國立交通大學

資訊管理研究所

碩 士 論 文

The study of Collaborative Product Commerce Using

Co-citation Analysis and Social Network Analysis

應用引文分析和社會網絡分析方法於協同產品分析

之研究

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中 華 民 國 九 十 六 年 六 月

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A Thesis
Submitted to Institute of Information Management
College of Management
National Chiao Tung University
in Partial Fulfillment of the Requirements
for the Degree of
Master of Science
in

Information Management

June 2007

Hsinchu, Taiwan, Republic of China

中華民國九十六年六月

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ABSTRACT

This paper presents the analysis of Collaborative Product Commerce documents associated by using co-citation analysis and social network analysis. Co-citation is a new form of document coupling the frequency with which two documents are cited together. In this paper we report an experiment by using data from Google scholar search and Social Science Citation Index to identify clusters of highly interactive documents in the subject of Collaborative Product Commerce. They may provide a new approach to indexing and to the creation easier search CPC area.

The study discovers five core papers which imply the four documents provide insight into the theory's evolution and clarifies future research work in CPC field. The trend in the field focuses on organizational layer, included knowledge management, system problem solution, and collaborative mechanism design. The conclusion can provide future research direction for the researcher in this field.

Keywords: Collaborative Product Commerce, Co-Citation analysis, Social network analysis.

ACKNOWLEDGMENT

I would like to express my sincere appreciation to my advisor, Dr. Chyan Yang for his valuable guidance and patience during the two years period in Chiao-Tung University. Thank you to oral examination committeeman, professor Chen-Hua Fu, Li-Fen Liao, and Duen-Ren Liu for their important propounds suggestion. In addition, I am very thankful to my faculty members, Szu-Hui Wu, Andes Young and Chien-Liang Chen for their discussions, suggestions and help at all times.
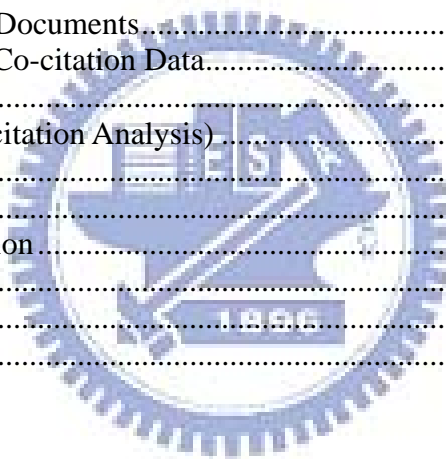
Finally, I want to deeply appreciate my family. They are the most important support behind me. Their love and encouragement with them were very constructive for me to accomplish this work.

<div align="right">

Joahanna Lee

June, 2007 at NCTU

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I. Introduction

Both bibliographic citations and co-citation in comprehensive papers have been used by a variety of researchers to establish relationships among documents. In this paper we report an experiment by using data from Google scholar search (google scholar search) and Social Science Citation Index (SSCI) to identify clusters of highly interactive documents in the subject of Collaborative Product Commerce (CPC). Unlike bibliographic coupling, which links source documents, co-citation links cited documents which are an acceptable indicator for the different information sources used.

The purpose of this paper is to define the coupling of CPC document references cited in the research works. The analysis of the references can be used to study the research fronts (Price DJ de Solla, 1965) and explore its relationship to other citation measures for identifying relationships by using an actual example from the CPC documents. The more the two documents are cited together, the closer the relationship 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).

Since this research study uses the co-citations or joint citations and social network analysis method that are based on frequently cited ulterior research works and individual network centralities, it is possible to infer that there must be some link between (Small H., 1974) CPC documents. By understanding analysis, researchers' processes and its outcomes help reveal the vitality and the evolution because it gives a sense of its future. In new field such as CPC, this understanding identifies the commitments that will serve as the foundation of the field as it matures.

In our case social network theory provides the conceptual framework and methodology for examining (Ennett S.T., Bauman K.E., 1993) CPC documents group connection. Individual document network centralities provide insight into the individual's location in the network (Orgnet.com). The present article uses UCINET 6.0 a social network analysis software package to applying the interrelationships by using CPC core documents.

This new approach, Collaborative product commerce (CPC), develops and services a product over its entire lifecycle. It is defined by the Aberdeen Group as a way to provide cross business process for each product to reduce time to market, get better quality and lower costs. CPC satisfies inter-enterprise and interdepartmental information sharing requirements that are involved in the supply-chain relationship, such as sellers, buyers, intermediaries and deliverers. It helps the company become tight and strong. In fact sharing the same database and application with other parties provides lower costs.

The present article uses the subject of CPC as the unit of sets documents associated with the Topical of 39 information papers. By statistical techniques these links between sets of subjects or documents allow the discovery of the most closed linked for CPC documents. Our co-citation analysis and social network analysis identifies the research fronts and the interconnections by the main CPC journals in this field.

II. Literature review

2.1 Collaborative Product Commerce

According to the Aberdeen Group proposal, the definition of CPC is an integrated suite of software and services; these software and services provide cross business process for each product, to become a singular, closed loop resolution schema (Aberdeen Group, 1999). The objective is to satisfy inter-enterprise and interdepartmental information sharing requirements, in order to reduce disparity between design, prototype, and monitor process. By making the entire design-chain process work more effectively, manufacturers can better capture innovation, reduce time to market, get better quality, and do it all faster and at lower costs (James Heppelmann, 2000).

Collaborative product commerce (CPC) is a relatively new approach to develop and service a product over its entire lifecycle. Some industry experts believe that CPC has the potential to dramatically compress the time it takes to field new product and reduce life-cycle costs of everything from aircraft to spacecraft (Theodore Farris II M, Wittmann Michael C, Hasty R., 2005). In recent years, CPC has received attention in Taiwan, China (Taiwan) as many industries tried to gain competitive advantage based on superior product design (Wu WH, Ho CF, 2005). The relationship sometimes further extends into a supply-chain relationship. Several entities are involved in the supply-chain relationship, such as sellers, buyers, intermediaries and deliverers. See Figure 1.
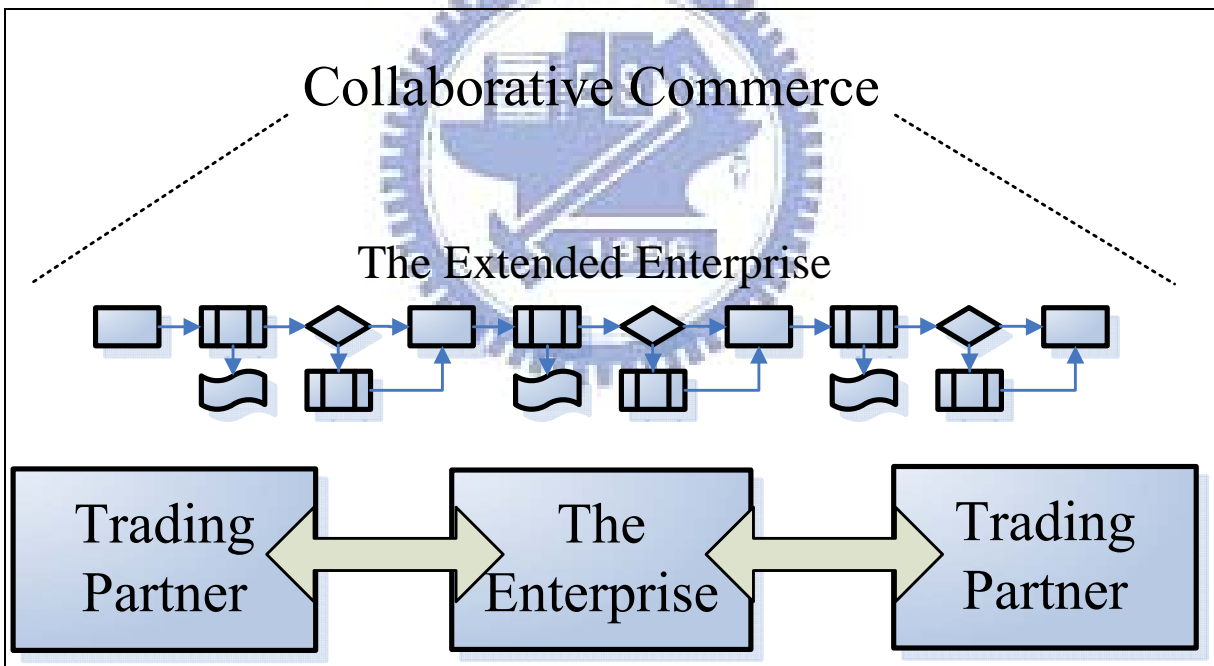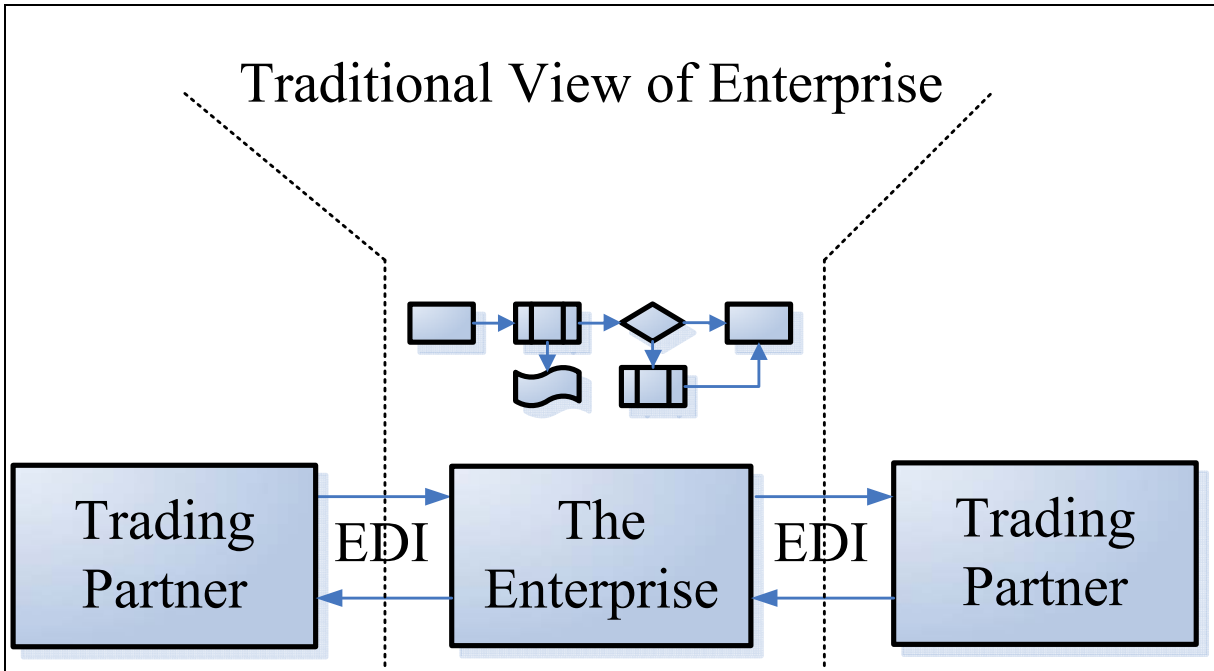
Figure 1 Tradition v.s Collaborative Commerce.
Source: Collaborative commerce, 2005

