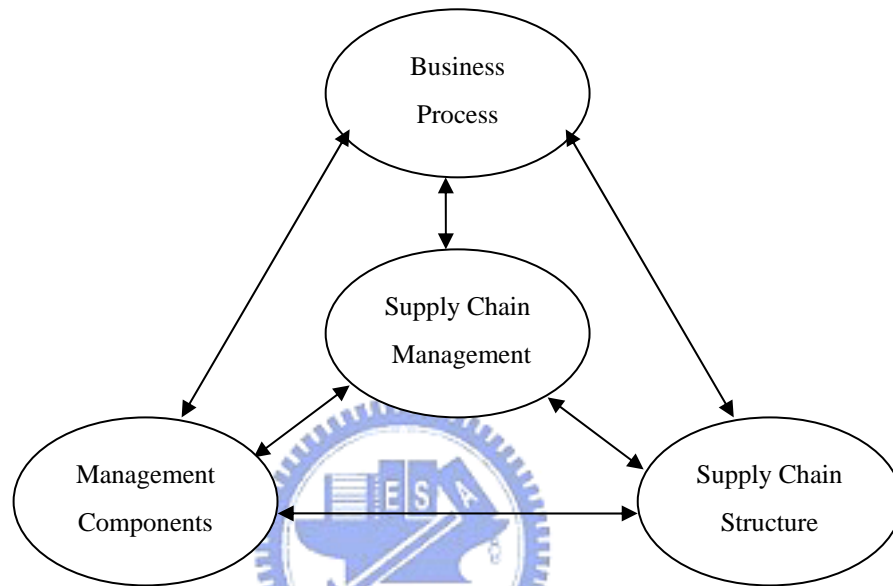
Figure 4 Elements in the Framework of Supply Chain Management
Source: Cooper et al., 1997

Cooper et al. (1997) presents components suggested in the supply chain literature (see Table 3), and these components span a range from strategic to operational, physical flow to information flow, tangible structures to organizational structures and cultures. From the conceptual framework of SCM, we find some part researchers who research in strategic perspective of SCM such as Tan (2001) merges the modern ear strategic approach to operations, materials, and logistics management, and the researchers discuss the role of "lean" (Leanness means developing a value stream to eliminate all waste, including time, and to enable a level schedule) and "agile" (Agility means using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile marketplace) that how to create cost-effective supply chains (Christopher & Towill, 2001; Naylor, Naim, & Berry, 1999)

Lee et al. (1997), (2004) they analyze and discuss four sources of the bullwhip effect in supply chain management: (1) demand signal processing, (2) rationing game, (3) order batching, and (4) price variations.

Gunasekaran et al. (2001) develop a framework for measuring the strategic, tactical and operational level performance in a supply chain.

Ballou et al. (2000) focus on the problems in managing inter-organizationally, and Davis (1993) presents the methodology to manage the supply chains more successfully.

The present paper analyzes the theory's heterogeneity by using co-citation and social network to identify the sub-areas of SCM fields.

Table 3 Key Components of Supply chain Management

A Supply Chain Management Perspective	A Business Process Reengineering Perspective
Houlihan (1985): ● Planning and control structure ● Product flow facility structure ● Information flow(IT-structure) ● Values and attitudes ● Organizational culture ● Management methods Stevens (1989) ● Process (work) structure ● Planning and control structure ● Product flow facility structure ● Information flow (IT-structure) ● Organization structure ● Management methods ● Power and leadership structure Cooper & Ellram (1990 & 1993): ● Process (work) structure ● Planning and control structure ● Product flow facility structure ● Information flow (IT-structure) ● Risk and reward structure ● Leadership structure ● Corporate philosophies	Hammer & Champy(1993): ● Process (work) structure ● Organization (job) structure ● Values and attitudes ● Management and evaluation structure Andrews & Stalick(1993): ● Process (work) structure ● Organization structure ● Technology structure ● Reward structure ● Measurement system ● Management methods ● Organizational culture ● Political power ● Individual belief systems Hewitt (1994): ● Process (work) structure ● Information flow (IT-structure) ● Decision authority MIT-model by Towers (1994): ● Process (work) structure ● Organization and skill structure ● Technology structure ● Values and behavior ● Management philosophies and decision structure

Source: Cooper et al., 1997

3. Research Methodology and Proposed Method

3.1 Research Methodology

3.1.1 Bibliographic and Co-citation

Figure 4 shows the essential different methodologies between Bibliographic coupling and Co-citation. When different authors cite one or more papers in common, papers are classified as bibliographically coupling. On the other hand, co-citation analysis is based primarily on identifying pairs of highly-cited papers. Bibliographic coupling, which is retrospective, is a fixed and permanent relationship, whereas co-citation, which is essentially a forward-looking perspective, changes as the interests and intellectual patterns of the field change (Garfield, 2001; Small, 1973).
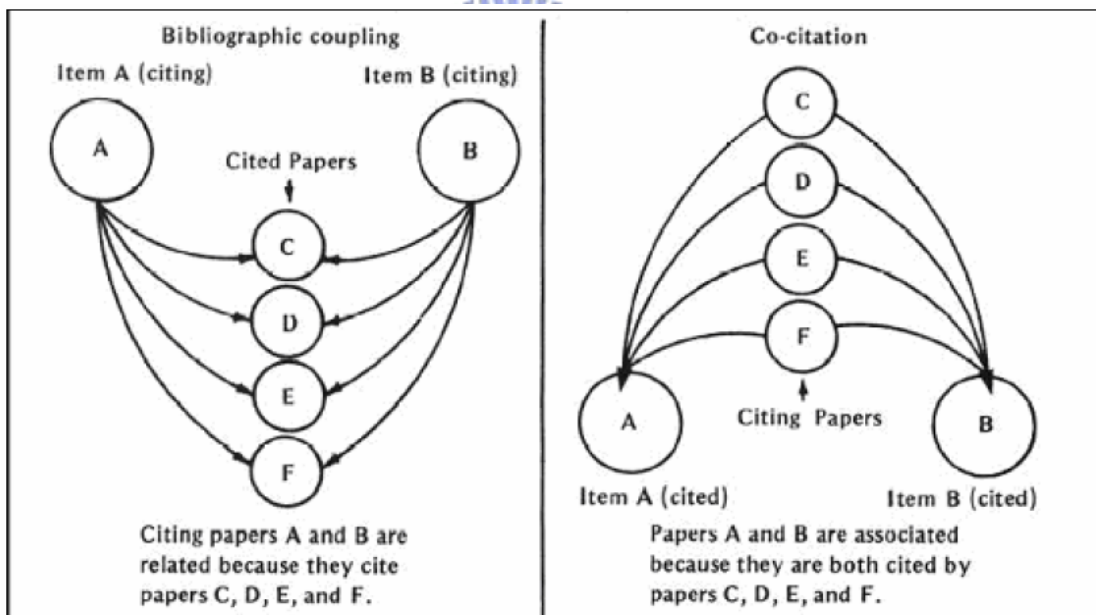
Figure 5 Bibliographic Coupling vs. Co-Citation

Source: Garfield E, 2001

Bibliographic Co-citation, which is a popular similarity measure used to establish a subject similarity between two items, has been used by a variety of researchers to establish relationships among documents. If item A and B of earlier literature are both cited by later literature, they could be said to be related to one another, even though they do not directly

refer to each other. If item A and B are both cited by many other items, then they would have a stronger relationship. The more items they are cited, the stronger relationship between them (Martins B. Class Co-citation).

The Co-citation method is defined as the frequency with which two documents or authors are cited together by the later literature in the same work. The aim of the Co-citation is to identify groups of closely related documents which can be considered as belonging to the same "research front" (Small, 1973). The co-citation is an objective, powerful and widely used methodology to study the structure of scientific disciplines and main trends for the researchers. In general, two items are considered as being co-citation when they appear together in the same reference list of a subsequent article (Zhao, 2006).

Author co-citation analysis (ACA), which moved the unit of analysis from co-cited documents to co-cited oeuvres, began at Drexel University in 1979. Oeuvres that called by French is a body of writing by a personal, and not the person himself (Dictionary). Based on co-citation frequencies of association between authors, ACA could be able to reveal pattern. It makes a prospective methodology for understanding the evolution of an academic discipline (White & McCain, 1998). To analyze the intellectual structure of science studies that ACA has been widely used in bibliometric technique as an analytical method. It is also used by researchers to investigate various phenomena, apply to identify authors from the same or similar research fields (He & Cheung Hui, 2002). To use ACA methodology, many researchers have already addressed the development (Culnan, 1986; He & Cheung Hui, 2002; White, 1990, 2003a, 2003b). It might contribute to the understanding of intellectual structure in the sciences and possibly in other areas to the extent that those areas rely on serial publications (White & Griffith, 1981).

In order to study the intellectual structure of this research field and infer to some characteristics of the corresponding scientific community, ACA researchers can use co-citation counts as similarity measures, which represent the proximity between authors. When we get the result of co-citation between authors, we can obtain the Pearson correlation, and use multivariate techniques and multidimensional scaling to analyze the data (White & Griffith, 1981; White & McCain, 1998).

In our study, there are two reasons for using a bibliometrical method: the first is to present a complete picture of the theory, and the second is to be objective, and then we can adopt the co-citation methodology to carry on empirical analysis of Supply Chain Management.

