Ten years of modern innovation research:
Concepts, theories and relationships

Hsing-Chau Tseng[1]　　**Hsiang-Jui Kung[2]**　　**Chi-Hsiang Duan[3*]**

[1]Graduate School of Business & Operations Management Chung-Jung Christian University, Professor
[2]Department of Information Systems Georgia Southern University, Associate Professor
[3]Graduate School of Business & Operations Management
Chung-Jung Christian University, Doctoral student/ Lecturer

Abstract

.

The purpose of this study is to explore and map the intellectual structure of innovation studies during 1997-2006. This study also attempts to identify the relevant publications and influential scholars as well as the correlations among these publications using citation and co-citation analyses. In this paper, bibliometrics and social network analysis techniques are used to research knowledge network of the innovation literature by analyzing 17,382 cited references of 775 articles from two innovation related journals in SSCI and SCI databases. Four factors emerged in this study: (1) product development and management, (2) marketing management and strategy, (3) product innovation concepts, and (4) new product development and performance. This study provides readers a tool for evaluating innovation publications and provides a systematic and objective ways of determining the relative knowledge nodes in the development of innovation research.

Keywords: Innovation, Intellectual structure, Bibliometrics, Social network analysis

*Corresponding author: Graduate School of Business & Operations Management, Chung-Jung Christian University, 396 Chang Jung Rd., Sec.1, Kway Jen, Tainan 71101, Taiwan,
Tel: +886-6-2491912
Fax: +886-6-2785942
E-mail: michael.hsiang@msa.hinet.net

I. INTRODUCTION

Innovation research splits into two broad areas: (1) an economics-oriented tradition, examines differences in the patterns of innovation across countries and industrial sectors, the evolution of particular technologies over time, and intra-sector differences in the propensity of firms to innovate, and (2) an organizations-oriented tradition, focuses at a micro-level regarding how specific new products are developed [1]. Researchers have produced a large number of articles in the innovation field over the last decade. The context of innovation research in theoretical as well as practical levels reveals the union of researchers' opinions stating that innovation is represented in the interaction of the scientific research base, technology development, and market needs. When studying the latter view, more and more often the innovation creation process is chosen as the scientific research objective. Research findings in innovation can be disseminated to scholars and managers in the form of journal articles, and other documents, readers are easily confused with the subjects and their contributions to the development of innovation because they are faced with plentiful publications. Many studies have been made to explore innovation issues [2][3][4][5], but all issues are usually discussed solely based on the subjective assessment of different professionals, which often conducts many disputes in the innovation field.

The research method used for this study is theory-based citation and co-citation analysis. Using citation analysis, the interlinked nodes are discovered and from these nodes, the most influential publications and scholars in the innovation field are identified. Co-citation analysis is used to investigate the intellectual structure of innovation over time periods, 1997-2006. Profile analysis and bibliometrics techniques are used to create maps displaying the relationships among authors as perceived by scholars citing their paper over the time periods. This involves counting documents from a chosen field – either paired or co-cited documents.

This study provides readers a tool for evaluating innovation publications and provides a systematic and objective means of determining the relative importance of different knowledge nodes in the development of innovation research. The purpose of this study is to explore and map the intellectual structure of innovation studies during 1997-2006. This study also attempts to help readers identify the relevant publications and influential scholars as well as the correlations among these publications by analyzing citation and co-citation.

After this introductory note, the theoretical development on the knowledge networks is presented in Section II. The relevance and the relationship of such knowledge networks to the scholarly inquires in a field are examined in Section III. The discussion of results based on bibliometrics methodologies are presented next.

II. LITERATURE REVIEW

A knowledge network in the innovation field is composed of sufficiently large numbers of published articles, active researchers (the intellectual architects) and citations appearing in various media relating to electronic commerce and other fields [6][7][8]. This knowledge network can depict the developmental and diffusion patterns and processes in the knowledge system of innovation. During the accumulation of cross-field knowledge, key nodes are the most important bridges to connect different or even separate domains. Key nodes gain the main status during the cross-fertilizing process, which facilitates the knowledge communication and transmission among relevant parts of the whole network.

Bibliometrics is a research method used in library and information science. It utilizes quantitative analysis and statistics to describe patterns of publication within a given field or body of literature. Researchers may use bibliometrics to determine the influence of a single author and, for example, describe the relationship between the given author and other authors. Citation analysis is based on the hypothesis that authors cite papers they consider to be important to the development of their research. Chandy and Williams [9] pointed out that citations are viewed as the explicit linkages between articles that have common aspects. Many researchers have studied citations, the "raw data" of citation analysis. Cronin [10] described the citation process as detailed theoretical scrutiny that includes a review of the role and content of citations. Co-citation analysis records the number of papers that have cited any particular pair of documents and it is interpreted as a measure for similarity of content of the two documents. Co-citation analysis is a bibliometrics technique that information scientists use to "map" the topical relatedness of clusters of authors, journals or articles, i.e., the intellectual structure of a research field. Co-citation studies compile co-citation counts in a matrix form and statistically scale them to capture "a snapshot at a distinct point in time of what is actually a changing and evolving structure of knowledge" [11].