Collaborative commerce is a kind of business-to-business (B2B) application being used for communication, design, planning, information sharing, and information discovery. These collaborative activities are usually performed between supply chain partners as well as within an organization (Du TC, Li EY, Rau H, Lian GY, 2006). It (C-commerce) is essentially an

integration of e-commerce, knowledge management and collaboration technologies (Thuraisingham B, Gupta A, Bertino E, Ferrari E, 2002). The definition of c-commerce is the integrated explanations of multiple business associations, the concept that reflects the transaction in computers (Li X, Fan H, 2005).

Collaborative commerce (C-commerce) enables collaboration beyond traditional, predefined trading partners to innovative ways of solving business problems, by capturing complementary competencies in meeting customer demands in an efficient and flexible manner (Peterson k, Cecere L, 2001). Collaborative commerce is more than a transaction exchange: it is an intellectual-capital exchange (Carol M, 2001). To realize Collaborative commerce, organizations need to implement collaborative (electronic) business platforms and strategies. As relationships form, their collaborative nature should be built into the governance structures used to organize those relationships, without jeopardizing the strategic flexibility that is characteristic of c-commerce nets (Peterson RR, 2002).

CPC has the potential to put entire supply networks at an advantage over competing supply networks (Theodore Farris II M, Wittmann Michael C, Hasty R, 2005). According to Gartner Group, the application system of enterprises will be designed into c-commerce stage in coordination and will replace inflexible Web-based Supply Chain system in 2004 (Wu SH, 2004). See Figure 2.
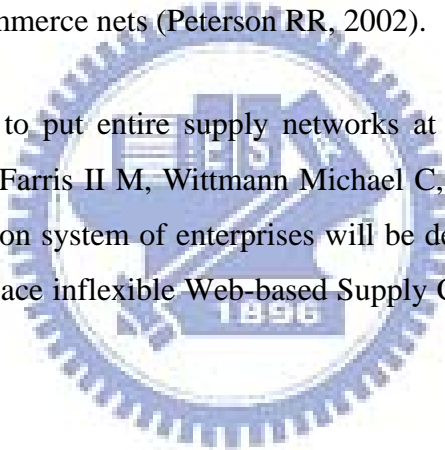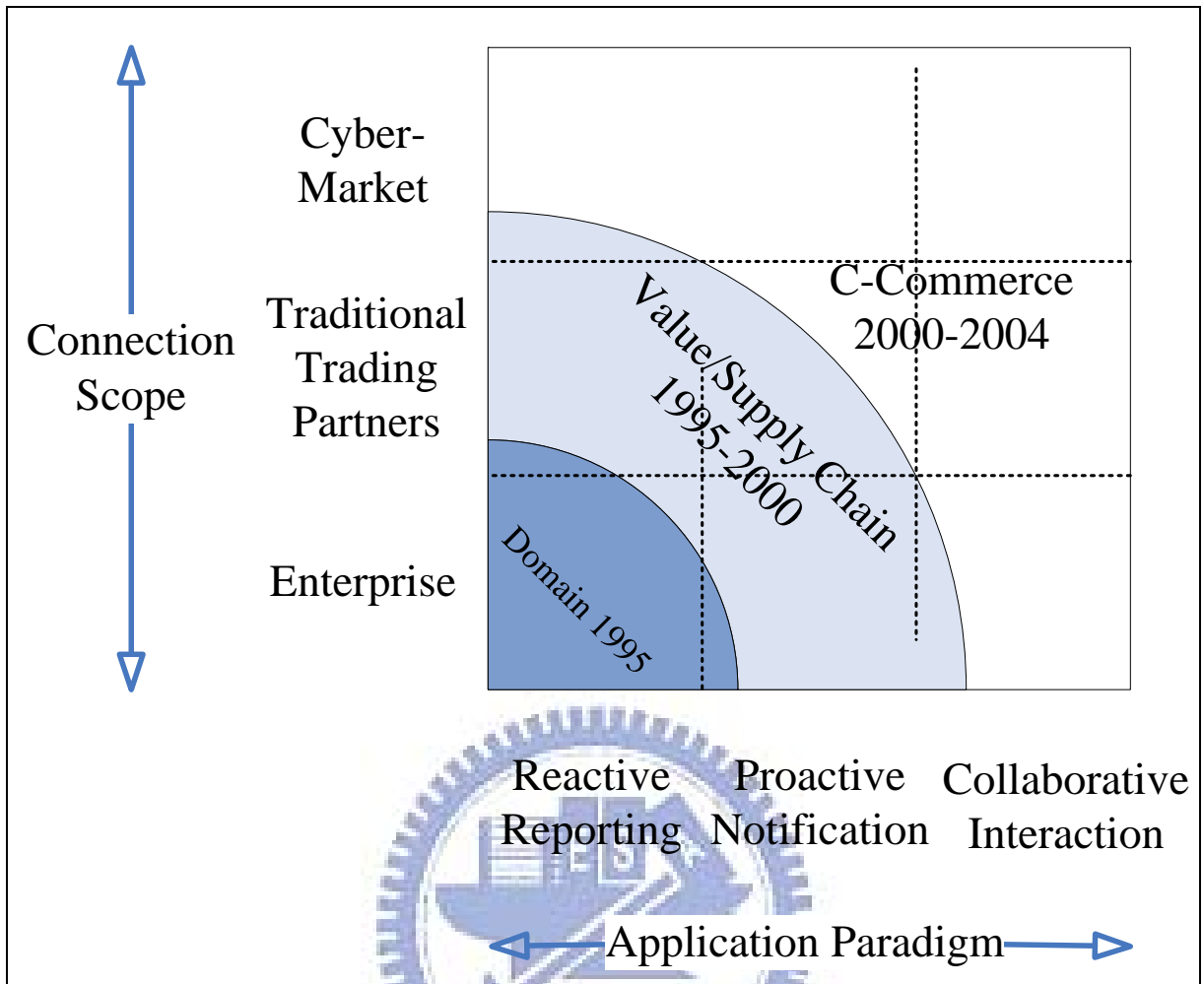
Figure 2 Business Application Evolution
Source : Wu SH, 2004

No matter what happens between interdepartmental or enterprise of companies, the coordination of commercial affairs such as Product design, making, sale, logistics, …etc. are all considered as the Collaborative commerce (Wu SH, 2004). See Figure 3.
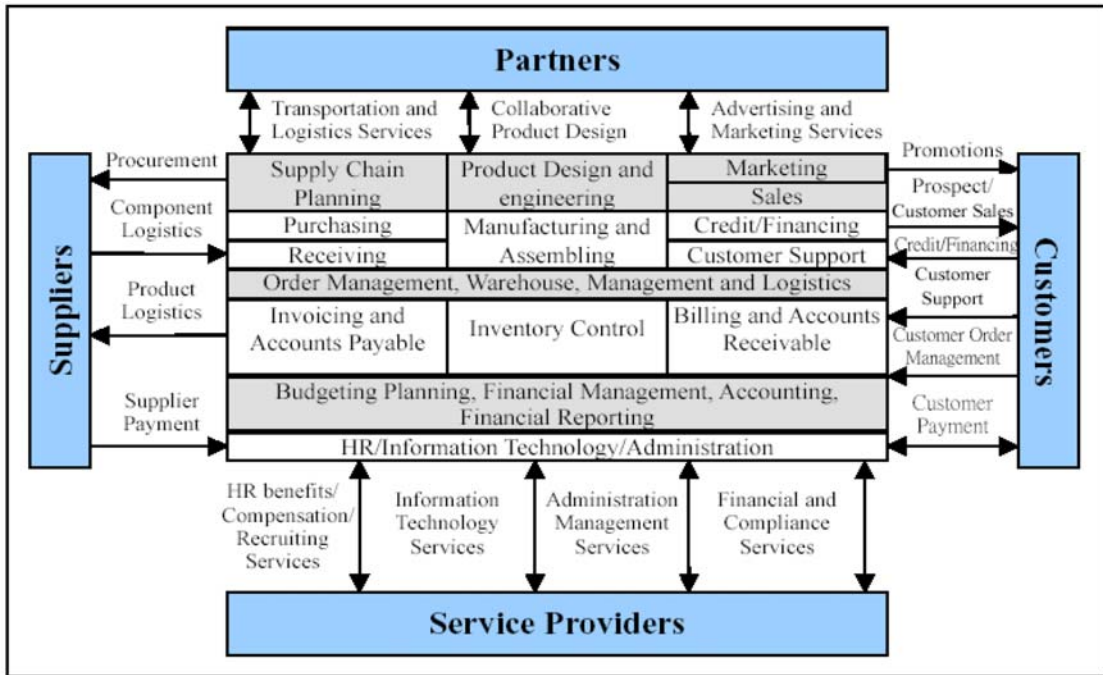
Figure 3 Collaborative Commerce for Coordination
Source : Wu SH, 2004

At the Highest level of Collaborative Commerce, a company is tightly integrating its databases and computer applications with those of suppliers, customers and/or business partners – or in fact is sharing the same database and application with those outside parties (A NerveWire, Inc., 2002). The main objective of this relationship is to share information with partners. Many collaborative models can be adopted in the collaborative commerce by sharing through intranet, extranet, and workflow. The present paper analyzes the theory's heterogeneity by using co-citation and social network to identify the CPC and approaches developed within it.