3.1.2 Social Network Analysis

A social network is a collection of people, each of whom is acquainted with some subset of the others. Such a network can be represented as a set of points (or vertices) denoting people, joined in pairs by lines (or edges) denoting acquaintance (Newman, 2001).Social network analysis (SNA) seeks to examine relationships ranging from single user, two-person ties, and small groups to the entire community network. Social network analysis approach can help to uncover the roles and importance of members in a community to understand the nature of a social network (Garton, Haythornthwaite, & Wellman, 1997).

A lot of work with social networks is primarily descriptive and/or exploratory, rather than confirmatory hypothesis testing. SNA focuses on using quantitative measurement to study the interaction among the members to profile the structure of the community and its members (Hanneman, 2001). Social network researchers measure network activity for a node by using the concept of degree where how many direct links between two or more nodes. The relationship between the centralities of all nodes can reveal much about the overall network structure (Orgnet.com). The definition of hub is a node in a graph with a high degree. Sometimes a node is connected to every other node in the graph. K-core is used to identify the strong ties in a network or community, and it is a set of nodes in a graph that each node in the set is connected to at least k other nodes in the set (ref. Graph theory). The more ties an actor has then, the more power they (may) have (Swan, 2001).

Social networks have been the subject of both empirical and theoretical study in the social sciences for at least 50 years. Stanley Milgram conducted a famous early empirical study of the structure of social networks (Newman, 2001). At present, social network analysts use two kinds of tools from mathematics to represent information about patterns of ties among social actors: graphs and matrices. It usually provides both a visual and a mathematical analysis of human relationships.

The theory of SNA emphasizes patterns of relationships among individuals and interprets the behavior of individuals in reference to their positions within social networks. A primary task of social network analysis is to use the international patterns among individuals to identify clusters or cliques within a network of individuals (Ennett & Bauman, 1993). A sub-graph that forms a clique is considered interesting because the high interconnectedness of the nodes suggests that the sub-graph forms an important structure.

3.2 Proposed Method

3.2.1 Objective

To address the issue of finding the core papers and sub-areas of the SCM, the data analysis was carried out by means of an exploratory factory analysis approach as this was customary in statistics. The quantitative data analysis was performed. Therefore, the social network analysis, factor analysis and multidimensional scaling were to do an empirical experiment. First, social network analysis was used to provide information about the interconnectedness of the papers due to the structure of the whole graph. In social network, an important focus is on the analysis of local structures to determine important actors and groups in the network (ref. Graph theory). Second, according to the first step result, we selected the core papers whose cited number is larger than 50 times to build a Co-citation matrix. Factors analysis which describes the internal structure of the covariance and correlation matrices concerned permits us to derive subfields from the co-citation matrix. It seeks to study correlations among a number of interrelated variables and to group them into a few highly descriptive factors (Lawley & Maxwell, 1962). Lastly, Multidimensional scaling (MDS), which is a data reduction procedure, would allow us to visualize the conceptual distance between various intellectual strands of research.

3.2.2 Build a Matrix

We selected core papers and assigned numbers to identify each of them. Then, in order to process data of papers, we created two database tables as in Figure Chien-Liang, 2007). The first one was "citation" table in which contained three attributes: (1) "Serial", which was the primary key, represented the serial numbers of the supply chain management core papers; (2) "paperserial", cited one of the core papers, and represented the serial numbers of papers; (3) "subserial", which had value the same as "Serial". And, the second one was "subpapers" table which contained two attributes: (1) "Serial" attribute, which was a foreign key of

"citation" table, represented a serial number of papers which cited core papers. (2) "Data" attribute stored the metadata about papers in the "citation" table.

Citation		Subpapers	
Serial		Serial	
paperserial		Data	
subserial			
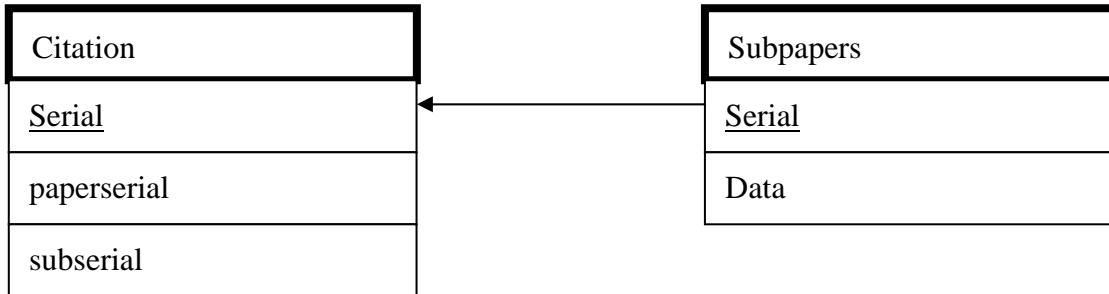
Figure 6 Table Schema
Source: Chien-Liang Chen, 2007

For example, we had two core papers, P1, P2 and two groups of citing papers which cited P1 and P2, respectively. In order to find identical citing papers between two groups, we followed the steps described in Figure 7. First, we set the value of co-citation number to zero. Then for each identical citing paper found, we increased co-citation number by one. Finally, we would get the result of co-citation number.
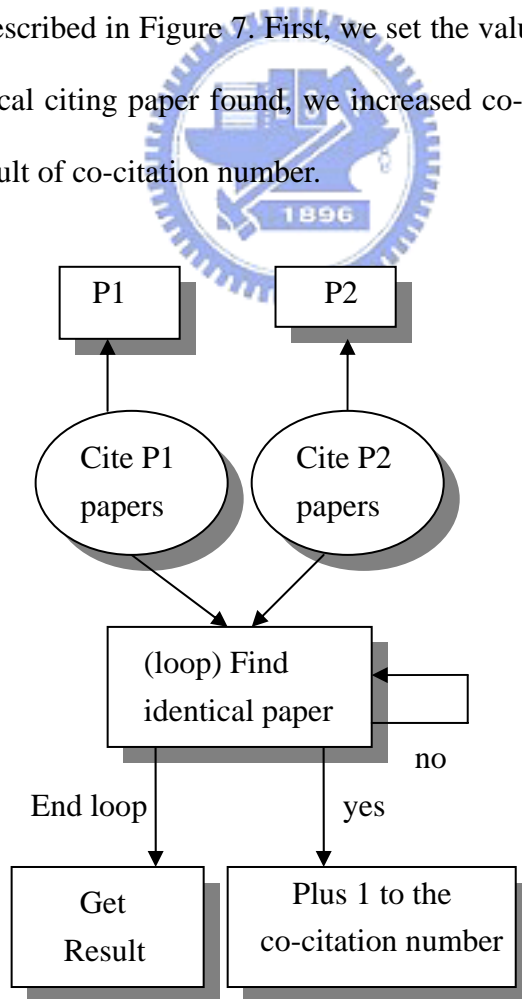
Figure 7 Getting co-citation number process

3.2.3 Research Method

The research method of this study is described in Figure 8. The steps of co-citation methodology is followed by White and Griffith in their published paper (White & Griffith, 1981), then we use social network analysis to find the core papers of SCM.
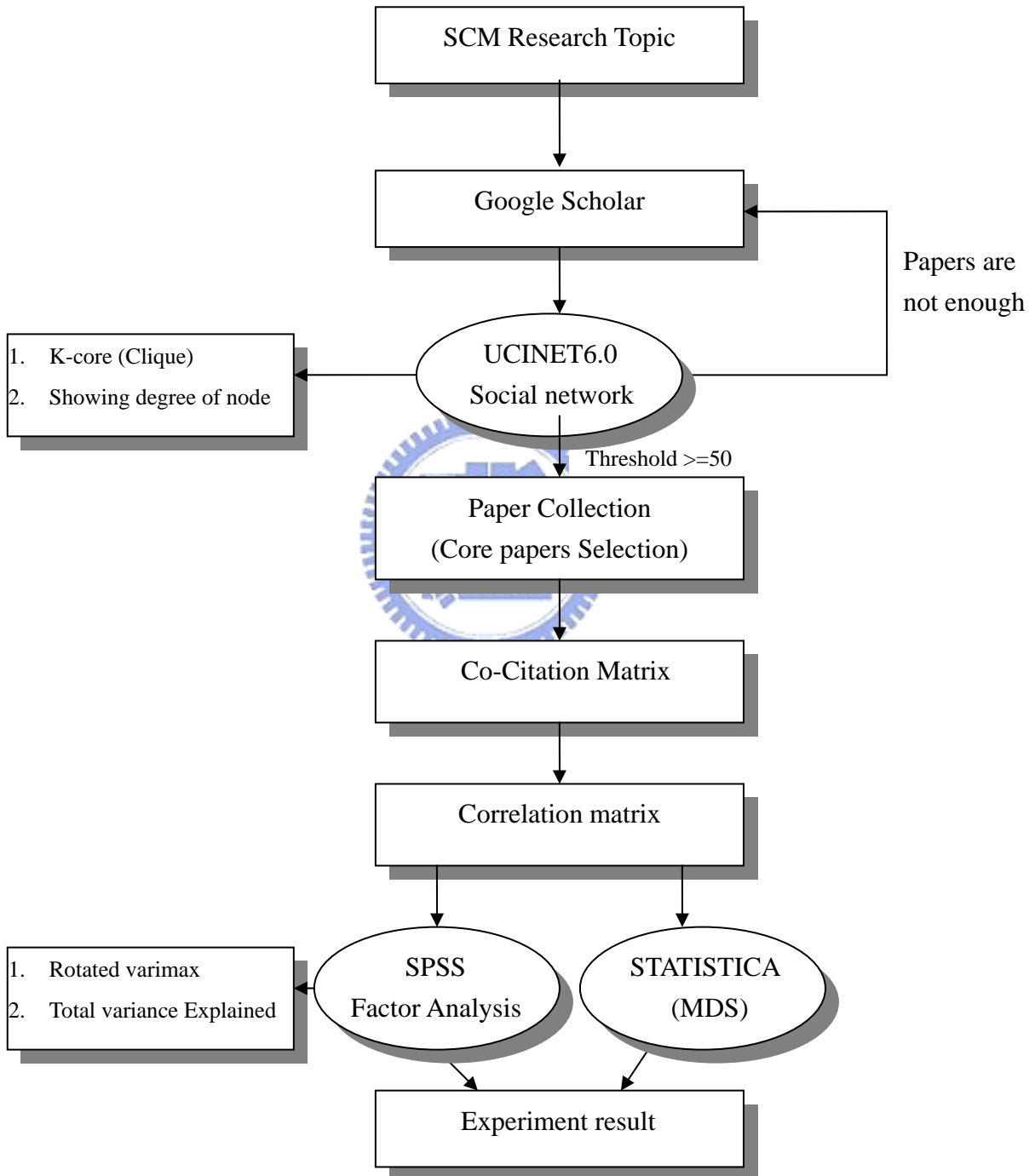
Figure 8 Research Method