Several studies have used the bibliometrics technique to study management research. For example, Pilkington and Teichert [12] investigated the intellectual pillars of the management of technology literature and explored whether they are distinct from those commonly associated with its rival fields; Acedo & Casillas [13] explored the research paradigms of international management research by applying factorial analysis techniques in an author co-citation study; Ramos-Rodriguez and

Ruiz-Navarro [14] examined the intellectual structure change of strategic management research by conducting a bibliometrics study of the strategic management journal; and Ponzi [15] explored the intellectual structure and interdisciplinary breadth of knowledge management in its early stage of development, using principle component analysis on an author co-citation frequency matrix. No such study has treated the field of innovation; therefore this study aims to fill a gap in innovation literature by applying bibliometrics techniques to a representative collection of research articles to map the structure of this field.

In social and economic networks, Jackson [16] offers a comprehensive introduction to social and economic networks, drawing on the latest findings in economics, sociology, computer science, physics, and mathematics. He provides empirical background on networks and the regularities that they exhibit, and discusses random graph-based models and strategic models of network formation. Jackson also describes the varied statistical and modeling techniques used to analyze social networks.

III. METHODOLOGY

The research methods used for this study are bibliometrics and social network analysis. Bibliometrics is a theory-based citation and co-citation analysis. Using citation analysis, the interlinked invisible nodes are discovered from which the most influential publications and scholars in the innovation field can be identified. Furthermore, co-citation analysis is conducted by utilizing social network analysis to explore the intellectual structure of innovation studies and the knowledge nodes that have contributed most to the studies of innovation and their evolution patterns.

The general methods of data gathering and

analysis in author co-citation analysis have been described by various scholars [17][18][19][20][21]. Detailed discussion of retrieval strategies and techniques of data manipulation could be found in these publications. This is based on the purpose of this study to explore and map the intellectual structure of modern innovation studies during 1997-2006. With citation and co-citation analysis, this study has three phases, each of which required different approaches to examine the evolution of the innovation studies.

The primary data collection of this study is conducted using bibliographic retrieval methods to ascertain the number of papers which of that author's work. These data are retrieved using Lockheed's DIALOG to search SSCISEARCH—the online version of the Social Science Citation Index (SSCI). The authors' names are entered in the most general form and linked using the "Boolean" AND command [20]. Thus:

CR= A? AND CR= B?

The command would retrieve a set of papers, each paper containing at least one reference to a work by A (author name) and one reference to a work by B (author name). By using limit command and accession number ranges, the data from SSCI database is transported into successive time periods from 1997 to 2006.

Co-citation counts of all author pairings over the time period are organized in the form of a matrix. The values in the diagonal cells are scaled to fit the range of co-citation value in the corresponding column [17].

Citation networks are social networks in which the actors are journals, articles, or authors, the valued resources are ideas and knowledge, and the interactions are actors' mutual citations. We used the graphing program NetDraw [22] to examine co-citation matrixes.

Network analysis (NA) is an analytical tool that reveals the number of interactions and, consequently, the closeness of the relationships between nodes within a network. It produces diagrammatical representations of the relative distance between nodes, and illustrates structural patterns and differing positions within the network [23]. The graphing program NetDraw was used to examine the co-citation matrixes [22].

In addition, a companion software package for NetDraw, Ucinet, was utilized to develop measures of degree, closeness, and betweenness. Nodes high on closeness have the shortest paths to all others and they monitor what is happening in the network. Finally, betweeness is a calculation of influence. A node with high betweenness has great influence over what flows in the network.

1. Selection

The databases of SSCI and SCI from 1997 to 2006 serve as the base for our analysis due to their reputations and their extensive collection of 8,292 refereed journals (JCR Social Science Edition, 2007). SSCI and SCI provide the most comprehensive and widely accepted databases of innovation publications. Unlike other prior studies in the electronic commerce field, data used in this study were not drawn from journals chosen by the peer researchers [6] [7]. We use the "key words" search of the journal title fields taking advantage of the management of subject categories in the SSCI and SCI databases to choose sample journals. Among the journals in SSCI and SCI of ISI (Institute for Scientific Information), the Journal of Product Innovation Management (JPIM) and Innovations in Education and Teaching International (IETI) are the only two that mainly focus on innovation journal and are used as the

source to identify the most influential scholars and documents in innovation studies. The advantages of choosing these journals are the "guaranteed quality" of their published papers and their clear boundaries of what are the acceptable methods and topics of the field as defined by their editorial policies. However, it was felt that the wide range of topics covered by the articles in these journals and the differences in readership focus would necessitate a manual and time consuming classification of the articles to identify those relevant to innovation research.