2.2 Co-citation Analysis

Author co-citation analysis (ACA) began at Drexel University in 1979. It moved the unit of analysis from co-cited documents to co-cited oeuvres-that is, to groups of documents by the same authors, as opposed to individual publications. ACA maps suggest the frequencies of author connections within a literature-information that may be useful for purposes of summarization or retrieval. The raw data, author co-citation counts, were gathered from Institute for Scientific Information (ISI) databases on the Dialog system. The work of the first decade was summed up in White; a companion piece, McCain, codified the methods (White HD, 2003). The strength of co-citation between two cited papers or books can be easily determined from a citation index much as the Science Citation index (SCI)(Small H, 1974). During the past 20 years, several mapmaking techniques have been tried in ACA (White HD, 2003)

ACA is one particular type of co-citation analysis. It is generally accepted that the co-citation concept was discovered independently by Small and Marshakova, and that document co-citation analysis was introduced by small and author co-citation analysis by White and Griffith. In co-citation analysis, a set of items is selected to represent a research area. Relationships between these items are then analyzed using co-citation counts as similarity measures and multivariate analysis techniques as analyzing tools in order to study the intellectual structure of this research field and to infer some of the characteristics of the corresponding scientific community. In general, two items are considered as being co-citation when they appear together in the same reference list of a subsequent article (Zhao D, 2006).

Bibliographic Co-citation is a popular similarity measure used to establish a subject similarity between two items. If A and B are both cited by C, they may be said to be related to one another, even though they don't directly reference each other. If A and B are both cited by many other items, they have a stronger relationship. The more items they are cited by, the stronger their relationship is (Martins B. Class Co-citation).
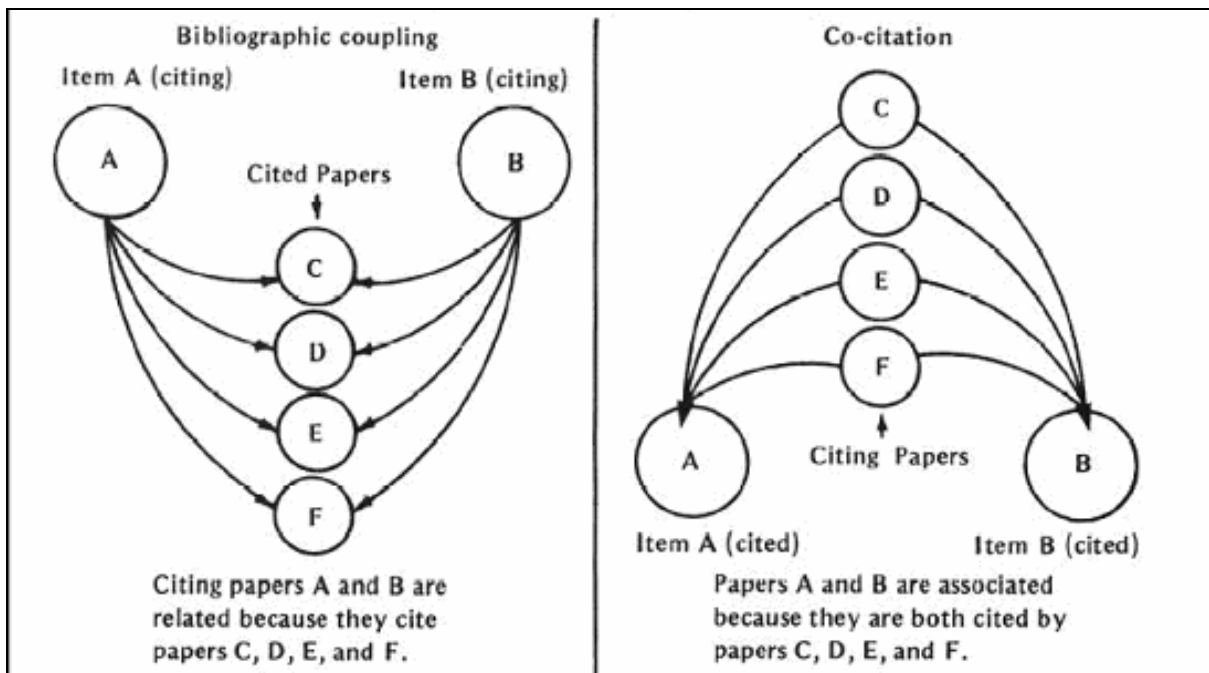
Figure 4 Bibliographic Coupling vs. Co-Citation
Source :Garfield E, 2001

The essence difference between Bibliographic coupling and Co-citation is reflected in Figure 4. Papers are bibliographically coupled when different authors cite one or more papers in common. On the other hand, co-citation analysis is based primarily on identifying pairs of highly-cited papers (Garfield E, 2001).

The notion of citation is fundamental to both the scholarly enterprise and to hypertext networks where it provides the primary mechanism for connection and traversal of the information space. Citation analysis was developed in information science as a tool to identify core sets of articles, authors, or journals of particular fields of study (Larson RR, 1996). The study analyzed subject of CPC in Google search and ISC to discovery the most closed linked for the CPC documents.

2.3 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 (M.E.J. Newman., 2001). Social network analysis is the mapping and measuring of relationships and flows between people, groups, organizations, animals, computers or other information/knowledge processing entities. The nodes in the network are the people and groups while the links show relationships or flows between the nodes (Orgnet.com). It usually provides both a visual and a mathematical analysis of human relationships.

Social networks have been the subject of both empirical and theoretical study in the social sciences for at least 150 years. Stanley Milgram conducted a famous early empirical study of the structure of social networks (M.E.J. Newman., 2001). Social network researchers measure network activity for a node by using the concept of degrees the number of direct connections a node has. The relationship between the centralities of all nodes can reveal much about the overall network structure (Orgnet.com).

Network analysis is distinguished from traditional social science by the dyadic nature of the standard data set (Borgatti S.P., Everett M.G., 1997). Martin argues that while predicting the specific content of ideas is often not possible, we can link the shape of an idea space to the structure of a network (Moody J., 2004).

Social network analysis is the study of social relationships between individuals in a society. Obviously, the more relational data the better the network analysis is (Sabater J., Sierra C., 2002). The theory 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 interactional patterns among individuals to identify clusters or cliques within a network of individuals (Ennett S.T., Bauman K.E., 1993). See Figure 5.
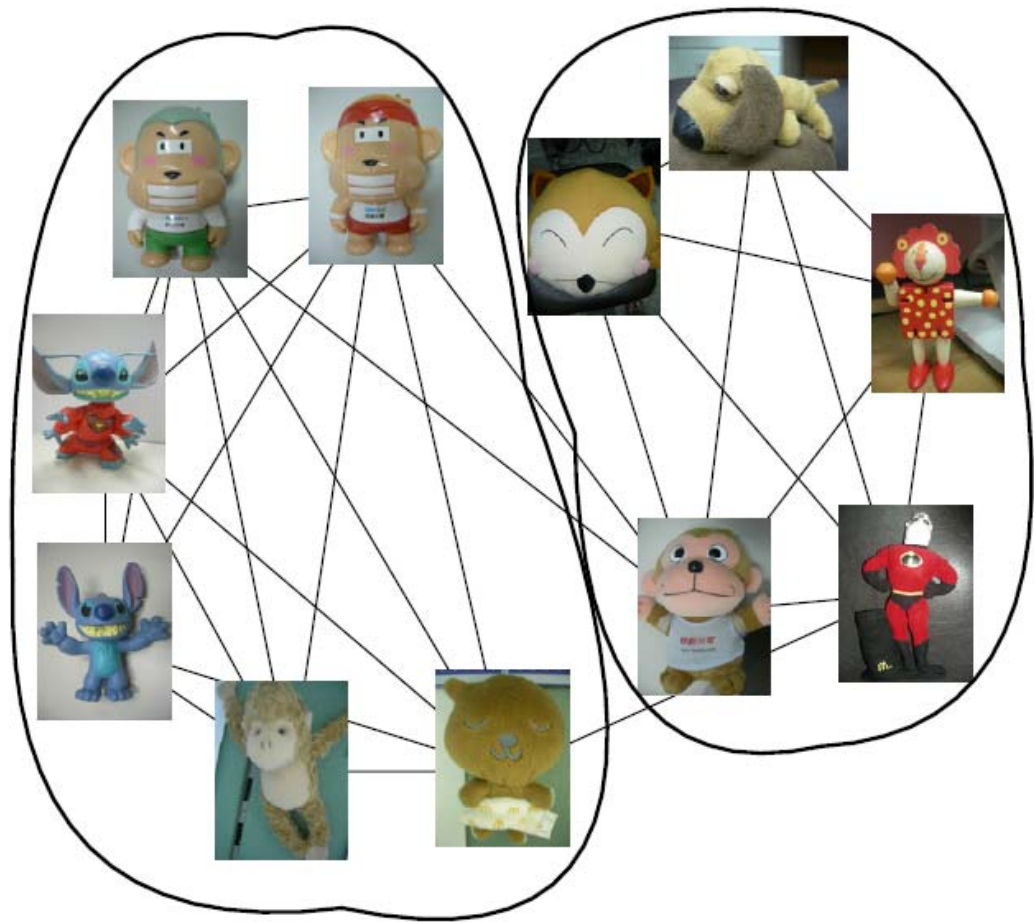
Figure 5 Social Network

III. Proposed Method

3.1 Objective

By using co-citation analysis and social network analysis to discovery the most closed linked for CPC documents to identify the CPC documents relationship and future research techniques.