4. Experiment Result

4.1 Data Collection

Data were collected primarily by means of a cited number, year and authors of papers from the Google scholar search engine (http://scholar.google.com). We had collected 178 source documents in Google scholar altogether to be our dataset. The cited numbers of these papers were between 10 to 1308 times. In order to cover all the development within SCM field and to find the core papers of SCM, there are no strict and fast rules, but the subjectivity inherence in the selection of SCM documents should be limited on their significant contributions to the field. We selected all papers which had related to SCM, and collected as many as core papers as possible.

4.1.1 Selection of Documents

In this study by running social network analysis latter, a list of 48 papers (see Table 4, involved three books, which were [v37] [v38] [v39]) was determined to be the core papers in our dataset and others were eliminated. Then, we found out the 48 source articles which had a total of 14478 citations, and the number of citations of these papers was between 50 to 1308 times in Google scholar. All of data (number of citations per paper) were downloaded from Google Scholar on May 10th, 2008. The research on an empirical study involved 48 core papers. In order to cover all the developments within the theory, our objective was to form a core as large as possible and selected core data of a theory or discipline is a critical stage in the process.

The list of SCM documents' result is shown in Table 4. The "Title" means the paper name, the "Count of Citation" means how many papers have already cited itself and the "No." is just the variable name for our research analysis.

4.1.2 Retrieval of Co-citation Data

The citation counts of SCM documents were collected from the Google scholar search engine. We used "Supply Chain" or "Supply Chain Management" as the keyword/subject to determine which documents were the most cited fellows. It was difficulty to determine a core paper dataset. Once this core set of SCM documents was identified, it was necessary to limit search terms to avoid retrieving misty subjects.

4.1.3 Central Core papers

The core papers allow a delimitation of the area under study on the basis that a scientific paper can be included when it cites one or more such source papers (Acedo, Barroso, & Galan, 2006). The most widely used criterion is the number of cites of papers, therefore, we take the most significant works representing the study field to be the core documents during the factor analysis and multidimensional scaling.

In this study, because of SCM being a field over the past decades, so we primarily collected data by means of a cited number, year and authors of papers. Some part core papers belong to Science Citation Index (SCI) or Social Sciences Citation Index (SSCI). The core papers represent assemblies' documents which share SCM subject, theory, or common methodology and describe current investigation. In addition, by using co-citation method, the more coherent and integrated discipline or sub-areas of SCM is the more scientific community determined.

Table 4 Core paper list with assigned numbers

No.	Title	Count of citations	Impact Factor (2007)
v01	Supply Chain Management: A Strategic Perspective (Bechtel & Jayaram, 1997)	239	--
v02	Supply Chain Management: More Than a New Name for Logistics (Cooper et al., 1997)	531	--
v03	Supply Chain Redesign (Hewitt, 1994)	76	--
v04	Characteristics of Supply Chain Management and the Implications for Purchasing and Logistics Strategy (Cooper & Ellram, 1993)	259	--
v05	Supply Chain Management : Implementation Issues and Research Opportunities (Lambert & Cooper, 2000)	387	--
v06	Issues in Supply Chain Management (Lambert & Cooper, 2000)	443	0.911
v07	The Role of the Internet in Supply Chain Management (Lancioni et al., 2000)	172	0.911
v08	The Bullwhip Effect in Supply Chains (Lee, Padmanabhan, & Whang, 1997)	934	0.849
v09	Information Distortion in a Supply Chain: The Bullwhip Effect (Lee, Padmanabhan, & Whang, 2004)	1308	1.931
v10	Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information (Chen, Drezner, Ryan, & Simchi-Levi, 2000)	468	1.931
v11	Supply chain design and analysis: Models and methods (Beamon, 1998)	380	0.995
v12	An empirical investigation into supply chain management: A perspective on partnerships (Spekman, Kamauff Jr, & Myhr, 1998)	237	--
v13	Defining supply chain management (Mentzer et al., 2001)	249	--
v14	A framework of supply chain management literature (Tan, 2001)	200	--
v15	Defining supply chain management: a historical perspective and practical guidelines (Lummus & Vokurka, 1999)	132	--
v16	Supply Chain Inventory Management and the Value of Shared Information (Cachon & Fisher, 2000)	448	1.931
v17	The Value of Information Sharing in a Two-Level Supply Chain (Lee, So, & Tang, 2000)	438	1.931
v18	Supply chain partnerships: Opportunities for operations research (Maloni & Benton, 1997)	234	1.096
v19	The four roles of supply chain management in construction (Vrijhoef & Koskela, 2000)	106	--
v20	Supply chain postponement and speculation strategies: How to choose the right strategy (Pagh & Cooper, 1998)	152	--
v21	Performance measures and metrics in a supply chain environment (Gunasekaran, Patel, & Tirtiroglu, 2001)	227	1.054
v22	The Agile Supply Chain Competing in Volatile Markets (Christopher, 2000)	233	0.911

No.	Title	Count of citations	Impact Factor (2007)
v23	An integrated model for the design of agile supply chains (Christopher & Towill, 2001)	121	--
v24	The rhetoric and reality of supply chain integration (Fawcett & Magnan, 2002)	86	--
v25	Ten mega-trends that will revolutionize supply chain logistics (Bowersox, Closs, & Stank, 2000)	113	--
v26	New Managerial Challenges from Supply Chain Opportunities (Ballou, Gilbert, & Mukherjee, 2000)	122	0.911
v27	Special research focus on supply chain linkages: Challenges for design and management in the 21st century (Mabert & Venkataramanan, 1998)	113	1.435
v28	Supply chain management in theory and practice: a passing fad or a fundamental change? (Chandra & Kumar, 2000)	81	--
v29	Causal linkages in supply chain management: An exploratory study of North American manufacturing firms (Narasimhan & Jayaram, 1998)	111	1.435
v30	Power, value and supply chain management (Cox, 1999)	129	0.913
v31	Leagility: Integrating the lean and agile manufacturing paradigms in the total supply chain (Naylor et al., 1999)	249	0.995
v32	A Total Cost/Value Model for Supply Chain Competitiveness (Cavinato, 1992)	96	--
v33	The supply chain management processes (Croxton, Garcia-Dastugue, Lambert, & Rogers, 2001)	76	--
v34	Effective supply chain management (Davis, 1993)	427	0.849
v35	Squaring lean supply with supply chain management (Lamming, 1996)	142	1.054
v36	Supply-Chain Management: The Industrial Organisation Perspective (Ellram, 1991)	192	--
v37	WHAT IS THE RIGHT SUPPLY CHAIN FOR YOUR PRODUCT? (Fisher, 2003)	905	--
v38	Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service (Christopher, 1999)	670	--
v39	Introduction to supply chain management (Handfield & Nichols, 1999)	616	--
v40	Supply chain management: an analytical framework for critical literature review (Croom et al., 2000)	220	--
v41	Supply Chain Management: Relationships, Chains and Networks (Harland, 1996)	282	1.534
v42	Integrating the supply chain (Stevens, 1989)	408	--
v43	The impact of supply chain integration on operating performance (Armistead & Mapes, 1993)	54	--
v44	International supply chain management (Houlihan, 1985)	277	--
v45	Supply chain migration from lean and functional to agile and customized (Christopher & Towill, 2000)	148	0.913

No.	Title	Count of citations	Impact Factor (2007)
v46	Supply chain management and advanced planning—basics, overview and challenges (Stadtler, 2005)	71	1.096
v47	Information sharing in a supply chain (Lee & Whang, 2000)	323	0.356
v48	The nature of interfirm partnering in supply chain management (Mentzer, Min, & Zacharia, 2000)	100	2.054

4.2 Results and discussion

UCINET 6.0 is a good helpful tool to deal with the complexity of social network. Using colors and shapes is a useful ways to convey information about what "type" of actor each node is. A good drawing can also help us to better understand how a particular "ego" (node) is "embedded" (connected to) its "neighborhood" (the actors that are connected to ego, and their connections to one another) and to the larger graph (Hanneman, 2001).