2. Data Collection and Analysis

Citation data is first collected by counting the number of articles published in the two selected journals and the references these articles cited between 1997 and 2006, resulting in a total of 775 published articles and 17,382 cited publications. Citation is tabulated for each of the 775 source documents. This data is imported to Microsoft Excel for analysis. After a series of operations, key nodes in the knowledge network of innovation studies are identified and the structures developed. For the period of 1997-2001, about 36.9% of the references are journal articles, and 2002-2006 about 63.1% of the references are journal articles. Citation of journal articles has increased which may reflect the easy access to journal articles with more and more journals are accessible on-line.

3. Data Mapping

The key-nodes from 1997 to 2006 are identified (a co-citation matrix). This data is imported to Ucinet software [22] for social network analysis and factor analysis [12]. The intellectual structure of innovation is mapped to describe the knowledge distribution process in the innovation area.

We used r-Pearson as a measure of similarity between author pairs, because it registers the likeness in shape of their co-citation count profiles over all other authors in the set [18]. The co-citation correlation matrix is analyzed using varimax rotation, a commonly used procedure, which attempts to fit (or load) the maximum number of authors on the minimum number of factors.

IV. RESULTS

1. Citation Analysis

Citation analysis was tabulated for each of the 775 source documents using Excel package. The preliminary phase of data analysis produced the frequency of journal citations, statistics indicated in Table 1. The subject category scope includes management- product innovation, marketing, engineering, strategy; organization science and business alongside the innovation specific journals.

The most influential documents with the most citation and the most influential scholars were then identified by total counts of citation within the selected journal articles. Among all the cited journal articles, the most cited innovation article titles between 1997 and 2006 are: Brown and Eisenhardt's [24] "Product development: Past research, present findings, and future directions," followed by Montoyaweiss and Calantone's [25] "Determinants of new product performance: A review and meta-analysis," Griffin and Page's [26] "PDMA success measurement project: Recommended measures for product development success and failure." (See Table 2)

The collected data are analyzed and systematized by sorting, summing, sub-totaling, ranking, and screening. Key nodes in the intellectual structure of strategic management studies are identified and the structure developed. Based on the total number of citations in the two journals and

connected all journal articles, the most cited scholars between 1997 and 2006 are: Griffin, followed by Cooper and Song (See Table 3). From the citation samples, the most cited and influential authors are identified. These scholars are highly influential in innovation research and collectively define this field. Although it does not exclude the bias against junior authors, it still represents the focus of the primary authors in the field and this gives us an indication of the popularity of some innovation topics.

Table1. Highly cited journals in innovation studies 1997-2006

No.	Journal name	Fq.
1	Journal of Product Innovation Management	211
2	Journal of Marketing	81
3	Journal of Marketing Research	63
4	Management Science	35
5	Administrative Science Quarterly	33
6	Academy of Management Review	23
7	Organization Science	16
8	California Management Review	13
9	IEEE Transactions on Engineering Management	12
10	Strategic Management Journal	10
11	Journal of the Academy of Marketing Science	8
12	Journal of Academy Marketing Science	6
13	Journal of Consumer Research	6
14	Journal of Management	6
15	Harvard Business Review	5
16	Journal of Management Studies	5

Table2. Highly cited journal articles in innovation studies 1997-2006

NO.	FQ	YEAR	AUTHOR	PUBLISHER	JOURNAL ARTICLES
1	17	1995	BROWN SL	ACAD MANAGE REV, V20, P343	Product development: Past research, present findings, and future directions
2	17	1994	MONTOYAWEISS MM	J PROD INNOVAT MANAG, V11, P397	Determinants of new product performance: A review and meta-analysis
3	15	1996	GRIFFIN A	J PROD INNOVAT MANAG, V13, P478	PDMA success measurement project: Recommended measures for product development success and failure
4	14	1996	GRIFFIN A	J PROD INNOVAT MANAG, V13, P191	Integrating R and D and marketing : A review and analysis of the literature
5	13	1979	COOPER RG	J MARKETING, V43, P93	The dimensions of industrial new product success and failure
6	13	1987	COOPER RG	J PROD INNOVAT MANAG, V4, P169	New products: What separates winners from losers
7	13	1973	GRIFFIN A	J PROD INNOVAT MANAG, V10, P291	An Interim Report on Measuring Product Development Success and Failure
8	13	1997	GRIFFIN A	J PROD INNOVAT MANAG, V14, P429	PDMA research on new product development practices: Updating trends and benchmarking best practices
9	12	1977	ARMSTRONG JS	J MARKETING RES, V14, P396	Estimating non-response bias in mail surveys
10	11	1986	GUPTA AK	J MARKETING, V50, P7	A model for studying research-and-development: Marketing interface in the product innovation process
11	10	1995	EISENHARDT KM	ADMIN SCI QUART, V40, P84	Accelerating adaptive processes: product innovation in the global computer industry
12	10	1997	SONG XM	J MARKETING RES, V34, P64	The determinants of Japanese new product success
13	9	1991	KLEINSCHMIDT EJ	J PROD INNOVAT MANAG, V8, P240	The impact of product innovativeness on performance
14	8	1997	GRIFFIN A	J MARKETING RES, V34, P24	The effect of project and process characteristics on product development cycle time
15	8	1990	GUPTA AK	CALIF MANAGE REV, V32, P24	Accelerating the development of technology-based new products
16	8	1993	JAWORSKI BJ	J MARKETING, V57, P53	Market orientation: Antecedents and consequences
17	8	1995	OLSON EM	J MARKETING, V59, P48	Organizing for effective new product development: The moderating role of product innovativeness.
18	8	1993	SONG X	J ACAD MARKET SCI, V21, P125	R&D-marketing interface in Japanese high-technology firms: Hypotheses and empirical evidence
19	8	1986	VONHIPPEL E	MANAGE SCI, V32, P791	Lead users: A source of novel product concepts
20	8	1990	ZIRGER BJ	MANAGE SCI, V36, P867	A model of new product development：An empirical test