3.2 Overview of documents Co-Citation analysis and Social Network analysis

Documents co-citation analysis consists of the assembling and interpretation of bibliographical statistics taken from the cited references which are taken from the selected citing articles. See Figure 6.

```
┌──────────────┐                              ┌──────────────┐
│   Google     │                              │              │
│   Scholar    │                              │    SSCI      │
└──────┬───────┘                              └──────┬───────┘
       │        Selection of documents and           │
       │        Finalizing the documents set         │
       │                   │                          │
       └───────────────────┼──────────────────────────┘
                           ▼
       ╭───────────────────────────────────────────╮
       │  Databases (CPC Documents for Co-citation) │
       ╰───────────────────────────────────────────╯
                           │
                           │      Input Data
                           │      Preparation
                           ▼
       ┌───────────────────────────────────────────┐
       │            Co-citation Matrix              │
       └───────────────────────────────────────────┘
   Output              │              │     Input Data
   Preparation         │              │     Preparation
                    ╭──────╮      ╭────────╮
                    │ SPSS │      │ UCINE  │
                    ╰──┬───╯      │ T 6.0  │
                       │          ╰───┬────╯
                       ▼              ▼
       ┌──────────────────┐   ┌──────────────────┐
       │                  │   │  Social Network  │
       │  Factor Analysis │   │    Analysis      │
       └────────┬─────────┘   └────────┬─────────┘
                │                       │
                └──────────┐  ┌─────────┘
                           ▼  ▼
                     ╭──────────────╮
                     │    RESULT    │
                     ╰──────────────╯
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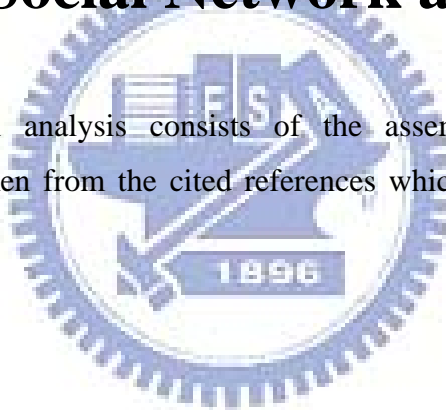
Figure 6 Documents Analysis Steps

3.3 Co-citation method

Much work has been done developing the theory and methodology of document co-citation analysis, firmly establishing it as a bibliometric research tool, realizing that new improvements on this methodology keep on coming out (Acedo FJ, Barroso C, Galan JL, 2006).

The co-citation method, which is based on a count of the number of times two documents are cited jointly in the CPC subject area. Their analysis has produced a diversity of methodologies. In which the co-citation or joint citations method is significantly relevant. This method aims to identify groups of documents who are closely related and which, consequently, can be affirmed as belonging to the same research front (price,1965),upon the premise that the more often two documents are cited together, the closer the relationship between them.

The structure of the database is derived from all the full papers published in the Google scholar search. Most electronic copies of these papers were gathered from the Google scholar search and the rest of papers were retrieved from Social Science Citation Index (SSCI), which is offered through the ISI web science system.

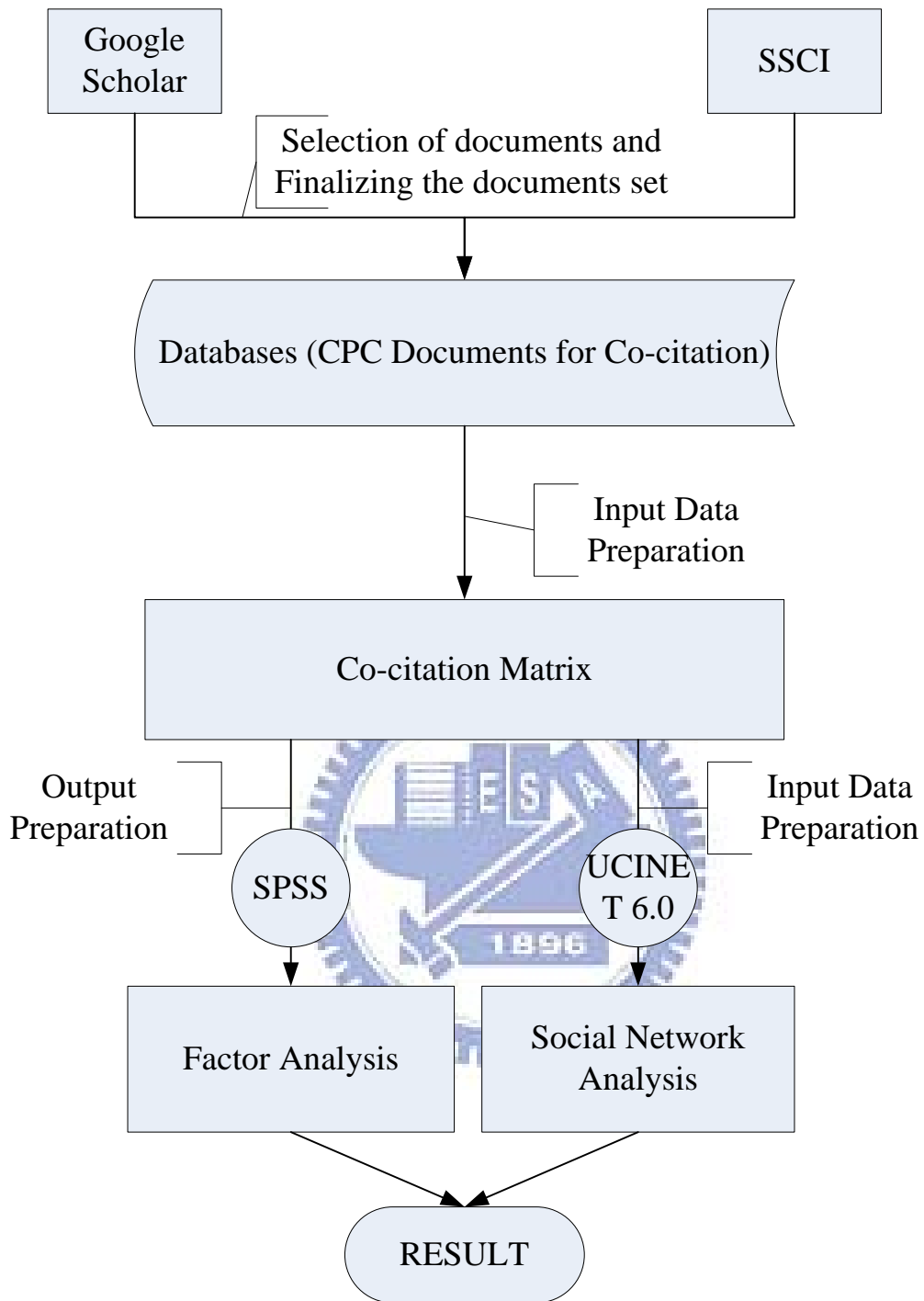Traditionally, researchers in information studies field rely on some statistical tools, such as SPSS which supports cluster analysis, factor analysis, to perform co-citation analysis (He Y, Hui SC, 2001). To do this, we first need to get the document co-citation raw matrix by using software tools.

To construct the matrices, the most frequently cited documents must first be identified. Therefore a minimum number of citations received per document must be chosen; documents receiving fewer citations do not appear in the databases. The documents should be chosen in such a way that the resulting matrix contains as few zeroes as possible (White HD, 1983). Factor analysis supported by SPSS has been used to identify the major research areas from the document co-citation patterns.

Co-citation analysis has a fairly consistent sequence of steps, regardless. These steps

consist of :

1. Selection of the core set of documents for the study.
2. Retrieval of co-citation frequency information for the core set.
3. Compilation of the raw co-citation frequency matrix.
4. Correlation analysis to convert the raw frequencies into correlation coefficients.(SPSS)
5. Interpretation of the Factor analysis results.

IV. Experimental Results

The starting point for multivariate analysis is the co-citation matrix, which represents the intensity of co-citation between any two documents. The more often two documents are cited together, the closer together the documents they research appear in the scientific community that cites them. Construction of the matrix is thus a key step in co-citation studies.

CPC data analysis requires the seven different procedures such as data collection, Row Co-citation documents Counts, Transposed Co-citation Frequency matrix, and Factor Procedure. See Figure 7.
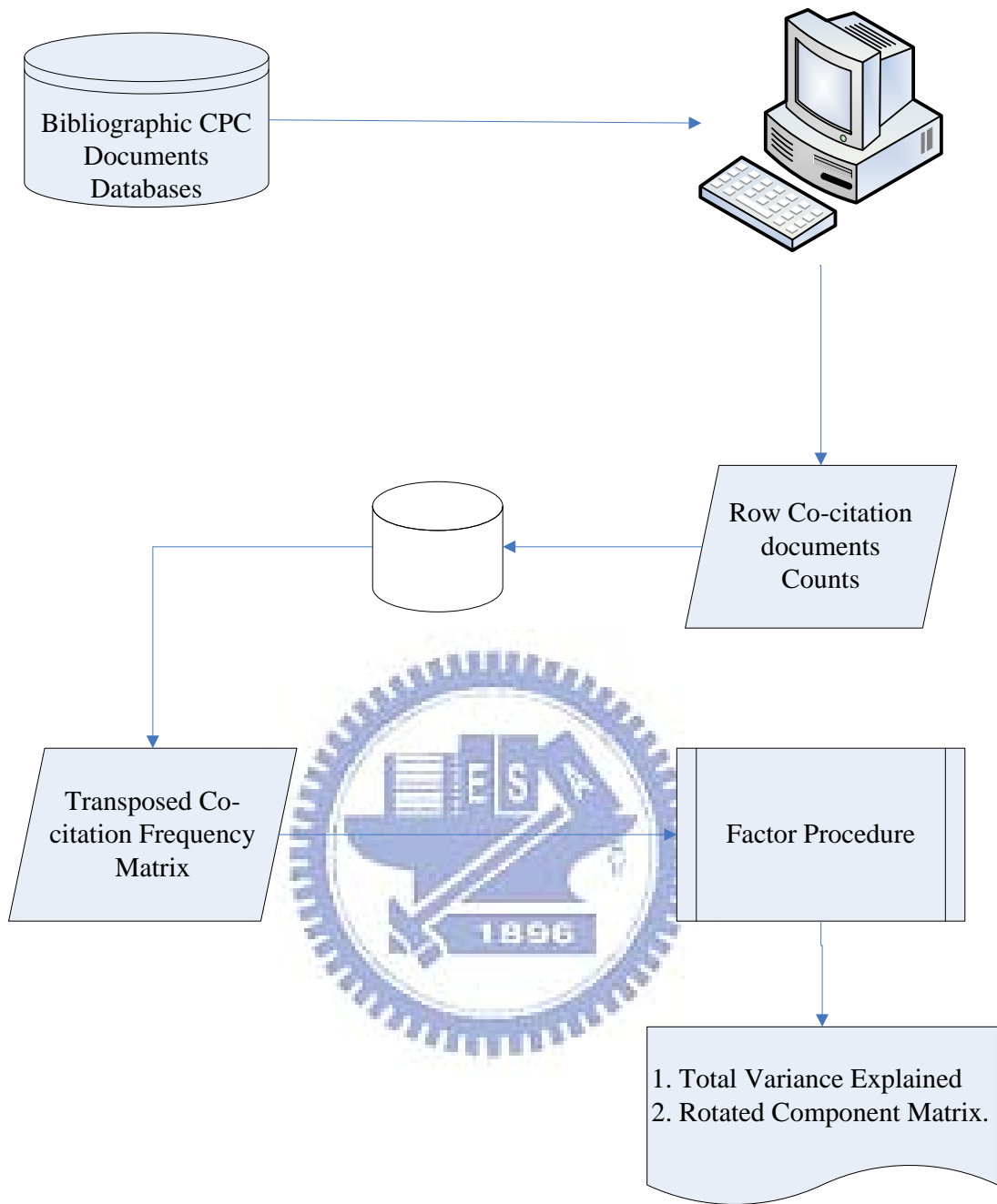
Figure 7 Flowchart for Co-Citation analysis

4.1 Data Collection

We selected those who where most frequently cited and those who were most frequently co-cited in the 52 documents of citable items. Co-citation counts can be either retrieved from commercial online bibliographical databases such as Science Citation Index, and Social Sciences Citation Index, or generated from Google scholar search databases. The selection of those source documents that make up the core data of a theory or discipline is a critical stage in the process. It computes document co-citation frequencies between any pair of topics under study. To cover all the developments within the theory, the objective is to form a core as large as possible, while ensuring that this core is made up only of documents that can be truly considered as shaping the theory. By using the relevance criterion favors older documents to detriment of more recent ones that might have had a greater impact on the theory.

4.1.1 Selection of Documents

In this study, selection of the core set documents was derived from a set of initial searches. There are no hard and fast rules, but the subjectivity inherence in the selection of CPC documents should be limited on their significant contributions to the field. A list of 39 papers was determined after examining initial citation data retrieved from ISI files and Google scholar search. The 39 source articles produced a total of 6041 citations (documents selection period before May 2007).

4.1.2 Retrieval of Co-citation Data