To illustrate, figure 9 depicts the papers of k-core analysis of social network. Subgroup can be identified by the measurements of component. So we can focus on the subgroup and the number of citations of papers. To use K-core function of UCINET 6.0 program would run to form the different color subgroup of social community.

On the left side, paper number 54, 74, 95, 157, 170 and 178 have no relationship with other members of the social network community. Other papers form the social network community of SCM. We could regard the strong relationship of papers which are inside the blue round shape as the hub.
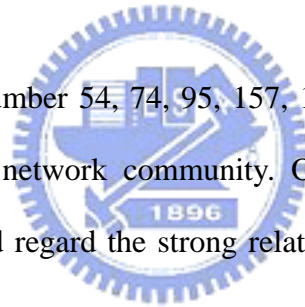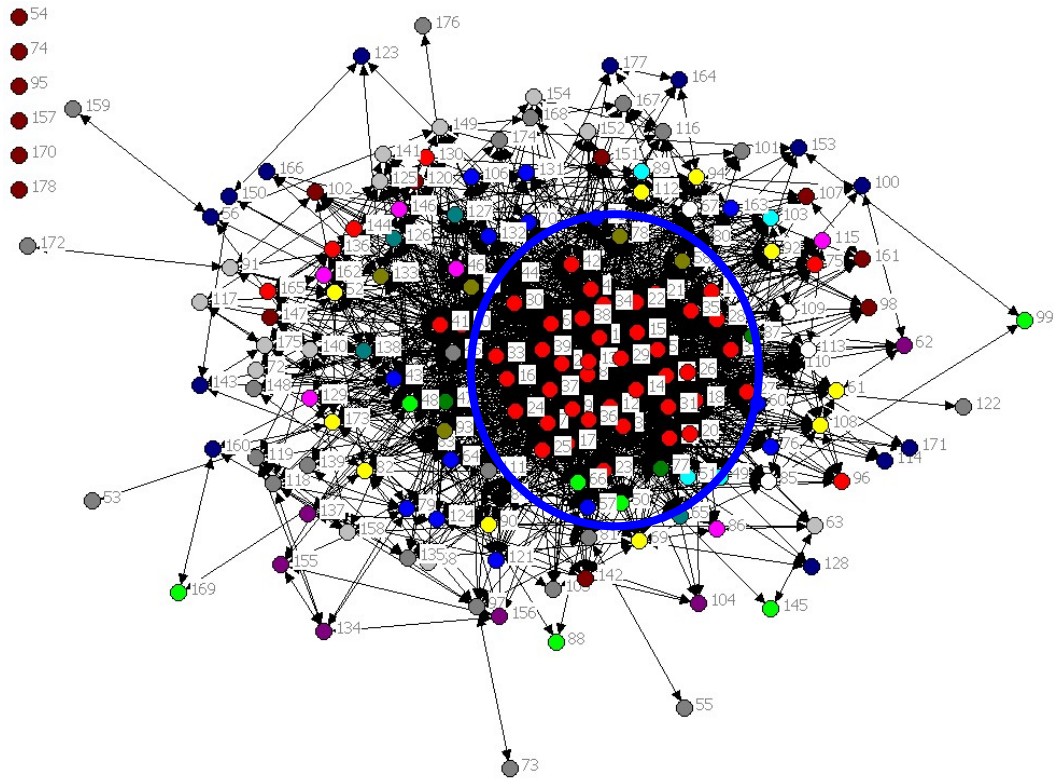
Figure 9 Papers of Social network analysis

UCINET 6.0 can use a node shape to deal with the complexity of social network. By using UCINET 6.0, we could find out the part in which each node has cited number larger than 50 times. As described in Figure 10, 48 nodes were surrounded by a blue round.

From the 48 core papers above, we built a row co-citation Matrix (see Figure 11). Then, we transformed the co-citation matrix into a Pearson correlation matrix. However, we could not find the weak relationships among papers.

Figure 10 Principal component of Social network

Figure 11 Co-citation Matrix:

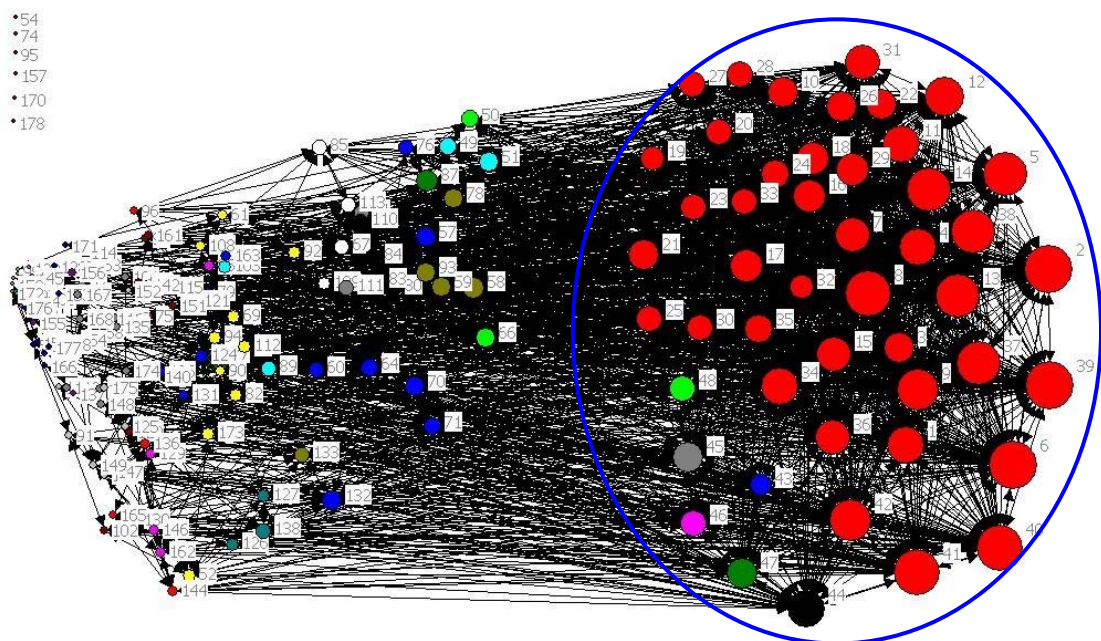| #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
1	0	96	24	46	41	23	3	29	17	1	11	22	25	12	7	7	6	5	4	9	13	7	6	11	2	10	13	7	5	2	7	17	7	25	13	18	36	64	37	3	1	3	0	2	2	0	0	0
2	96	0	30	76	109	85	15	41	27	8	28	26	51	30	24	10	14	8	6	15	15	11	9	14	5	25	17	13	10	5	13	18	25	38	15	39	54	123	74	1	3	8	0	7	2	2	2	1
3	24	30	0	21	11	10	1	10	2	2	3	4	3	3	4	3	4	0	0	4	4	2	1	1	1	2	5	4	3	1	2	3	4	6	1	13	11	19	12	1	1	7	0	4	0	0	1	1
4	46	76	21	0	36	39	7	21	13	4	13	28	23	10	12	4	4	6	6	6	9	8	2	6	2	13	15	7	12	4	4	16	3	33	9	22	18	62	38	1	2	6	0	4	1	0	2	1
5	41	109	11	36	0	60	10	34	33	7	30	21	41	24	21	3	6	12	4	16	14	21	6	16	5	31	16	10	14	5	15	7	24	25	8	23	44	79	45	4	3	7	0	2	2	2	3	0
6	23	85	10	39	60	0	24	17	12	4	30	27	35	39	12	12	11	15	8	3	17	20	7	10	6	30	15	9	12	9	14	7	11	19	7	16	44	65	48	5	3	3	1	1	3	2	3	1
7	3	15	1	7	10	24	0	8	7	5	8	5	6	11	3	6	4	4	1	0	4	8	1	0	3	9	3	0	5	1	4	3	4	5	0	2	10	12	17	2	1	0	2	0	1	0	0	1
8	29	41	10	21	34	17	8	0	260	167	34	20	20	10	12	73	100	26	5	11	16	16	13	4	11	11	11	10	10	1	17	8	3	52	5	21	103	65	47	1	2	7	2	5	3	3	8	4
9	17	27	2	13	33	12	7	260	0	218	36	11	19	12	5	127	147	21	3	15	15	9	7	3	10	3	11	2	15	2	28	5	2	45	8	12	78	59	37	2	1	6	0	3	2	4	7	0
10	1	8	2	4	7	4	5	167	218	0	13	2	5	5	5	93	128	9	1	0	9	4	0	0	1	8	3	1	3	0	4	4	1	5	0	3	16	9	13	0	0	3	0	2	1	0	8	1
11	11	28	3	13	30	30	8	34	36	13	0	9	9	12	11	6	6	22	4	5	19	9	3	1	1	5	11	5	9	2	10	1	5	28	10	8	19	35	22	1	3	1	0	2	2	0	0	0
12	22	26	4	28	21	27	5	20	11	2	9	0	16	12	16	5	3	4	0	4	7	6	7	10	8	7	5	8	5	14	6	8	5	14	18	6	26	28	19	1	2	1	0	3	1	0	0	0
13	25	51	3	23	41	35	6	20	19	5	9	16	0	21	13	11	10	3	2	3	6	10	11	21	7	9	3	7	4	4	10	4	8	10	5	13	26	40	29	4	2	3	0	1	1	1	0	1
14	12	30	3	10	24	39	11	10	12	5	12	12	21	0	13	4	10	3	5	4	6	9	4	6	3	5	4	3	7	6	9	3	6	15	5	6	19	18	16	8	2	4	1	0	2	1	2	0
15	7	24	4	12	21	12	3	12	5	5	11	16	13	13	0	7	3	3	1	3	10	5	2	7	0	4	3	19	5	8	5	6	2	5	2	5	12	18	17	1	1	1	0	0	2	1	0	0
16	7	10	3	4	3	12	6	73	127	93	6	5	11	4	7	0	174	6	0	0	3	4	1	2	4	15	4	6	7	0	4	0	1	7	0	4	31	13	23	1	0	1	0	1	0	1	16	1
17	6	14	4	4	6	11	4	100	147	128	6	3	10	10	3	174	0	9	1	0	5	5	5	1	3	6	1	2	5	2	6	0	4	4	0	0	23	15	18	1	1	4	0	2	0	1	15	1
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19	4	6	0	6	4	8	1	5	3	1	4	0	2	5	1	0	1	3	0	0	2	4	0	1	2	3	1	1	0	2	5	0	0	3	3	3	3	6	2	2	0	1	0	0	0	1	0	0
20	9	15	4	6	16	3	0	11	15	0	5	4	3	4	3	0	0	4	0	0	1	17	15	1	3	2	1	3	4	4	27	3	2	15	5	5	54	26	5	0	1	0	0	1	3	0	1	0
21	13	15	4	9	14	17	4	16	15	9	19	7	6	6	10	3	5	8	2	1	0	4	2	2	0	6	0	2	5	0	7	3	5	7	5	2	25	14	14	1	0	2	1	0	2	0	0	0
22	7	11	2	8	21	20	8	16	9	4	9	6	10	9	5	4	5	5	4	17	4	0	24	6	0	13	7	6	1	3	46	1	4	9	5	6	39	26	14	1	2	2	0	0	5	0	0	0
23	6	9	1	2	6	7	1	13	7	0	3	7	11	4	2	1	5	0	0	15	2	24	0	8	1	3	3	4	4	3	30	0	3	5	2	2	29	15	4	0	1	0	0	0	2	0	1	0
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25	2	5	1	2	5	6	3	11	10	1	1	8	7	3	0	4	3	3	2	3	0	0	1	3	0	2	2	1	8	2	1	0	3	7	0	0	12	19	7	0	1	0	1	1	0	1	0	0
26	10	25	2	13	31	30	9	11	3	8	5	7	9	5	4	15	6	4	3	2	6	13	3	8	2	0	11	1	4	3	2	0	3	11	6	6	11	15	18	2	0	2	0	1	1	0	0	1
27	13	17	5	15	16	15	3	11	11	3	11	5	3	4	3	4	1	5	1	1	0	7	3	0	2	11	0	1	18	0	2	4	0	18	5	12	7	10	12	0	0	3	0	0	0	0	0	0
28	7	13	4	7	10	9	0	10	2	1	5	8	7	3	19	6	2	1	1	3	2	6	4	9	1	1	1	0	3	3	2	1	4	3	1	1	8	9	6	0	2	0	0	0	0	0	0	0
29	5	10	3	12	14	12	5	10	15	3	9	5	4	7	5	7	5	0	0	4	5	1	4	2	8	4	18	3	0	1	4	2	0	14	2	6	22	12	17	1	2	4	1	0	0	1	0	1
30	2	5	1	4	5	9	1	1	2	0	2	14	4	6	8	0	2	0	2	4	0	3	3	5	2	3	0	3	1	0	3	5	1	2	8	2	11	15	7	3	1	2	0	0	1	1	0	1
31	7	13	2	4	15	14	4	17	28	4	10	6	10	9	5	4	6	6	5	27	7	46	30	5	1	2	2	2	4	3	0	1	2	11	8	3	88	35	11	0	0	4	0	0	8	2	2	0
32	17	18	3	16	7	7	3	8	5	4	1	8	4	3	6	0	0	4	0	3	3	1	0	2	0	0	4	1	2	5	1	0	0	11	4	12	10	18	8	1	0	1	0	2	0	0	0	0
33	7	25	4	3	24	11	4	3	2	1	5	5	8	6	2	1	4	0	0	2	5	4	3	6	3	3	0	4	0	1	2	0	0	1	1	2	10	15	5	1	1	1	1	0	0	0	1	0
34	25	38	6	33	25	19	5	52	45	5	28	14	10	15	5	7	4	14	3	15	7	9	5	3	7	11	18	3	14	2	11	11	1	0	19	30	68	41	39	3	1	7	0	7	3	1	2	2
35	13	15	1	9	8	7	0	5	8	0	10	18	5	5	2	0	0	2	3	5	5	2	2	0	6	5	1	2	8	8	4	1	19	0	13	16	24	8	1	2	1	0	2	1	0	0	0	
36	18	39	13	22	23	16	2	21	12	3	8	6	13	6	5	4	0	8	3	5	2	6	2	1	0	6	12	1	6	2	3	12	2	30	13	0	23	38	23	3	3	4	1	4	0	0	1	2
37	36	54	11	18	44	44	10	103	78	16	19	26	26	19	12	31	23	12	3	54	25	39	29	20	12	11	7	8	22	11	88	10	10	68	16	23	0	96	50	3	5	6	0	2	9	2	7	3
38	64	123	19	62	79	65	12	65	59	9	35	28	40	18	18	13	15	16	6	26	14	26	15	14	19	15	10	9	12	15	35	18	15	41	24	38	96	0	68	3	5	9	0	3	7	2	1	0
39	37	74	12	38	45	48	17	47	37	13	22	19	29	16	17	23	18	16	2	5	14	14	4	9	7	18	12	6	17	7	11	8	5	39	8	23	50	68	0	2	1	6	0	6	0	1	3	2
40	3	1	1	1	4	5	2	1	2	0	1	1	4	8	1	1	1	2	2	0	1	1	0	1	0	2	0	0	1	3	0	1	1	3	1	3	3	3	2	0	31	20	3	21	10	6	12	5
41	1	3	1	2	3	3	1	2	1	0	3	2	2	2	1	0	1	0	0	1	0	2	1	2	1	0	0	2	2	1	0	0	1	1	2	3	5	5	1	31	0	17	1	25	9	1	2	7
42	3	8	7	6	7	3	0	7	6	3	1	1	3	4	1	1	4	1	1	0	2	0	2	0	2	3	0	4	2	4	1	1	7	1	4	6	9	6	20	17	0	2	50	9	4	14	5	
43	0	0	0	0	0	1	2	2	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	1	0	0	1	0	0	0	3	1	2	0	0	0	2	3	0
44	2	7	4	4	2	1	0	5	3	2	2	3	1	0	0	1	2	3	0	1	0	0	0	0	1	1	0	0	0	0	0	2	0	7	2	4	2	3	6	21	25	50	0	0	6	1	10	3
45	2	2	0	1	2	3	1	3	2	1	2	1	1	2	2	0	0	2	0	3	2	5	2	1	0	1	0	0	0	1	8	0	0	3	1	0	9	7	0	10	9	9	0	6	0	3	5	1
46	0	2	0	0	2	2	0	3	4	0	0	0	1	1	1	1	1	0	1	0	0	0	0	0	1	0	0	0	0	1	2	0	0	1	0	0	2	2	1	6	1	4	2	1	3	0	2	0
47	0	2	1	2	3	3	0	8	7	8	0	0	0	2	0	16	15	1	0	1	0	0	1	1	0	0	0	0	1	0	2	0	1	2	0	1	7	1	3	12	2	14	3	10	5	2	0	7
48	0	1	1	1	0	1	1	4	0	1	0	0	1	0	0	1	1	2	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	2	3	0	2	5	7	5	0	3	1	0	7	0

Figure 11 Co-citation Matrix

Table 5 shows the results of the factorial analysis with varimax rotation which has the advantage of showing the loads on more than one factor and expresses the importance of the variables loading on a given factor. We rank the factor loadings on papers with a 0.40 minimum cutoff point. Six factors are extracted, and they explain 74.464% of total variance. The first factor accounts for 43.404% of the variance and the second for 10.583%. The other results are 9.008% (factor 3), 5.735% (factor 4), 2.931% (factor 5) and 2.803% (factor 6).

