

Mapping the Intellectual Structure of Contemporary Electronic Commerce Research

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ABSTRACT

To map the intellectual structure of electronic commerce research in this century, this study identified the most important publications and the most influential scholars as well as the correlations among these scholar's publications. In this study, bibliometric and social network analysis techniques are used to investigate the intellectual pillars of the electronic commerce literature. By analyzing 28,470 citations of 1,333 articles published in SSCI and SCI journals in electronic commerce area between 2000 and 2006, this study maps an invisible network of knowledge of electronic commerce studies. The results of the mapping can help identify the research direction of electronic commerce research and provide a valuable tool for researchers to access the literature in this area.

Key Words: electronic commerce, intellectual structure, bibliometric technique, social network analysis, invisible network of knowledge

探索當代電子商務研究之智慧結構

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摘要

本研究之目的為探索內含在當代電子商務研究文獻之智慧結構。本研究以書目計量學和社會網路分析技術為研究方法；以 2000 年至 2006 年發表在 SSCI 及 SCI 期刊有關電子商務議題的研究文獻為對象，共計分析了 1,333 篇文獻及 2,8470 筆參考文獻資料。研究結果呈現當代電子商務研究領域最具影響力的學者和文獻及其間的相關性；進一步描繪出當代電子商務研究領域的泛知識網路及闡明研究領域的發展及變化。

關鍵詞：電子商務，智慧結構，書目計量學，社會網路分析，泛知識網路

I. INTRODUCTION

Over the last decade the scholars have produced a great deal of papers in electronic commerce field. While research findings in electronic commerce can be disseminated to scholars and managers in the form of journal articles, books, and other documents, scholars are easily confused with the subjects and their contributions to the development of electronic commerce when faced with abundant publications. Many studies have been made to explore these issues (Ngai & Wat, 2002; Shaw, Gardner, & Thomas, 1997; Wareham, Zheng, & Straub, 2005), yet all the issues are usually discussed solely based on the subjective assessment of different experts, which often leads to many controversies in the electronic commerce area.

The research methods used for this study are bibliometric and social network analysis. Bibliometric 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 electronic commerce field are identified. Further, co-citation analysis is conducted to utilize the social network analysis mining the intellectual structure of electronic commerce studies and to explore the invisible knowledge nodes that have contributed most to the studies of electronic commerce and their possible evolution patterns.

The objective of this study is to find out the invisible network of knowledge during 2000-2006 year and to explore the intellectual structure of contemporary electronic commerce research. This study also attempts to help researchers identify the linkage among different scholars and confirm the status of each scholar in their contribution to the electronic commerce field.

II. THEORY OF THE INVISIBLE NETWORK OF KNOWLEDGE

1. Concept of Knowledge

Knowledge refers to the output of learning process, just as plans are the output of the planning process. Gibbons, Limorges, Nowwothy, Schwartzman, Scott, and Trow (1994) contend that the terms of science and knowledge are frequently adopted interchangeably to form scientific knowledge. Latour (1987) defined knowledge in term of *familiarity* and argued that a novice should become familiar with the intended knowledge generation or production system of a given field in order to understand the nature, potential uses and evolutionary process of knowledge in this field over time.

2. Concept of Network

Networks have been extensively applied in engineering

and science for managing complex systems. In engineering and sciences, *network* commonly refers to a system or a web of inter-linked sub-systems or components, each optimally designed to perform a designated task effectively. Each sub-system is highly specialized and generally draws on high levels of accumulated knowledge and expertise within its expected domain of operations. Engineers and scientists achieve a much broader, and more complex, range of functions and capabilities than the reach of individual components or sub-systems by optimal inter-linking of these components. Theoretically, the system as a whole may not be truly optimal, yet it can be effective and flexible enough to perform the task at hand, well beyond the capabilities of its individual components. The two important components of a network are the key nodes and linkages whereby key nodes point out the system resources for knowledge generation with their connections via linkages.