NO.	FQ	YEAR	AUTHOR	PUBLISHER	JOURNAL ARTICLES
21	7	1986	COOPER RG	J PROD INNOVAT MANAG, V3, P71	An investigation into the new product process: Steps, deficiencies, and impact
22	7	1995	COOPER RG	J PROD INNOVAT MANAG, V12, P374	Benchmarking the firm's critical success factors in new product development
23	7	1993	GRIFFIN A	J PROD INNOVAT MANAG, V10, P112	Metrics for measuring product development cycle time
24	7	1990	HENDERSON RM	ADMIN SCI QUART, V35, P9	Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms
25	7	1996	KAHN KB	J PROD INNOVAT MANAG, V13, P137	Interdepartmental integration: A definition with implications for product development performance
26	7	1990	KOHLI AK	J MARKETING, V54, P1	Market orientation: The construct, research propositions, and managerial implications
27	7	1984	MAIDIQUE MA	IEEE T ENG MANAGE, V31, P192	A study of success and failure in product innovation: The case of the US electronics industry
28	7	1990	NARVER JC	J MARKETING, V54, P20	The effect of a market orientation business profitability
29	7	1986	VANDEVEN AH	MANAGE SCI, V32, P590	Central problems in the management of innovation
30	6	1988	BAGOZZI RP	J ACADEMY MARKETING, V16, P74	On the evaluation of structural equation models
31	6	1991	BARNEY J	J MANAGE, V17, P99	Firm resources and sustained competitive advantage
32	6	1979	CHURCHILL GA	J MARKETING RES, V16, P64	A paradigm for developing better measures of marketing constructs
33	6	1994	COOPER RG	J PROD INNOVAT MANAG, V11, P3	Third-generation new product processes
34	6	1994	COOPER RG	J PROD INNOVAT MANAG, V11, P381	Determinants of timeliness in product development
35	6	1991	CORDERO R	J PROD INNOVAT MANAG, V8, P283	Managing for speed to avoid product obsolescence: A survey of techniques
36	6	1992	CRAWFORD CM	J PROD INNOVAT MANAG, V9, P188	The hidden costs of accelerated product development
37	6	1992	DOUGHERTY D	ORGAN SCI, V3, P179	Interpretive barriers to successful product innovation in large firms
38	6	1989	EISENHARDT KM	ACAD MANAGE REV, V14, P532	Building theories from case study research
39	6	1997	FISHER RJ	J MARKETING, V61, P54	Enhancing communication between marketing and engineering: The moderating role of relative functional identification
40	6	1985	GATIGNON H	J CONSUM RES, V11, P849	A propositional inventory for new diffusion research
41	6	1997	GATIGNON H	J MARKETING RES, V34, P77	Strategic orientation of the firm and new product performance
42	6	1988	GERBING DW	J MARKETING RES, V25, P186	An updated paradigm for scale development incorporating unidimensionality and its assessment.

43	6	1992	GRIFFIN A	MANAGE SCI, V38, P360	Patterns of communication among marketing, engineering and manufacturing—A comparison between two new product teams
44	6	1993	GRIFFIN A	MARKET SCI, V12, P1	The voice of the customer
45	6	1990	HOWELL JM	ADMIN SCI QUART, V35, P317	Champions of technological innovation
46	6	1998	LI T	J MARKETING, V62, P13	The impact of market knowledge competence on new product advantage: conceptualization and empirical examination

Table3. Highly cited scholars in innovation studies 1997-2006

No.	Key- nodes	Fq.
1	GRIFFIN A	82
2	COOPER RG	52
3	SONG XM	28
4	GUPTA AK	19
5	BROWN SL	17
6	MONTOYAWEISS MM	17
7	EISENHARDT KM	16
8	VONHIPPEL E	13
9	ARMSTRONG JS	12
10	GATIGNON H	12
11	DOUGHERTY D	11
12	DAY GS	10
13	SOUDER WE	10
14	KLEINSCHMIDT EJ	9
15	JAWORSKI BJ	8
16	OLSON EM	8
17	ZIRGER BJ	8
18	HENDERSON RM	7
19	KAHN KB	7
20	KOHLI AK	7

2. Co-citation Analysis

Data mapping is conducted and the intellectual structure of innovation studies revealed by using co-citation analysis. Co-citations are tabulated for each of the 775 source documents and 17,382 cited publications using the Microsoft Excel package. Many of the authors had very low co-citations and were either unlikely to have had a significant impact on the development of the field or were too recent to have had time to impact the literature. Following the recommended procedures of White and Griffith [18], the total numbers of citations in the selected journals are used to identify the top 20 scholars, and then a co-citation matrix (20×20) is created to represent the correlations among different publications.