Table 5 Factor analysis with factor loadings at 0.40 or higher

No.	Authors	Year	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
v 13	Mentzer et al.	2001	.900					
v 04	Cooper & Ellram	1992	.897					
v 01	Bechtel & Jayaram	1997	.883					
v 36	Ellram	1991	.867					
v 03	Hewitt	1994	.866					
v 39	Handfield & Nichols	1999	.850					
v 05	Lambert & Cooper	2000	.842					
v 32	Cavinato	1992	.839					
v 12	Spekman, Kamauff Jr, & Myhr	1998	.838					
v 33	Croxton,Garcia-Dastugue, Lambert, & Rogers	2001	.836					
v 06	Lambert & Cooper	2000	.835					
v 26	Ballou, Gilbert, & Mukherjee	2000	.829					
v 14	Tan	2001	.817					
v 15	Lummus & Vokurka	1999	.806					
v 38	Christopher	1999	.778					
v 27	Mabert & Venkataramanan	1998	.760					
v 07	Lancioni et al.	2000	.753					
v 02	Cooper, Lambert, & Pagh	1997	.724					
v 11	Beamon	1998	.705	.401				
v 19	Vrijhoef & Koskela	2000	.700					
v 21	Gunasekaran, Patel, & Tirtiroglu	2001	.696		.426			
v 35	Lamming	1996	.688					
v 28	Chandra & Kumar	2000	.680					
v 24	Fawcett & Magnan	2002	.680		.460			
v 34	Davis	1993	.636		.456			
v 29	Narasimhan & Jayaram	1998	.625					
v 25	Bowersox, Closs, & Stank	2000	.554					
v 30	Cox	1999	.534		.444			
v 10	Chen, Drezner, Ryan, & Simchi-Levi	2000		.879				
v 17	Lee, So, & Tang	2000		.843				
v 16	Cachon & Fisher	2000		.840				
v 08	Lee, Padmanabhan, & Whang	1997		.793				
v 09	Lee, Padmanabhan, & Whang	2004		.730				
v 47	Lee & Whang	2000		.632			.427	
v 18	Maloni & Benton	1997	.511	.575				
v 20	Pagh & Cooper	1998			.856			
v 23	Christopher & Towill	2001			.826			
v 31	Naylor, Naim, & Berry	1999			.814			
v 22	Christopher	2000			.764			
v 44	Houlihan	1985				.884		
v 48	Mentzer, Min, & Zacharia	2000				.868		
v 43	Armistead & Mapes	1993				.733		
v 45	Christopher & Towill	2000			.530	.678		
v 40	Croom, Romano, & Giannakis	2000				.608		
v 46	Stadtler	2005				.601		

v 42	Stevens	1989			.880
v 41	Harland	1996		.441	.771
v 37	Fisher	2003	.462		.667

In Table 5, Factor 1 is the best primary factor, and the factor name is "Effective managed framework & strategic perspective of SCM". It includes 28 core papers. Many kinds of topics are covered in this factor. 28 core papers are divided to five groups.

The first group includes papers [v13], [v15] and [v39], and it introduces and defines the supply chain management.

The second group of papers [v1], [v4], [v14], [v30], [v33] and [v37] (overlaps in the Factor 6) focuses on strategic perspective such as Cooper & Ellram (1993) [v4] focus on purchasing and logistics strategy, Tan (2001) reviews the literature to merge the modern ear of a holistic and strategic approach to operations, materials, and logistics management, and Croxton et al. (2001) [v33] provide strategic and operational descriptions of each of the eight supply chain processes.

The third group of papers [v2], [v5], [v6], [v11], [v18] (overlaps in the Factor 2), [v26], [v27], [v28], [v32] and [v35] proposes the concept, theory, model, and guidance for business leaders and managers to overcome issues of challenges, and hope them to make a decision and manage the SCM well.

The fourth group of papers [v3], [v7], [v21], [v25] and [v34] focus on the effective and efficiency issues. Hewitt (1994) [v3] proposes supply chain redesign to improve the process efficiency and process effectiveness. Lancioni et al. (2000) [v7] discuss how the internet is being used in managing the major components of supply chains. Bowersox et al. (2000) [v21] indicate the ten mega-trends which would imply substantial change in logistics practices

among supply chain partners as they struggle to establish efficient, effective, and relevant product/service solutions for end-customer. Gunasekaran et al. (2001) [v21] and Davis (1993) [v34] address the performance measures in supply chain.

Other group of papers [v12], [v19], [v24] and [v29] is about empirical analysis. For instance, Spekman et al. (1998) [v12] indicate that buyers and sellers do not share a common voice and have moved slowly to bridge the gaps that separate them. Vrijhoef & Koskela (2000) [v19] identify that SCM has four specific roles in construction, and Narasimhan & Jayaram(1998) [v29] test their proposed conceptual framework to investigate the key causal linkages in SCM by using structural equation modeling techniques.

The Factor 2 "Information sharing issue in SCM" covers 7 papers [v8], [v9], [v10] [v16], [v17], [v18] and [v47], and another paper [v11] (locates in the Factor 2). The big reason for causing "bullwhip effect" is information distortion. The issue is related to bullwhip effect papers which are [v8], [v9], and [v10] papers. Lee et al. (1997) [v8], (2004) [v9] discuss the phenomenon of bullwhip effect in a supply chain. Chen et al. (2000) [v10] propose two factors which are demand forecasting and order lead time in their model, and assume them to cause the bullwhip effect. And they demonstrate that the bullwhip effect can be reduced, but not completely eliminated. Information system technology can now work a tight coordination between supply chain partners. The researches of [v16], [v17], [v18] and [v47] are all about information sharing. Information technique, such as Electronic Data Interchange (EDI) and Vendor-Managed-Inventory (VMI), plays an important role in SCM for sharing information. Cachon & Fisher (2000) [v16] hope to improve increasing delivery frequency by reducing shipment batch sizes, and Lee et al. (2000) [v17] hope to provide significant inventory reduction and cost savings to the manufacturer, Beamon (1998) [v11] provides a focused review of literature in multi-stage supply chain modeling, and it addresses the demand

distortion and variance amplification issues of supply chain modeling.

The Factor 3 "Agile and lean SCM's strategies" includes [v20], [v22], [v23] and [v31] papers, and other papers [v21], [v24], [v30] and [v34] which is primarily located in the Factor1. Pagh & Cooper (1998) [20] identify a framework for selecting postponement and speculation strategies to achieve delivery of products in a timely and cost-effective manner. Christopher (2000) [v22] suggests that the key to survive in these changed conditions is through "agility", in particular, by the creation of responsive supply chains. Christopher et al. (2001) [v23] and Naylor et al. (1999) [v31] indicate the role of "lean" and "agile" into supply chains. Cox (1999) [v30] indicates a case which makes for understanding supply chains from a strategic as well as from an operational perspective. Papers [v21] and [v34] propose a framework for measuring the performance of supply chain management. Christopher & Towill (2000) [v45] propose a cyclic migratory model which describes the PC supply chain attributes during its evolution from traditional to its present customized "leagile" operation. As have described from above statements, according to the business adopting different strategic of SCM would result different performance for managing the supply chain management.

The Factor 4 "Integrated evolution of SCM" owns 6 papers which are [v40], [v43], [v44], [v45], [v46] and [v48]. Croom et al. (2000) [v40] recognize that developments in SCM require multi-disciplinarity. Armistead & Mapes (1993) [v43] investigate the contribution of new manufacturing techniques and approaches to increase integration across the value chain on manufacturing performance. Houlihan (1985) [44] describes the approaches how to manage change in international chains. Christopher & Towill (2000) [v45] encourage "supply chain migration from lean and functional to agile and customized". Stadtler (2005)[v46] points out interdisciplinary research incorporating computer science, accounting and

organizational theory, etc., for their great progress in modeling and solution capabilities. Mentzer et al. (2000) [48] provides an inclusive "partnering" phenomenon with the environmental pressures, antecedents, orientation and consequences of strategic and operational partnering for vertical relationships within retail supply chains.

The Factor 5 "Collaborative Supply Chain" involves papers: [v41] and [v42], and paper [v47] which locates in the Factor 2. Harland (1996) [v41] summarizes the system approach that how to manage relationships, chains and networks in SCM. Stevens (1989)[v42] points out involving some degree of collaboration to solve bottlenecks in the supply chain, and overcome bumps in demand or supply. Lee & Whang (2000) [v47] describe the types of information shared because it is a basic enabler for supply chain partners to work in tight coordination.

Finally, the Factor 6 is "Choosing right supply chain". Fisher (2003) [v37] indicates the cause of plaguing problems, which many supply chains is a mismatch between the type of product (they are either primarily functional or primarily innovative) and the type of supply chain (they are efficient supply of functional products and responsive supply of innovative product).