Basic citation counts on CPC documents were collected form the Google scholar search and ISI databases. Searches using the keyword/subject was conducted to determine which documents were the most cited fellows. Determining a core paper set poses an initial difficulty. Once this core set of CPC documents was identified, it was necessary to limit searches to avoid retrieving misty subjects.

4.1.3 Central Core

The core documents 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 documents (Acedo F.J., Barroso C., Galan J.L., 2006). It seems likely that many of the documents we shall read about define the cognitive or intellectual structure of CPC and the CPC area's specialties. The most widely used criterion is the number of cites, and so we take the most significant works representing the study field to be the core documents during the factor analyzed.

The core documents represent assemblies' documents that share CPC subject, theory, or common methodology and describe current investigation. We often cite the same documents that have the same collective representation of their investigating activity; consequently, the higher the co-citation is among them, the more coherent and integrated is the scientific community determined by the method.

The resulting list of CPC documents is show in Table 1. The Title means the title of the paper, the number of Count of Citation means how many papers have cited it and the Number of Documents is just the variable name for future analyses. Each complete document list is shown in the appendix.
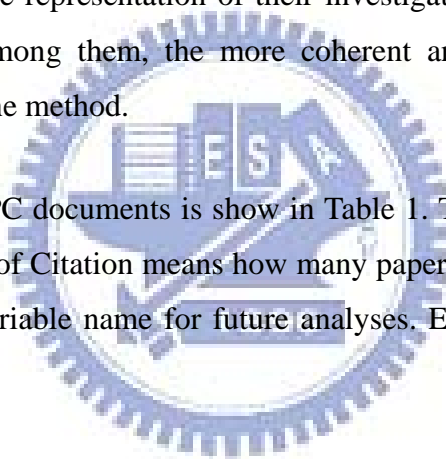
Table 1 CPC Finals Articles Citation Frequency

Number of Documents	Title	Count of Citations
v1	A Dynamic Theory of Organizational Knowledge Creation	995
v2	A Model for Studying R&D-Marketing Interface in the Product Innovation Process	161
v3	A multi-resolution collaborative architecture for web-centric global manufacturing	20
v4	A role-driven component-oriented methodology for developing collaborative commerce systems	6
v5	Agent-Based System Design for B2B Electronic Commerce	7
v6	Agent-mediated electronic commerce: a survey	369
v7	Agents that buy and sell	453
v8	An exploratory study of small business Internet commerce issues	140
v9	An Internet Virtual reality collaborative environment for effective product design	26
v10	Brokering and 3D collaborative viewing of mechanical part models on the Web	18
v11	Collaboration, motivation, and the size of organizations	10
v12	Collaborative commerce	8
v13	Collaborative commerce and knowledge management	9
v14	Collaborative computer-aided design—research and development status	5
v15	Collaborative conceptual design—state of the art and future trends	33
v16	Collaborative planning forecasting and replenishment: new solutions needed for mass collaboration	26
v17	Collaborative planning, forecasting, and replenishment	7
v18	Competing for the Future-Breakthrough Strategies for Seizing Control of Your Industry and Creating the Markets of Tomorrow	91
v19	Competition for Competence and Inter-Partner Learning within International Strategic Alliance	796
v20	Creating a custom mass-production channel on the Internet	36
v21	Exploring the experiences of collaborative planning initiatives	48
v22	Implementing collaborative forecasting to improve supply chain performance	13
v23	Information Links and Electronic Marketplaces: The Roles of Inter-Organizational Information Systems in Vertical Markets	121
v24	Interdepartmental Interdependence and Coordination: The Case of the Design/Manufacturing Interface	127
v25	Knowledge Management: An Organizational Capabilities Perspective	172
v26	Madefast: Collaborative Engineering over the Internet	111
v27	Managing Trust and Commitment in Collaborative Supply Chain Relationships	39
v28	Organizational information requirements, media richness and structural design	964
v29	Research paper Collaborative planning: supporting automatic replenishment programs	37

Table 2 CPC Finals Articles Citation Frequency (cont.)

Number of Documents	Title	Count of Citations
v30	Retail exchanges: a research agenda	15
v31	Synchronised web applications for product development in the 21st century	10
v32	Technology Adaptation The case of implementing a collaborative product commerce system to new product design	121
v33	The collaborative supply chain: a scheme for information sharing and incentive alignment	35
v34	The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration	172
v35	The Value of Internet Commerce to the Customer	100
v36	WeBid: A web-based framework to support early supplier involvement in new product development	27
v37	What's Your Strategy for Managing Knowledge?	709
v38	Toward unified view of electronic commerce, electronic business, and collaborative commerce: a knowledge management approach	1
v39	Business-to-Business Value Drivers and eBusiness Infrastructures in Financial Services: Collaborative Commerce Across Global Markets and Networks	3

4.2 Data Analysis (Co-citation Analysis)

The set of cited authors chosen for analysis is determined by citation frequency. Co-citation analysis can be applied to different levels of aggregation: on the level of single publications, it can be use to study relationships among specific conceptual ideas or empirical findings (Small, 1974).

ACA shows how authors are positioned relatively to each other in the research field. In our case, Table 1 gives the frequencies with which a particular individual document has been cited. Co-citation are counts of the frequency with which two existing documents are cited together in a new document and their analysis enables us to say something about the way ideas support and interact with each other and also to plot the structure of intellectual disciplines (Small, 1973; White and Griffith, 1981).

All of the citations were imported into a Microsoft Office Excel and subsequently into a Microsoft Access database for additional processing. The co-citation counts for each documents pair were derived using ODBC (Open Database Connectivity) and small program searched the citation field of each bibliographic record, counting the number of times two documents were cited together. We address such issues by performing various analyses on the co-citation matrix. The result was the basis of all future analyses used in this project.

4.2.1 Matrix

We perform two first-document and two inclusive all-document co-citation analyses based on the two dataset and two different approaches to matrix generation. The one pair of first-document and inclusive all-document co-citation analyses commences from an n x n matrix. The other pair of first-document and inclusive all-document co-citation analyses commences from an n x m data matrix, which corresponds to conventional multivariate data analysis.