Social network analysis tools can be used to graph the relations in the co-citation matrix and identify the strongest links and the core areas of interest in innovation [12]. Figure 1 shows the core disciplines- co-citation network of cited author.

Ucinet software [22] shows graphically the core areas of interest. The different shapes of the nodes result from performing a faction study of these authors. This method seeks to group elements in a network based on the sharing of common links. These factions can be interpreted as the concentration of the interactions between product development and management, marketing management and strategy, product innovation concepts, and new product development and performance.

Figure 1 shows a clear picture whose focus is only on the very core area. The co-citation matrix and the grouping of authors (using factor analysis of the correlation between the entries) determine which authors are grouped together and which share a common interest. According to this, the closeness of author points on such maps is algorithmically related to their similarity as perceived by citers.
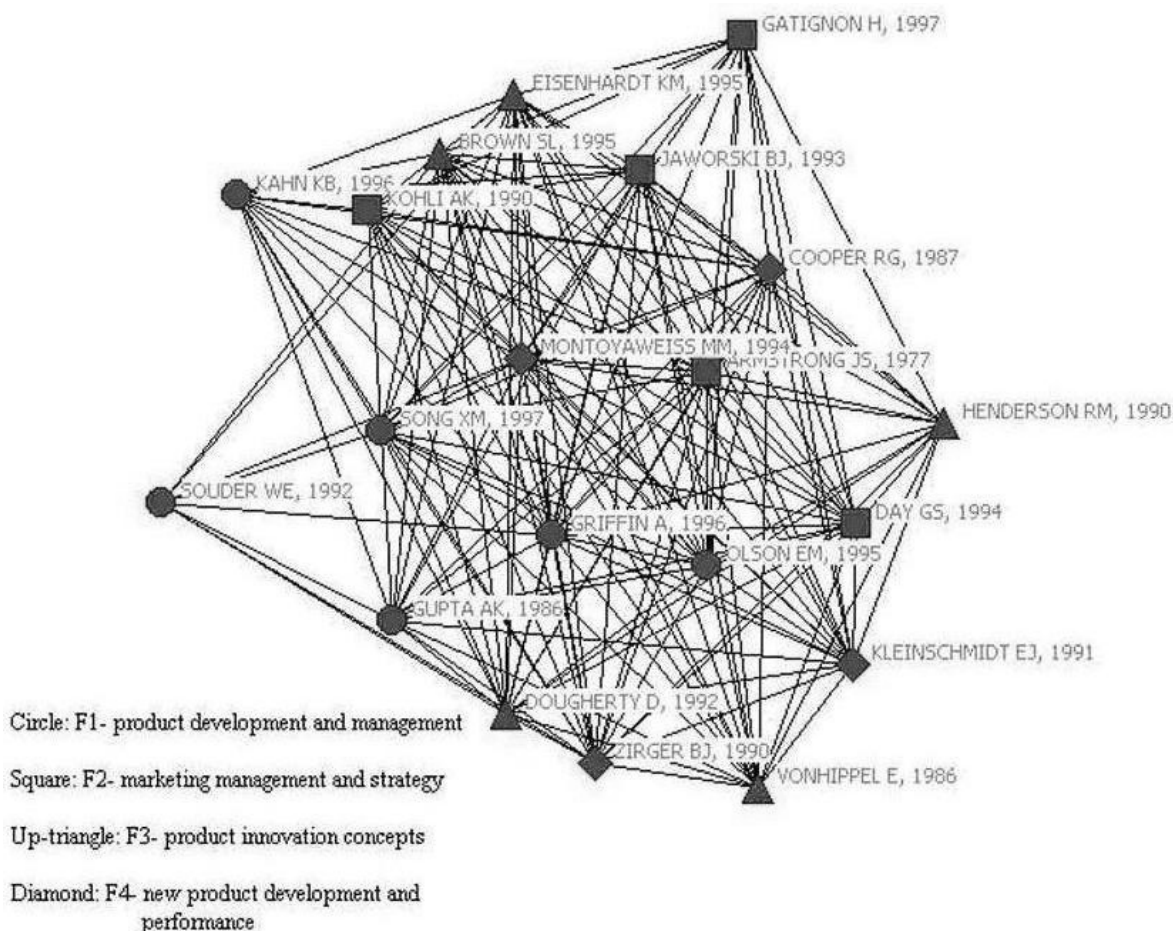
Circle: F1- product development and management