3. Concept of Invisible Network of Knowledge (INK)

Knowledge is complex and invisible making it is very hard for those who attempt to obtain knowledge. This is because people each have their own views concerning knowledge, often results in misunderstanding about what is the knowledge add where it is residing. Consequently, an effective approach is strongly required to help people visualize knowledge, and further maintain and develop a common visualization and representation of knowledge. Chandy and William (1994) argued that each localized knowledge network is a part or sub-system of a broader and more general system. From that perspective, the knowledge network of one discipline could be viewed as an offshoot of its interacting foundational domains which are well-established sub-systems.

The concept of invisible hand reflects our admiration for the elegant and smooth functioning of the market system as a coordinator of autonomous individual choices in an interdependent world. Similarly, because the development and diffusion of knowledge of one discipline can be formulated and changed by the nature and objective of relevant journals (especially those famous and major journals in this discipline), one discipline's journals can be regarded as an "invisible hand" influencing the locus of development and diffusion of the knowledge network of a given field.

By combining the invisible hand of journals and the knowledge in term of citation networks of scientific papers as most important scientists' communications (Price, 1965), this study constructed a concept of Invisible Network of Knowledge production of a discipline (an INK model) to help *make the invisible more visible*. Besides the merits of the conventional concept of knowledge network, INK model

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focuses mostly on how invisible knowledge affects a discipline (or a field) to increase its visibility using computer-aided epistemology. The INK model can help map the knowledge network of a field (or a discipline) and reveal its locus of theory development and evolutionary trends. The invisible network of knowledge (INK) model could be an effective meta-method to represent invisible knowledge of a field. An invisible network of a field in nature can be considered as the repository of broad and complex sets of expertise, experience, and accumulated theoretical essentials in its various parts of knowledge, from which both inside and outside members can draw to help advance and refine this field.

4. How Has the INK of Electronic Commerce Developed?

An invisible network of knowledge of any given field embodies both the knowledge content of its nodes and the inter-linkages of those nodes within its domain and to other fields. It can be regarded as the organized and the *de-facto* mirror of a field. The INK of electronic commerce can be considered as an offshoot of its interacting foundational domains, which are well-established sub-systems of electronic commerce (i.e. publications relevant to electronic commerce). Even though these constituent or foundational fields may not contain sufficient concepts, ideas, frameworks or relevant theoretical essentials to provide adequate solutions for the emerging problems facing the field of electronic commerce, they generate an environment for the cross-fertilization of the relevant parts of constituent fields. This environment enables the field of electronic commerce to develop and mature.

The landscape of a mature knowledge network in the electronic commerce field is composed of sufficiently large quantities of published articles, active researchers (the intellectual architects) and citations appearing in various media relating to electronic commerce and other fields (Ngai & Wat, 2002; Shaw et al., 1997; Wareham et al., 2005). The following sections describe this invisible network, which is a collection of interconnected knowledge resources in terms of the intellectual, conceptual, or theoretical linkages. This knowledge network can portray the developmental and diffusion patterns and processes in the knowledge system of electronic commerce.

III. RESEARCH METHODOLOGY

Based on the proposed INK model, the authors explored the intellectual structure of electronic commerce between 2000 and 2006. This study chose this time period because the electronic commerce studies of this century represent the most important and the most updated research in electronic commerce area. Citation and co-citation analysis are the main

methods for this study. With citation and co-citation analysis, this research assumed three stages, each of which required different approaches to examining the evolution of the electronic commerce studies.