The values of the diagonal cells are computed using the adjusted value approach, taking the three highest intersections and dividing by two would generate diagonals which would

approximate the next highest score in the distribution, thus indicating in a general way the relative importance of a particular (White HD, Griffith BC, 1981) documents within the field.

A matrix shown in Table 2 was constructed with recorded document titles. This was then subjected to a factor analysis to extract latent structures from the pattern of documents citations. The names of each factor were given by the documents after investigating the titles themselves. The raw co-citation matrix was entered into the SPSS system for the future analyses. It was first converted to a correlation matrix.

Table 3 Co-citation Matrix

	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17	v18	v19	v20	v21	v22	v23	v24	v25	v26	v27	v28	v29	v30	v31	v32	v33	v34	v35	v36	v37	v38	v39
v1	84	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	1	20	0	0	22	0	0	0	3	0	2	0	0	80	0	0
v2	0	14	0	0	0	2	2	3	0	0	0	1	0	0	0	0	0	2	7	2	0	0	2	10	0	0	2	10	0	0	0	0	0	2	1	0	8	0	0
v3	0	0	2	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
v4	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
v5	0	0	0	0	2	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
v6	1	2	0	0	0	35	64	1	0	0	0	1	0	0	0	0	0	0	2	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	2	0	3	0	0
v7	1	2	0	0	3	64	36	3	0	0	0	1	0	0	0	0	0	0	1	2	0	0	3	1	1	1	1	0	0	0	0	0	0	1	5	0	3	0	0
v8	0	3	0	0	0	1	3	5	0	0	0	0	0	0	0	0	0	1	1	2	0	0	3	1	0	0	1	2	0	0	0	0	0	1	0	0	3	0	0
v9	0	0	2	0	0	0	0	0	4	3	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0	1	0	0	0
v10	0	0	1	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	1	0	0	0	1	0	0	0
v11	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	2	0	2	0	0	0	0	0	0	0	0
v12	0	1	0	0	0	1	1	0	0	0	0	4	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5	1	0	2	0	0
v13	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
v14	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0
v15	0	0	0	0	0	0	0	0	2	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0
v16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	1	0	0	0	11	1	0	0	0	0	0	0	4	3	0	0	1	0	0	0	0	0	0
v17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
v18	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6	5	1	1	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	4	0	0
v19	65	7	0	0	0	2	1	1	0	0	0	1	0	0	0	0	0	5	48	1	0	0	1	4	4	0	1	13	2	0	0	1	1	3	1	0	18	0	0
v20	0	2	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	1	1	3	0	0	2	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0
v21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	1	0	0	0	14	7	2	0	0	0	0	1	10	5	0	0	6	0	0	1	0	0	0
v22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	7	7	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0
v23	0	2	0	0	0	1	3	3	0	0	0	0	0	0	0	0	0	1	1	2	2	0	5	2	0	0	3	3	1	0	0	0	0	0	4	0	2	0	0
v24	1	10	0	0	0	1	1	1	0	0	0	1	0	0	0	0	0	0	3	4	1	0	2	16	1	2	2	18	0	0	0	0	0	1	1	0	2	0	0
v25	20	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	4	0	0	0	0	1	31	0	0	6	1	0	0	4	0	4	0	0	35	0	0
v26	0	0	1	0	0	0	1	0	2	3	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0	0	1	3	0	0	0	0	0
v27	0	2	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	3	2	0	0	4	3	0	0	0	0	1	0	0	0	1	0	0
v28	22	10	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	3	13	1	1	0	3	18	6	1	3	29	0	0	0	16	0	17	2	0	18	0	0
v29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	2	10	3	0	1	0	1	0	0	9	2	0	0	4	0	0	0	1	0	0
v30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	5	0	0	0	0	0	0	0	2	5	0	0	0	0	0	0	0	0	0
v31	0	0	1	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	2	0	0	0
v32	3	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0	16	0	0	0	22	0	24	0	0	2	0	0
v33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	6	3	0	0	1	0	0	1	0	4	0	0	7	0	0	0	1	0	0
v34	2	2	0	0	0	1	1	0	0	0	2	5	0	0	0	0	0	0	3	0	0	0	0	1	4	0	0	17	0	0	0	24	0	26	1	0	10	0	0
v35	0	1	0	0	0	2	5	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	4	1	0	1	0	2	0	0	0	0	0	1	6	0	0	0	0
v36	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	2	0	0	0	0	3	0	0	0
v37	80	8	0	0	0	3	3	3	0	0	0	2	0	0	0	0	0	4	18	1	0	0	2	2	35	0	1	18	0	0	0	2	1	10	0	0	67	0	0
v38	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
v39	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

4.2.2 Factors

Factor analysis must be regarded as a natural development in a field in which large sets of correlated variates arise, as a means of examining and describing the internal structure of the covariance and correlation matrices concerned. (D.N. Lawley and A.E. Maxwell, 1962). It has an underlying theoretical model it also seeks to study correlations among a number of interrelated variables and to group them into a few highly descriptive factors.

In this case, documents can contribute to more than one factor and usually load most heavily on a single factor, with documents loadings of 0.7 or greater as likely to be the most useful for interpretation. SPSS is commonly done to determine the number of factors with the most explanatory power. Rotation is also commonly used to interpret results, with varimax rotation being the most popular in ACA.

4.3 Results and discussion

Eight factors were extracted from the data and together they explain 100% of the variance in the co-citation matrix. The results of the factor analysis are summarized in Table 3 which shows the factor loadings for the documents in the first 8 factors.

Table 4 Factor analysis Results

Number of Documents	Author	Component (Factor)							
		1	2	3	4	5	6	7	8
v21	Mark Barratt and Alexander Oliverira	0.956							
v29	Theodore P. Stank, Patricia J. Daugherty, Chad W. Autry	0.942							
v16	Jan Holmström, Kary Främling, Riikka Kaipia, Juha Saranen	0.892							
v33	Togar M. Simatupang, R. Sridharan	0.82							
v22	Teresa M. McCarthy and Susan L. Golicic	0.814							
v30	Leigh Sparks, Beverly A. Wagner	0.767							
v17	Williams SH.	0.625							
v2	Ashok K. Gupta, S. P. Raj, David Wilemon		0.838						
v27	Bill Welty, Irma Becerra-Fernandez		0.818						
v24	Paul S. Adler		0.814						
v23	J. Yannis Bakos		0.75						
v20	Greg Elofson, William N. Robinson		0.721						
v8	Simpson Poon, Paula M.C. Swatman		0.698						
v18	G Hamel, CK Prahalad		0.666						
v10	YeoNgho Kim, YoungSang Choi and Sang Bong Yoo			0.881					
v3	Mihaela Ulieru, Douglas Norrie, Rob Kremer and Weiming Shen			0.862					
v31	G. Q. Huang, S. W. Lee, K. L. Mak			0.838					
v9	H. Y. Kan, Vincent G. Duffy, Chuan-Jun Su			0.828					
v26	Mark R. Cutkosky, Jay M. Tenenbaum, Jay Glicksman			0.745					0.534
v1	Ikujiro Nonaka				0.966				
v37	MT Hansen, N Nohria, T Tierney				0.945				
v19	Gary Hamel				0.863				
v25	Andrew H. Gold, Arvind Malhotra, Albert H. Segars				0.794				
v32	Wen-Hsiung Wu, Chin-Fu Ho					0.934			