Square: F2- marketing management and strategy

Up-triangle: F3- product innovation concepts

Diamond: F4- new product development and performance

Figure1. Co-citation network of innovation studies

The most influential scholars in the innovation studies between 1997 and 2006 are grouped together. Four factors were extracted from the data and together they explain over 85% of the variance in the correlation matrix (See Table 4). Table 5 lists the four most important factors along with the authors that had a factor loading of at least 0.5. As is usual in this type of analysis, documents with less than a 0.5 loading were dropped from the final results [27]. We tentatively assigned names to the factors on the basis of our own interpretation of the authors with high associated loadings. Our interpretation of the analysis results concluded that the innovation field comprises four basic but different sub-fields: (1) product development and management, (2) marketing management and strategy, (3) product innovation concepts, and (4) new product development and performance. We made no attempts to interpret the remaining factors on account of their relative small eigenvalues (< 2.060). They have likewise been excluded from Table 5.

Table4. Eigenvalues of the top four factors 1997-2006

Factor	Eigenvalue	Pct. OF Var.	Cum. Pct.
1	6.774	33.3	33.3
2	5.800	28.5	61.8
3	2.794	13.7	75.5
4	2.060	10.1	85.6

Table5. Authors factor loadings (varimax rotation) at 0.5 or higher 1997-2006

F1 Product development and management	33.3% variance	F2 Marketing management and strategy	28.5% variance	F3 Product innovation concepts	13.7% variance	F4 New product development and performance	10.1% variance
Kahn	0.936	Day	0.985	Dougherty	0.937	Kleinschmidt	0.908
Gupta	0.843	Armstrong	0.981	Brown	0.904	Montoyaweiss	0.777
Sounder	0.825	Gatignon	0.975	Henderson	0.883	Cooper	0.754
Griffin	0.824	Jaworski	0.967	Eisenhardt	0.869	Zirger	0.722
Song	0.749	Kohli	0.961	Vonhippel	0.504		
Olson	0.715						

In Figure 1 and Table 5, *Factor 1* showed that the main research focused on product development and management. Kahn [28] presented the results of a study exploring how collaboration and interaction affect product development performance and product management (post-launch) performance. To best manage interdepartmental integration, managers should first assess their firm's levels of interdepartmental collaboration and interaction. The scales presented in this study can be used for this benchmarking effort. The results of this assessment can be used for developing and implementing an action plan for improving interdepartmental integration. Gupta, Raj and Wilemon [29] proposed that a firm's strategy and how it perceives environmental uncertainty can influence the need for R&D-marketing integration. Factors related to organizational design and senior management support,

along with the socio-cultural differences between R&D and marketing managers, can influence the level of integration achieved by an organization, and the gap between the level of integration needed and that achieved can influence innovation success. Souder and Moenaert [30] argued that the synergistic results of integration can best be understood as a within-role increase of uncertainty reduction, and a between-role convergence of functional uncertainty reduction.

Factor 2 represented the marketing management and strategy. Day [31] addressed a comprehensive change program aimed at enhancing these capabilities includes: (1) the diagnosis of current capabilities, (2) anticipation of future needs for capabilities, (3) bottom-up redesign of underlying processes, (4) top-down direction and commitment, (5) creative use of information technology, and (6)

continuous monitoring of progress. Armstrong and Overton [32] indicated valid predictions for the direction of non-response bias were obtained from subjective estimates and extrapolations in an analysis of mail survey data from published studies. For estimates of the magnitude of bias, the use of extrapolations led to substantial improvements over a strategy of not using extrapolations. Gatignon and Xuereb [33] proposed a structural model of the impact of the strategic orientation of the firm on the performance of a new product.

Factor 3 revealed the product innovation concepts. Dougherty [34] examined these problems by focusing on the shared interpretive schemes people use to make sense of product innovation. Two interpretive schemes are found to inhibit development of technology-market knowledge: departmental thought worlds and organizational product routines. Brown and Eisenhardt [24] organized the burgeoning product-development literature into three streams of research: product development as rational plan, communication web and disciplined problem solving; synthesized research findings into a model of factors affecting the success of product development; and indicated potential paths for future research based on the concepts and links that are missing or not well defined in the model. Henderson and Clark [35] examined such innovations more closely and, distinguishing between the components of a product and the ways they are integrated into the system that is the product "architecture," define them as innovations that change the architecture of a product without changing its components. They illustrated the concept's explanatory force through an empirical study of the semiconductor photolithographic alignment equipment industry, which has experienced a number of architectural innovations.

Factor 4 exhibited the new product development and performance. Kleinschmidt and

Cooper [36] demonstrated that the relationship between product innovativeness and commercial success is U-shaped. That means that both high and low innovativeness products are more likely to be more successful than those in-between. Montoyaweiss and Calantone [25] conducted a comprehensive review of this literature and observed a wide variety of study designs and methodological approaches. They developed quantitative comparisons of the results, which, although cumbersome, provide a look at the persistent exploratory nature of this research. Cooper and Kleinschmidt [37] concluded that product superiority is the number one factor influencing commercial success and that project definition and early, predevelopment activities are the most critical steps in the new products development process.