Table 6 Factor Topics

Factor 1:	Effective managed framework & strategic perspective of SCM
Factor 2:	Information sharing issues in SCM
Factor 3:	Agile and lean SCM's strategies
Factor 4:	Integrated evolution of SCM
Factor 5:	Collaborative Supply Chain
Factor 6:	Choosing right supply chain

In Figure 12, by using social network analysis, we could group each factor inside a blue round shape. In total 178 papers, we measure the importance of each paper in the social network by using degree criterion, then for each factor encloses the papers whose degree is larger than or equal to 70 inside a green circle. We consider them maybe play important roles in the SCM. Factor 1 has papers [v2], [v5], [v6], [v12], [v13], [v14], [v38] and [v39]. Factor 2 has papers [v8] and [v9], Factor 4 has paper [v40], Factor 5 has papers [v41] and [v42], and Factor 6 has paper [v37].
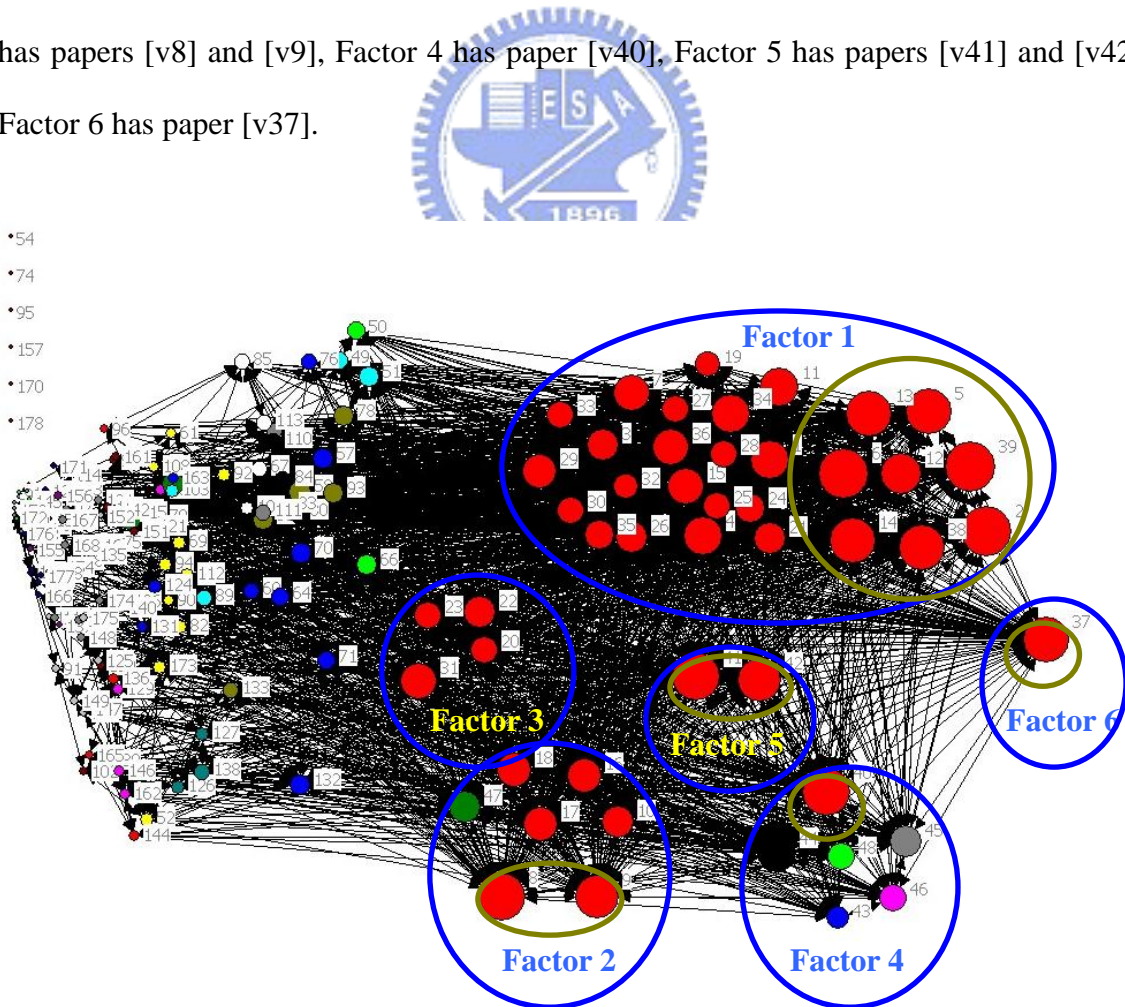
Figure 12 Factors of Social network

After comparing the results of Figure 12 and Figure 13, we found that the papers [v2], [v5], [v6], [v8], [v9], [v13], [v14], [v37], [v38] and [v39] are in the red round shape in the center of Figure 13. Furthermore, by double checking the results of high importance of papers, we could find these main trends papers which play important roles in SCM field ([v12] and [v40] are excluded). However, others papers [v41] and [v42] have high importance in minor trends papers.

In Figure 13, Factor 1 locates in quadrant II, III, IV, Factor 2 locates quadrant I, Factor3 locates in IV, Factor 4 and Factor 5 locate in quadrant I and IV and Factor6 locates in III. Factor 1, Factor 3 and Factor 6 are about "effective framework or strategic perspective of SCM", and the topics of SCM of Factor 4, Factor 5 are related to "integration and collaboration of SCM". Therefore, we learn that Factor 2 plays as a bridge between the group1 (includes Factor1, Factor3 and Factor 6) and group2 (includes Factor 4 and Factor 5). From the above result, we could see the critical role of information sharing issues in the inter-relationships between a company and its collaborative participants, and the intra-relationships among the divisions in a company.

The multidimensional analysis provides a graphic vision of the different trends. In Figure 13, the y-axis shows the division between "The framework and strategic perspective of SCM" trends and "Information sharing & Integration of SCM" trends. We name the "Information sharing & Integration of SCM" in which there are three kinds of factors (which are Factor 2 "Information sharing issues in SCM", Factor 4 "Integrated evolution of SCM", and Factor 5 "Collaborative Supply Chain") in the right-hand side. Then we name the "The framework and strategic perspective of SCM" in which also has other three kinds of factors (which are Factor 1 "Effective managed framework & strategic perspective of SCM", Factor 3 "Agile and lean SCM's strategies" and Factor 6 "Choosing right supply chain") in the left-hand side.

Figure 13 Multidimensional Scaling

5. Conclusion and Future Works

5.1 Conclusion

The study combines exploratory factor analysis and social network analysis for SCM to carry an empirical study. We hope that based on our research results to help specialists easily realize the main trends, understand of intellectual structure and movement in the SCM and in other areas. According to this study experiment results, we can find the three findings which are worth summarizing below:

First, by using social network analysis and the threshold of the cited number defined, we found the core papers of SCM field to do factor analysis. The factor analysis extracted six factors, which are "Effective managed framework & strategic perspective of SCM", "Information sharing issues in SCM", "Agile and lean SCM's strategies", "Integrated evolution of SCM", "Collaborative Supply Chain" and "Choosing right supply chain". We recognized the main trends were factor 1, factor 2, factor 3 and factor 4, and the minor trends were factor 5 and factor 6.

Second, comparing results from factor analysis and social network analysis, we leant the variable numbers of paper [v2], [v5], [v6], [v8], [v9], [v13], [v14], [v37], [v38] and [v39] had higher importance of main trends papers in SCM fields. While others papers [v41] and [v42] had high importance in minor trends papers. Based on these papers, the specialists would extend the topic and discuss the issues of SCM

Lastly, by multidimensional analysis (MDS) providing a graphic vision of the different trends, we saw that y-axis made a clear division between "The framework and strategic perspective of SCM" trends in the left-hand side and "Information sharing & Integration of SCM" trends in the right-hand-side. We could also match these papers with the MDS map to

see which quadrant they belonged to and the topics they related to. In addition, the other worth point was that "information sharing issues" played a critical bridge between the group1 (which are Factor1, Factor 3 and Factor 6) and group 2 (which are Factor 4 and Factor 5).

Researchers might benefit from these findings for their future studies. However, this study is only the first exciting step. Therefore, future researches are obviously required.

5.2 Future works

There are some limitations in our research, yet they also points out new possibilities for future research.

1. To collect more papers: This method of investigation is not without problems, but it still lacks enough sample core papers to do analyze, in the future research, we can collect more sample papers of SCM fields to do an experiment. Maybe the larger the pool of core papers, then the more reliable the results is, and the result of Social network analysis maybe have more findings.

2. To use other search terms about SCM: In our study we only use two search terms which are "Supply Chain" and "Supply Chain management". The title of our all core papers has Supply Chain or Supply chain management keywords. In addition, many other papers might use other search terms as related to SCM fields, and they do not use our search terms to be keywords. In the future research, we can investigate more search terms to find more core papers of SCM field in order to make a precise exploratory analysis.

3. To expand other criterions to measure the relationships of papers in SCM: In this work, we use degree criterion of Social network analysis to measure the relationships among the papers. For the future work, we could add others criterions such as density, closeness and betweenness to measure the network, group and the individual/node position status related to other nodes (Hanneman, 2001).

6. References

Acedo, F. J., Barroso, C., & Galan, J. L. (2006). The resource-based theory: Dissemination and main trends. *Strategic Management Journal, 27*(7), 621-636.

Armistead, C. G., & Mapes, J. (1993). The impact of supply chain integration on operating performance. *Logistics Information Management, 6*(4), 9-14.

Ballou, R. H., Gilbert, S. M., & Mukherjee, A. (2000). New Managerial Challenges from Supply Chain Opportunities. *Industrial Marketing Management, 29*(1), 7-18.

Beamon, B. M. (1998). Supply chain design and analysis: Models and methods. *International Journal of Production Economics, 55*(3), 281-294.

Bechtel, C., & Jayaram, J. (1997). Supply Chain Management: A Strategic Perspective. *International Journal of Logistics Management, 8*(1), 15-34.

Bowersox, D. J., Closs, D. J., & Stank, T. P. (2000). Ten mega-trends that will revolutionize supply chain logistics. *Journal of Business Logistics, 21*(2), 1-16.

Cachon, G. P., & Fisher, M. (2000). Supply Chain Inventory Management and the Value of Shared Information. *Management Science, 46*(8), 1032-1048.

Cavinato, J. L. (1992). A total cost/value model for supply chain competitiveness. *Journal of Business Logistics, 13*(2), 285-301.