v34	Catherine Durnell Cramton					0.933			

Table 5 Factor analysis Results (cont.)

Number of Documents	Author	Component (Factor)							
		1	2	3	4	5	6	7	8
v11	Bernardo A. Huberman, Christoph H. Loch					0.698			
v28	Richard L. Daft, Robert H. Lengel		0.486		0.571	0.598			
v12	Scott Kownslar					0.554			
v13	Bhavani Thuraisingham , Amar Gupta , Elisa Bertino , Elena Ferrari						0.949		
v4	Hwagyoo Park, Woojong Suh, Heeseok Lee						0.907		
v38	Clyde W. Holsapple and Meenu Singh						0.907		
v39	Alea M. Fairchild, Ryan R. Peterson						0.595		
v6	Robert H. Guttman, Alexandros G. Moukas and Pattie Maes							0.942	
v7	Pattie Maes, Robert H. Guttman and Alexandros G. Moukas							0.827	
v35	Ralph L. Keeney							0.685	
v5	Anthony Karageorgos, Simon Thompson, Nikolay Mehandjiev							0.672	
v14	W.D. Li, W.F. Lu, J.Y.H. Fuh, Y.S. Wong								0.847
v15	Lihui Wang, Weiming Shen, Helen Xie, Joseph Neelamkavil, Ajit Pardasani								0.79
v36	G. Q. Huang and K. L. Mak			0.598					0.622

We have labeled all 39 documents and ranked them, loading most heavily on each, 0.4 being an arbitrary minimum cutoff point. If a documents does not load 0.4 or higher on any of the factors, the document's highest loading, whatever it may be, is presented. As is usual in this type of analysis, documents with less than a 0.4 loading were dropped from the final results (J.Hair, R.Anderson, R.Tatham and W.Black, 1998).

We tentatively assigned the documents with high associated loadings. Implicitly, our interpretation of the analysis results is that the CPC field is composed of at least eight different sub fields: Supply Chain partners and CPFR, Organizational Model design and Coordination mechanism, Web Collaborative design Model, Organization Knowledge and Management Knowledge, System and Solve CPC problems, c-commerce combines e-commerce, Design for e-commerce, and CAD system. See Table 4. All 39 papers load on at least one factor, V26 load on two and V28 on three, as shown by subscripts to their documents numbers. The 8 factors help in understanding relationships, such as that between businesses and IS strategies.
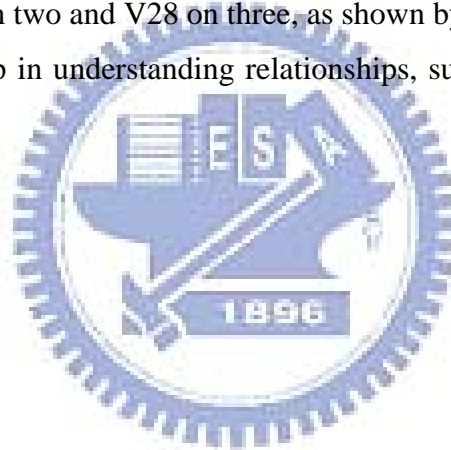
Table 6 Documents factor loadings at 0.40 or higher (decimals omitted).[a]

	Factor 1	
	Supply Chain partners, CPFR	Factor Loading
v21	Exploring the experiences of collaborative planning initiatives	0.96
v29	Research paper Collaborative planning: supporting automatic replenishment programs	0.94
v16	Collaborative planning forecasting and replenishment: new solutions needed for mass collaboration	0.89
v33	The collaborative supply chain: a scheme for information sharing and incentive alignment	0.82
v22	Implementing collaborative forecasting to improve supply chain performance	0.81
v30	Retail exchanges: a research agenda	0.77
v17	Collaborative planning, forecasting, and replenishment	0.63

	Factor 2	
	Organizational Model design, Coordination mechanism	Factor Loading
v2	A Model for Studying R&D-Marketing Interface in the Product Innovation Process	0.84
v27	Managing Trust and Commitment in Collaborative Supply Chain Relationships	0.82
v24	Interdepartmental Interdependence and Coordination: The Case of the Design/Manufacturing Interface	0.81
v23	Information Links and Electronic Marketplaces: The Roles of Inter-Organizational Information Systems in Vertical Markets	0.75
v20	Creating a custom mass-production channel on the Internet	0.72
v8	An exploratory study of small business Internet commerce issues	0.70
v18	Competing for the Future-Breakthrough Strategies for Seizing Control of Your Industry and Creating the Markets of Tomorrow	0.67
v28 [3]	Organizational information requirements, media richness and structural design	0.49

	Factor 3	
	Web Collaborative design Model	Factor Loading
v10	Brokering and 3D collaborative viewing of mechanical part models on the Web	0.88
v3	A multi-resolution collaborative architecture for web-centric global manufacturing	0.86
v31	Synchronised web applications for product development in the 21st century	0.84
v9	An Internet Virtual reality collaborative environment for effective product design	0.83
v26 [1]	Madefast: Collaborative Engineering over the Internet	0.75
v36	WeBid: A web-based framework to support early supplier involvement in new product development	0.60

Table 7 Documents factor loadings at 0.40 or higher (decimals omitted).[a] (cont.)

Factor 4		
Organization Knowledge, Management Knowledge		Factor Loading
v1	A Dynamic Theory of Organizational Knowledge Creation	0.97
v37	What's Your Strategy for Managing Knowledge?	0.95
v19	Competition for Competence and Inter-Partner Learning within International Strategic Alliance	0.86
v25	Knowledge Management: An Organizational Capabilities Perspective	0.79
v28 $_2$	Organizational information requirements, media richness and structural design	0.57

Factor 5		
System, Solve CPC problems		Factor Loading
v32	Technology Adaptation The case of implementing a collaborative product commerce system to new product design	0.93
v34	The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration	0.93
v11	Collaboration, motivation, and the size of organizations	0.70
v28 $_1$	Organizational information requirements, media richness and structural design	0.60
v12	Collaborative commerce	0.55

Factor 6		
c-commerce combines e-commerce		Factor Loading
v13	Collaborative commerce and knowledge management	0.95
v4	A role-driven component-oriented methodology for developing collaborative commerce systems	0.91
v38	toward unified view of electronic commerce, electronic business, and collaborative commerce: a knowledge management approach	0.91
v39	Business-to-Business Value Drivers and eBusiness Infrastructures in Financial Services: Collaborative Commerce Across Global Markets and Networks	0.60

| Factor 7		
Design for e-commerce		Factor Loading
v6	Agent-mediated electronic commerce: a survey	0.94
v7	Agents that buy and sell	0.83
v35	The Value of Internet Commerce to the Customer	0.69
v5	Agent-Based System Design for B2B Electronic Commerce	0.67

Table 8 Documents factor loadings at 0.40 or higher (decimals omitted).[a] (cont.)

	Factor 8	
	CAD, System	Factor Loading
v14	Collaborative computer-aided design—research and development status	0.85
v15	Collaborative conceptual design—state of the art and future trends	0.79
v36	WeBid: A web-based framework to support early supplier involvement in new product development	0.62
v26 [2]	Madefast: Collaborative Engineering over the Internet	0.53

[a]Subscripts: 1 = first appearance, 2 = second appearance, 3 = third appearance.