V. CONCLUSIONS

This study explores and maps the intellectual structure of innovation studies during 1997-2006, by analyzing 17,382 cited references of 775 articles from two innovation related journals in SSCI and SCI databases. We identify the relevant publications (high impact) and the influential scholars as well as the correlations among these publications by analyzing citation, co-citation and conducting social network analysis. Researchers can also use these methods to explore the intellectual structure of their own fields.

Social network analysis tools can be used to graph the relations in the co-citation matrix and identify the strongest links and core areas of interest [12] in innovation. Co-citation matrix and the grouping of authors (using factor analysis of the correlation between the entries) determined the clusters of authors. According to this, the closeness of author points on such maps is algorithmically related to their similarity as perceived by citers. A factor

analysis of the co-citations proposed that the field includes four different concentrations of interest within the ten years: (1) product development and management, (2) marketing management and strategy, (3) product innovation concepts, and (4) new product development and performance.

The intellectual structure of innovation and the development path discussed above can help researchers as well as professionals by recognizing the influential publications and scholars of this field. This method also provides researchers a wide spectrum of inter-connected (web-like) nodes laden with ideas, concepts, and theories with which scholars and thinkers can start their own exploring. In other words, the contributions of this research is to provide valuable research direction in the innovation area and an objective and systematic means of determining the relative importance of different knowledge nodes in the development of the innovation field.

Even though this research has its merit of offering valuable insights into the intellectual structure of innovation studies, it also has some limitations: our data collection criteria exclude some journals that may have published innovation articles and our research method could not exclude the phenomenon of self citation. In order to overcome the limitations associated with citation analysis, future research is encouraged to combine citation analysis with content analysis, a research tool used to determine the presence of certain words or concepts within texts or sets of texts.

REFERENCES

1. Adler, P.S., "Technology Strategy: A Guide to the Literatures, in R.S. Rosenbloom and R.A. Burgelman,ed., Reaearch on Technological Innovation, Management and Policy," Greenwich, Connectocut: JAI Press, Vol. 4, 25-151 (1989).

2. Banytė, J. and Salickaitė, R., "Successful diffusion and adoption of innovation as a means to increase competitiveness of enterprises," *Engineering Economics*, Vol. 56, No. 1, 48-56 (2008).

3. Griffith, R., Huergo, E., Mairesse, J., and Peters, B., "Innovation and productivity across four European countries," *Oxford Review of Economic Policy*, Vol. 22, 483–498 (2006).

4. Gebhardt, C., The impact of managerial rationality in the organizational paradigm. Role models in the management of innovation, *Technology Analysis & Strategic Management*, Vol. 17, No. 1, 21–34 (2005).

5. Stephan, J., 'The productivity gap between east and west Europe: What role for sectoral structures during integration?,' *Acta Oeconomica*, Vol. 52, 289–305 (2002).

6. Ngai, E.W.T. and Wat, F.K.T., "A literature review and classification of electronic commerce research," *Information and Management*, Vol. 39, No. 5, 415-429 (2002).

7. Shaw, M.J., Gardner, D.M. and Thomas, H., "Research opportunities in electronic commerce," *Decision Support Systems*, Vol. 21, 149-156 (1997).

8. Wareham, J., Zheng, J.G. and Straub, D., "Critical themes in electronic commerce research: A meta-analysis," *Journal of Information Technology*, Vol. 20, 1-19 (2005).

9. Chandy, P.R. and Williams, T.G., "The impact of journals and authors on international business research: A citation analysis," *Journal of International Business Studies*, Vol. 25, 715-728 (1994).

10. Cronin, B., *The citation process: the role and significance of citations in scientific communication*, London: Taylor Graham

(1984).

11. Small, H.G., "Macro-level changes in the structure of co-citation clusters: 1983-1989," *Scientometrics*, Vol. 26, 5-20 (1993).

12. Pilkington A. and Teichert T., "Management of technology: Themes, concepts and relationships," *Technovation*, Vol. 26, 288-299 (2006).

13. Acedo, F.J. and Casillas, J.C., "Current paradigms in the international management field: An author co-citation analysis," *International Business Review*, Vol. 14, 619-639 (2005).

14. Ramos-Rodriguez, A.R. and Ruiz-Navarro, J., "Changes in the intellectual structure of strategic management research: A bibliometrics study of the strategic management journal, 1980-2000," *Strategic Management Journal*, Vol. 25, 981-1004 (2004).

15. Ponzi, L.J., "The intellectual structure and interdisciplinary breadth of knowledge management: A bibliometric study of its early stage of development," *Scientometrics*, Vol. 55, 259-272 (2002).

16. Jackson, M.O., *Social and Economic Networks*, Princeton University Press, Princeton, NJ (2008).

17. White, H.D., "A co-citation map of the social indicators movement," *Journal of the American Society for Information Science*, Vol. 34, 307–312 (1983).