Chandra, C., & Kumar, S. (2000). Supply chain management in theory and practice: a passing fad or a fundamental change? *Industrial Management and Data Systems, 100*(3), 100-113.

Chen, F., Drezner, Z., Ryan, J. K., & Simchi-Levi, D. (2000). Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times, and Information. *Management Science, 46*(3), 436-443.

Christopher, M. (1999). Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service. *International Journal of Logistics Research and Applications, 2*(1), 103-103.

Christopher, M. (2000). The Agile Supply Chain Competing in Volatile Markets. *Industrial Marketing Management, 29*(1), 37-44.

Christopher, M., & Towill, D. (2001). An integrated model for the design of agile supply chains. *Management, 31*(4).

Christopher, M., & Towill, D. R. (2000). Supply chain migration from lean and functional to agile and customised. *Supply Chain Management: An International Journal, 5*(4), 206-213.

Cooper, M. C., & Ellram, L. M. (1993). Characteristics of Supply Chain Management and the Implications for Purchasing and Logistics Strategy. *International Journal of Logistics Management, 4*(2), 13-24.

Cooper, M. C., Lambert, D. M., & Pagh, J. D. (1997). Supply Chain Management: More Than a New Name for Logistics. *International Journal of Logistics Management, 8*(1), 1-14.

Cox, A. (1999). Power, value and supply chain management. *Supply Chain Management: An International Journal, 4*(4), 167-175.

Croom, S., Romano, P., & Giannakis, M. (2000). Supply chain management: an analytical framework for critical literature review. *European Journal of Purchasing and Supply Management, 6*(1), 67-83.

Croxton, K. L., Garcia-Dastugue, S. J., Lambert, D. M., & Rogers, D. S. (2001). The Supply Chain Management Processes. *International Journal of Logistics Management, 12*(2), 13-36.

Culnan, M. J. (1986). The Intellectual Development of Management Information Systems, 1972-1982: A Co-Citation Analysis. *Management Science, 32*(2), 156-172.

Davis, T. (1993). Effective supply chain management. *Sloan Management Review, 34*(4), 35-46.

Ellram, L. M. (1991). Supply chain management: the industrial organization perspective. *International Journal of Physical Distribution and Logistics Management, 21*(1), 13-22.

Ennett, S. T., & Bauman, K. E. (1993). Peer group structure and adolescent cigarette smoking: a social network analysis. *Journal of Health and Social Behavior, 34*(3), 226-236.

Fawcett, S. E., & Magnan, G. M. (2002). The rhetoric and reality of supply chain integration. *Management, 32*(5), 339-361.

Fisher, M. L. (2003). WHAT IS THE RIGHT SUPPLY CHAIN FOR YOUR PRODUCT? *Operations Management: Critical Perspectives on Business and Management, 105*(1), 16.

Forrester, J. W. (1958). Industrial Dynamics: A Major Breakthrough for Decision Makers. *Harvard Business Review, 36*(4), 37-66.

Garfield, E. (2001). From bibliographic coupling to co-citation analysis via algorithmic historio-bibliography. *speech deliveredat DrexelUniversity, Philadelphia, PA, November, 27*.

Garton, L., Haythornthwaite, C., & Wellman, B. (1997). Studying Online Social Networks. *Journal of Computer-Mediated Communication, 3*(1).

Gunasekaran, A., Patel, C., & Tirtiroglu, E. (2001). Performance measures and metrics in a supply chain environment. *International Journal of Operations & Production Management, 21*(1/2), 71-87.

Handfield, R. B., & Nichols, E. L. (1999). *Introduction to supply chain management*: Prentice Hall Upper Saddle River, NJ.

Hanneman, R. A. (2001). Introduction to Social Network Methods. *URL: URL: http://faculty.*

ucr. edu/hanneman/SOC157/NETTEXT. pdf (accessed 31 May 2007).

Harland, C. M. (1996). Supply Chain Management: Relationships, Chains and Networks. *British Journal of Management, 7*(s1), 63-80.

He, Y., & Cheung Hui, S. (2002). Mining a Web Citation Database for author co-citation analysis. *Information Processing and Management, 38*(4), 491-508.

Hewitt, F. (1994). Supply Chain Redesign. *International Journal of Logistics Management, 5*(2), 1-10.

Houlihan, J. B. (1985). International supply chain management. *International Journal of Physical Distribution and Logistics Management, 15*(1), 22-38.

Lambert, D. M., & Cooper, M. C. (2000). Issues in Supply Chain Management. *Industrial Marketing Management, 29*(1), 65-83.

Lambert, D. M., Cooper, M. C., & Pagh, J. D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. *International Journal of Logistics Management, 9*(2), 1-20.

Lamming, R. (1996). Squaring lean supply with supply chain management. *International Journal of Operations & Production Management, 16*(2), 183-196.

Lancioni, R. A., Smith, M. F., & Oliva, T. A. (2000). The Role of the Internet in Supply Chain Management. *Industrial Marketing Management, 29*(1), 45-56.

Lawley, D. N., & Maxwell, A. E. (1962). Factor Analysis as a Statistical Method. *Statistician, 12*(3), 209-229.

Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The bullwhip effect in supply chains. *Sloan Management Review, 38*(3), 93-102.

Lee, H. L., Padmanabhan, V., & Whang, S. (2004). Information Distortion in a Supply Chain: The Bullwhip Effect. *Management Science, 50*(12 Supplement), 1875-1886.

Lee, H. L., So, K. C., & Tang, C. S. (2000). The Value of Information Sharing in a Two-Level Supply Chain. *Management Science, 46*(5), 626-643.

Lee, H. L., & Whang, S. (2000). Information sharing in a supply chain. *International Journal of Technology Management, 20*(3), 373-387.

Lummus, R. R., & Vokurka, R. J. (1999). Defining supply chain management: a historical perspective and practical guidelines. *Industrial Management and Data Systems, 99*(1), 11-17.

Mabert, V. A., & Venkataramanan, M. A. (1998). Special Research Focus on Supply Chain Linkages: Challenges for Design and Management in the 21st Century*. *Decision Sciences, 29*(3), 537-552.

Maloni, M. J., & Benton, W. C. (1997). Supply chain partnerships: Opportunities for operations research. *European Journal of Operational Research, 101*(3), 419-429.

McCain, K. W. (1990). Mapping Authors in Intellectual Space: A Technical Overview. *Journal of the American Society for Information Science, 41*(6), 433-443.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., et al. (2001). Defining supply chain management. *Journal of Business Logistics, 22*(2), 1-25.

Mentzer, J. T., Min, S., & Zacharia, Z. G. (2000). The nature of interfirm partnering in supply chain management. *Journal of Retailing, 76*(4), 549-568.

Narasimhan, R., & Jayaram, J. (1998). Causal Linkages in Supply Chain Management: An Exploratory Study of North American Manufacturing Firms. *Decision Sciences, 29*(3), 579-605.

Naylor, J. B., Naim, M. M., & Berry, D. (1999). Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain. *International Journal of Production Economics, 62*(1/2), 107-118.

New, S. J., & Payne, P. (1995). Research frameworks in logistics. *Management, 25*(10), 60-77.

Newman, M. E. J. (2001). The structure of scientific collaboration networks. *PNAS, 98*(2), 404-409.

Oliver, R. K., & Webber, M. D. (1992). Supply-chain management: logistics catches up with strategy. *Logistics: The Strategic Issues, Chapman & Hall, London*, 63-75.

Pagh, J. D., & Cooper, M. C. (1998). Supply chain postponement and speculation strategies: how to choose the right strategy. *Journal of Business Logistics, 19*(2), 13-33.

Price, D. J. (1965). NETWORKS OF SCIENTIFIC PAPERS. *Science, 149*, 510-515.

Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. *Journal of the American Society for Information Science, 24*(4), 265-269.

Spekman, R. E., Kamauff Jr, J. W., & Myhr, N. (1998). An empirical investigation into supply chain management. *Management, 28*(8), 630-650.

Stadtler, H. (2005). Supply chain management and advanced planning—basics, overview and challenges. *European Journal of Operational Research, 163*(3), 575-588.

Stevens, G. C. (1989). Integrating the supply chain. *International Journal of Physical Distribution & Logistics Management, 19*(8), 3-8.

Tan, K. C. (2001). A framework of supply chain management literature. *European Journal of Purchasing and Supply Management, 7*(1), 39-48.

Vrijhoef, R., & Koskela, L. (2000). The four roles of supply chain management in construction. *European Journal of Purchasing and Supply Management, 6*(3-4), 169-178.

White, H. D. (1990). Author co-citation analysis: Overview and defense. *Scholarly communication and bibliometrics*, 84–106.

White, H. D. (2003a). Author cocitation analysis and Pearson'sr. *Journal of the American Society for Information Science and Technology, 54*(13), 1250-1259.

White, H. D. (2003b). Pathfinder networks and author cocitation analysis: A remapping of

paradigmatic information scientists. *JASTIS, 54*(5), 423-434.

White, H. D., & Griffith, C. (1981). Author Cocitation: A Literature Measure of Intellectual Structure. *J. ASIS, 32*(3), 163-171.

White, H. D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972-1995. *Journal of the American Society for Information Science, 49*(4), 327-355.

Wilkinson, L. (1998). Multidimensional scaling. *Systat, 8*, 615-642.

Zhao, D. (2006). Towards all-author co-citation analysis. *Information Processing and Management, 42*(6), 1578-1591.