Figure 8 is a graph of the visualization of the semantic space derived from 39 core papers. The sphere and line each represent there relationship between two core papers. The colors of these spheres indicate the "co-citation number in co-citation matrix (from table 2)" of corresponding documents: the first-document and two inclusive all-document co-citation analyses based on the two dataset, we count once when the first document and n document have same co-citation document, no matter how many co-citation appear. For example, From Table 2 showed V5 have connection with V7 and V27 that we count as two lines, it will connect V5 with V7 and V5 with V27 as we can see from Figure 8.

The purple colors represent the core documents have same co-citation document from paper number one to five, black represent six to ten, yellow represent eleven to sixteen, and red represent seventeen to nineteen.

Figure 8 The Core Documents and their Interrelationships
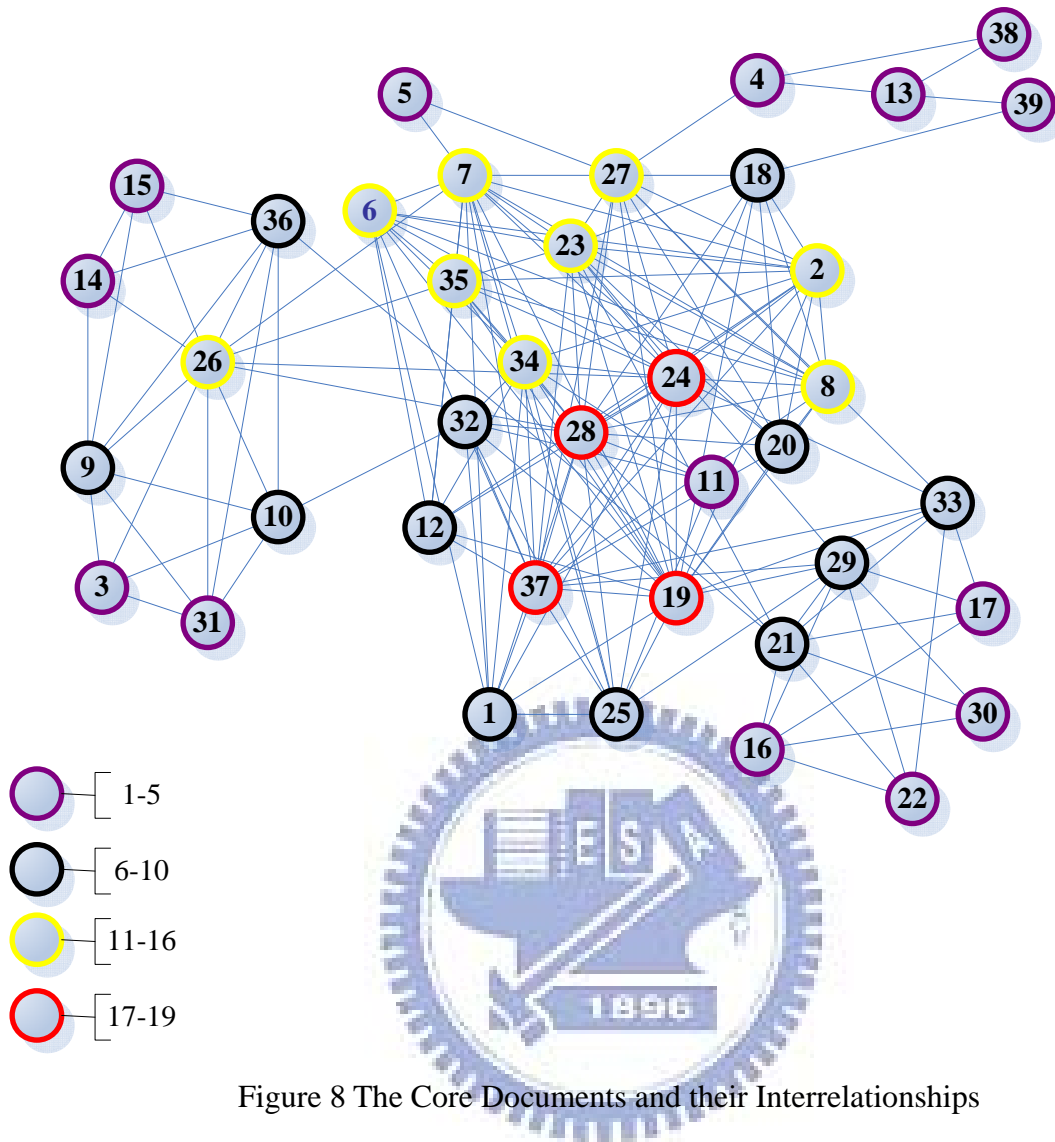
In the subsequent document co-citation analysis and associated co-citation maps, this tendency becomes even stronger and more intuitive. Figure 9 summarizes the intellectual structure within the core. Documents are co-located according to a multidimensional scaling of their interconnectedness in a two-dimensional space. The relative amount of co-citations of documents is indicated by the thickness circle lines and all factors received clear view.
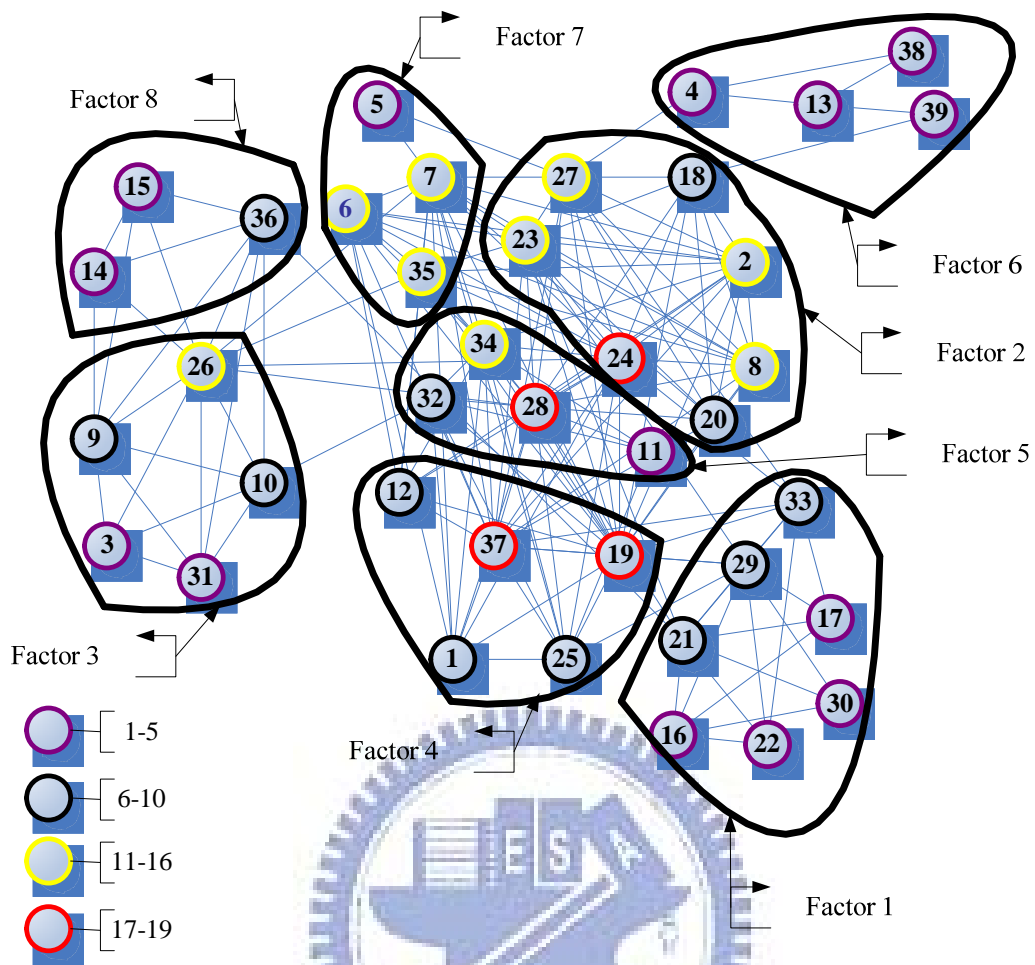
Figure 9 The Core documents and their factor analyses

The program UCINET 6.0 was investigated in more detail with the help of an example data set. UCINET 6.0 (a social network analysis software package) is a comprehensive program for the analysis of social networks and other proximity data. It is probably the best known and most frequently used software package for the analysis of social network data and contains a large number of network analytic routines (Huisman M., Marijtje A.J. van Duijn., 2003). By applying the UCINET 6.0 program the given 39 CPC documents identified as a core data set, a social network analysis graph emerges in Figure 10.
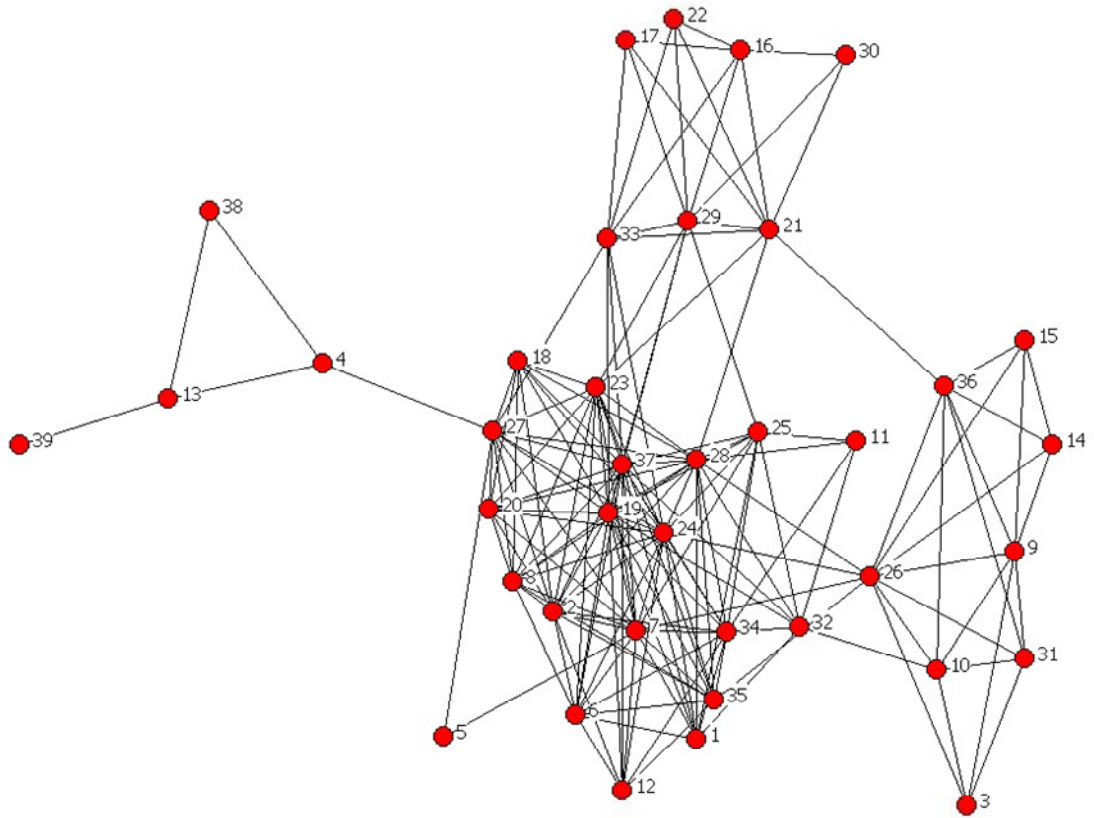
Figure 10 Social network analyses for CPC documents

Figure 11 summarizes the intellectual structure within the factors. Factors are co-located according to a multidimensional scaling of their interconnectedness in a two-dimensional space. The relative amount of factors is indicated by the thickness circle lines and all other factors received clear view.
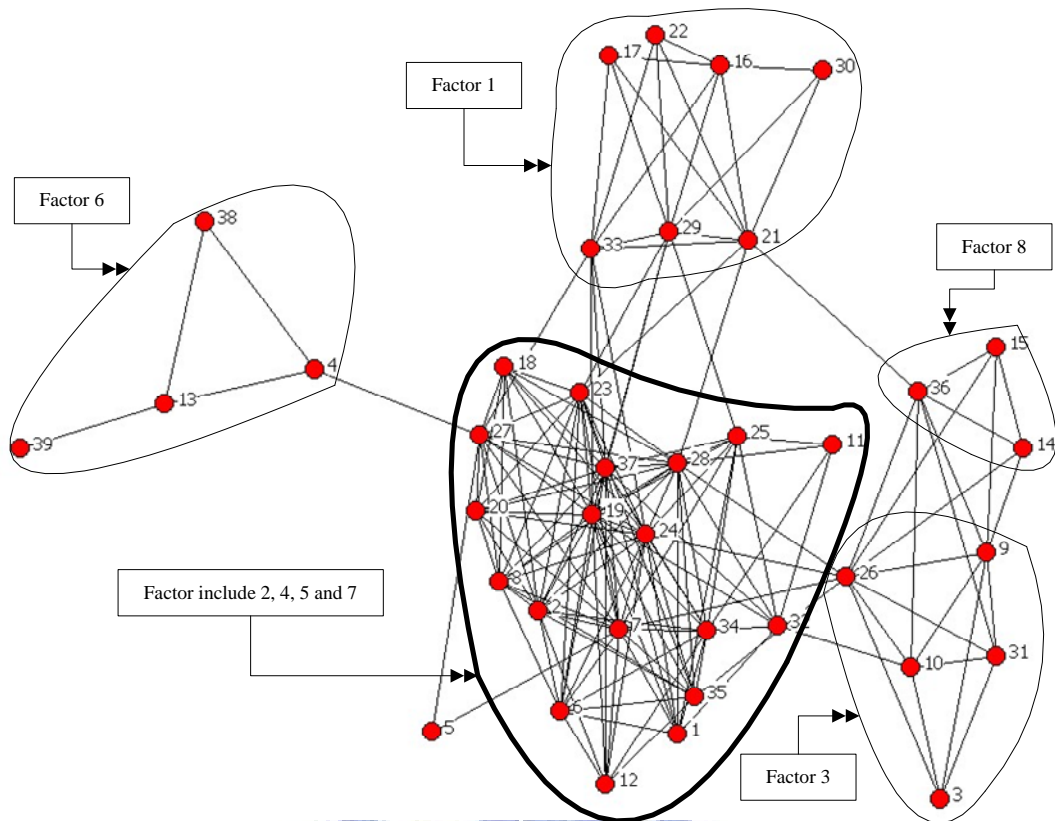
Figure 11 The social network analyses and their interrelationship

Overall, the graph visualizes the relative positioning of documents within the core. Their location stems from the fact that the graph reflects interrelations with in the core connected to all co-citation documents. The more similar the co-citation documents, the closer they will be displayed in the graph: the documents linked to many other source documents will be located in areas close to the graph's center (McCain 1986).

As the figure 8 and 9 show, the different cores are grouped together depending upon the documents interrelationship. The eight resulting group represent different theoretical trends within the CPC study field. Core papers number 19, 24, 28, 34 and 37 are the necessarily cited key paper in this field.

According to its factor meaning and the social network structure method combining figure 9 and 11 shows the different factor are grouped together, those represent the factor two, four, five and seven been labeled as Organizational Model design, Coordination mechanism, Organization Knowledge, Management Knowledge, System, Solve CPC problems, Design for e-commerce. This means in this field, Organizational Model, Organizational Knowledge, Management Knowledge, and system are popular. The situation is totally clarified when

analyzing the future research work of CPC, the researcher mostly focuses on Organizational model, Organizational Knowledge, Management Knowledge and System such as factor two, four, five and seven.

The factor one, three, six and eight been labeled as Supply Chain partners, CPFR, Web Collaborative design Model, c-commerce combines e-commerce and CAD System are not very connected with this field although they may connect CPC for some small idea. For the future research factor two, four, five and seven (Organizational Model design, Coordination mechanism, Organization Knowledge, Management Knowledge, System, Solve CPC problems, Design for e-commerce) is the most clarified for the search area.

V. Conclusion

The co-citation and social network study provides CPC field professionals a perspective that heretofore has not been afforded. As such, those can be one of several tools used to help individuals access and visualize scholarly communication within the field. Those helps identify the most productive and prominent document in the field, the documents that are cited, the amount they are co-cited with other informatics documents, and the documents that appear in similar subject areas.

This paper introduced documents co-citation analysis without relying on commercial citation databases, based on custom bibliographic database and co-citation matrix generation systems specifically developed to use the custom database. This study also demonstrates the matrix and their potential problems in factor analysis.

The study combines a content-similarity analysis, a factor analysis, document co-citation analysis, social network analysis, and structural visualization together on the field of hypertext as a whole. The factor analysis extracted 8 factors, which may be the roots of many new specialties to be identified in future work. By combining co-citation analysis and social network analysis, the clearly factors result has been identify.

The most clarified factors are factor two, four, five and seven standing for Organizational Model design, Coordination mechanism, Organization Knowledge, Management Knowledge, System, Solve CPC problems, Design for e-commerce. For factor one, three, six and eight standing for Supply Chain partners, CPFR, Web Collaborative design Model, c-commerce combines e-commerce and CAD System not very clarified for CPC future research.

From these eight different factors it appears that the CPC co-citation and network analysis shows the existence of four different and related components such as Organizational Model design, Coordination mechanism, Organization Knowledge, Management Knowledge, System, Solve CPC problems, Design for e-commerce. These are the main trends and more important to development within the theory. This study also discovers the core papers such as variable number 19, 24, 28, 34 and 37, which implies the four components provides insight

into the theory's evolution and clarifies future research work with in CPC.

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Appendix

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