18. White H. and Griffith B., "Author co-citation: A literature measure of intellectual structure," *Journal of the American Society for Information Science*, Vol. 32, No. 3, 163-171 (1981).

19. McCain, K.W., "The Author Co-citation Structure of Macroeconomics," *Scientometrics*, Vol. 5, 277-289 (1983).

20. McCain, K.W., "Longitudinal author co-citation mapping: The changing structure of macroeconomics," *Journal of the American Society for Information Science*, Vol. 35, 351-359 (1984).

21. McCain, K.W., "Mapping authors in intellectual space: A technical overview," *Journal of the American Society for Information Science*, Vol. 41, No. 6, 433-443 (1990).

22. Borgatti, S.P., Everett, M.G. and Freeman, L.C., *Ucinet for Windows: Software for social network analysis*, Analytic Technologies, Harvard, MA (2002).

23. Wasserman, S. and Faust, K., *Social network analysis: Methods and applications*, Cambridge University Press, Cambridge, MA (1997).

24. Brown, S.L. and Eisenhardt, K.M., "Product development: Past research, present findings, and future directions," *The Academy of Management Review*, Vol. 20, No. 2, 343-378 (1995).

25. Montoyaweiss, M.M. and Calantone, R., "Determinants of new product performance: A review and metaanalysis," *Journal of Product Innovation Management*, Vol. 11, No. 5, 397-417 (1994).

26. Griffin, A. and Page, A.L., "PDMA success measurement project: Recommended measures for product development success and failure," *Journal of Product Innovation Management*, Vol. 13, No. 6, 478-496 (1996).

27. Hair, J.F., Anderson, R.E., Tatham, R.L. and Black, W.C., *Multivariate data analysis*, Prentice Hall, Upper Saddle River, NJ (1998).

28. Kahn, K.B., "Interdepartmental integration: A definition with implications for product development performance," *Journal of Product Innovation Management*, Vol. 13, No. 2, 137-151 (1996).

29. Gupta, A.K., Raj, S.P. and Wilemon, D., "A

model for studying research-and-development: Marketing interface in the product innovation process," *Journal of Marketing*, Vol. 50, No. 2, 7-17 (1986).

30. Souder, W.E. and Moenaert, R.K., "Integrating marketing and research-and-development project personnel within innovation projects: An information uncertainty model," *Journal of Management Studies*, Vol. 29, No. 4, 485-512 (1992).

31. Day, G.S., "The capabilities of market-driven organizations," *Journal of Marketing*, Vol. 58, No. 4, 37-52 (1994).

32. Armstrong, J.S. and Overton, T.S., "Estimating nonresponse bias in mail surveys," *Journal of Marketing Research*, Vol. 14, No.3, 396-402 (1977).

33. Gatignon, H. and Xuereb, J.M., "Strategic orientation of the firm and new product performance," *Journal of Marketing Research*, Vol. 34, No. 1, 77-90 (1997).

34. Dougherty, D., "Interpretive barriers to successful product innovation in large firms," *Organization Science*, Vol. 3, No. 2, 179-202 (1992).

35. Henderson, R.M. and Clark, K.B., "Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms," *Administrative Science Quarterly*, Vol. 35, No. 1, 9-30 (1990).

36. Kleinschmidt, E.J. and Cooper, R.G., "The impact of product innovativeness on performance," *Journal of Product Innovation Managementa*, Vol. 8, No. 4, 240 (1991).

37. Cooper, R.G. and Kleinschmidt, E.J., "New products: What separates winners from losers," *Journal of Product Innovation Management*, Vol. 4, No. 3, 169–184 (1987).

近十年創新研究之概念、理論與其關聯性

曾信超 [1]　　孔祥瑞 [2]　　段起祥 [3*]

[1] 長榮大學經營管理研究所 教授
[2] 美國南喬治亞大學資訊系統系 副教授
[3] 長榮大學經營管理研究所 博士生/ 講師

摘　　要

　　本研究目的在探索與繪製 1997 年至 2006 年間創新研究領域的智慧結構，使用引文與共引文分析來確認研究領域中相關文獻和有影響力的學者及其間的關聯性。本文藉由十年間發表在 SSCI 及 SCI 資料庫中二個有關創新期刊的文獻為研究樣本，共計分析了 775 篇文獻及 17,382 筆參考文獻資料，並以書目計量學與社會網路分析技術為研究方法來研究創新文獻。研究結果可提供讀者一個有系統又客觀之研發方法及評估創新刊物的工具且出現四個不同的要素(議題)：(1)產品發展與管理，(2)行銷管理與策略，(3)產品創新概念，與(4)新產品發展與績效。

關鍵詞：**創新，智慧結構，書目計量學，社會網路分析。**

*連繫作者：長榮大學經營管理研究所，71101 台南縣歸仁鄉長榮路一段 396 號。
Tel: +886-6-2491912
Fax: +886-6-2785942
E-mail: michael.hsiang@msa.hinet.net