First, the databases were identified as the sources of electronic commerce publications. Then data collection and analysis techniques were designed to collect the desired information about the topics, authors, and journals on electronic commerce research. For the data presented here, the Social Science Citation Index (SSCI) and Science Citation Index (SCI) were used as parts of the databases. The SSCI and SCI were widely used databases, which included citations published in about 6000 refereed journals. Using SSCI and SCI provided the most comprehensive and widely accepted databases of electronic commerce 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 (Ngai & Wat, 2002; Shaw et al., 1997). Instead, the entire databases of SSCI and SCI from 2000 to 2006 served as the universe for conducting the analysis. In order to choose sample articles, this study uses "key words" method which utilizes the SSCI and SCI databases key word search in article's title. The authors argue that the key word search in article's title is more accurate than in article's key words. Using "E-commerce" and "electronic commerce" as key words, this study included 1,333 journal articles which cited 28,470 other publications as references. The cited publications in these papers include both published books and other journal articles.

In the second stage, citation analysis was tabulated for each of the 1,333 source documents using the *Excel* package. After a series of operations, key nodes in the invisible network of knowledge in electronic commerce studies were identified and the structures developed. In the final stage, co-citation analysis is conducted to utilize the social network analysis and factor analysis which mining the intellectual structure of electronic commerce studies and to explore the invisible knowledge nodes that have contributed most to the studies of electronic commerce and their possible evolution patterns.

IV. RESULTS

1. Citation Analysis

Preliminary analyses of the data produced interesting background statistics, for example the frequency of journal citations, listed in Table 1. General management and marketing specific journals featured prominently alongside the electronic commerce specific journals; with a cluster of information systems focused titles also evident, while

Table 1. The Most Frequently Cited Journals

Journal title	Number of citations
Communications of the ACM	698
International Journal of Electronic Commerce	399
MIS Quarterly	386
Management Science	372
Journal of Marketing	313
Harvard Business Review	252
Decision Support Systems	206
Information Systems Research	202
Journal of Marketing Research	179
Strategic Management Journal	179
Information & Management	177
Journal of Management Information Systems	150
Academy Management Review	145
Internet Research	145
Journal of Consumer Research	141
Sloan Management Review	130
Electronic Markets	128
Journal of the Academy of Marketing Science	108
Academy Management Journal	106
Information Systems Journal	94

economic is less prominent.

The most influential documents with the most citation and the most influential scholars were then identified by their total counts of citation within the selected journal articles. Among all the cited documents, the most cited electronic commerce document between 2000 and 2006 was Malone, Yates, and Benjamin's paper (1987) *Electronic Market and Electronic Hierarchies*, followed by Kalakota and Whinston's book (1996) *Frontiers of Electronic Commerce*, and Maes, Guttman, and Moukas's paper (1999) *Agents that Buy and Sell*:

Transforming Commerce as We Know it (see Table 2). Journal articles and books combined, the most cited scholar between 2000 and 2006 was Bakos, followed by Jarvenpaa and Porter (See Table 3). These scholars have the most influence in the development in the electronic commerce area and thus collectively define this field. Although it does not eliminate the bias against younger authors, it still represents the focus of the main authors in the field and this gives us an indication of the popularity of certain electronic commerce topic.

2. Co-citation Analysis

In this stage, data mapping was conducted and an intellectual structure of the electronic commerce studies was revealed by using co-citation analysis. Co-citations were tabulated for each 1,333 source documents using the *Excel* package. Many of the authors had very few co-citations and were either unlikely to have had a significant impact on the development of the field and/or were too recent to have had time to impact on the literature. To facilitate the running of our analyses and improve the probability of its success, the authors made sure that all authors in the final set had at least twenty citations. Based on the total number of citations in the selected journals, the top 30 scholars were identified, and then a co-citation matrix (30 X 30) was built before a pictorial map was drawn to describe the correlations among different scholars. In doing so, we were following the procedures recommended by White and Griffith (1981).

Social network analysis tools can be used to graph the relations in the co-citation matrix and identify the strongest links and so the core areas of interest in electronic commerce (Pilkington & Teichert, 2006). Figure 1 shows the core of the co-citation in this study sample articles with links of greater

Table 2. Article Citation Frequency (Frequency \geq 20)

No.	Frequency	Full citation index for document
1	37	MALONE TW, 1987, COMMUN ACM, V30, P484
2	33	KALAKOTA R, 1996, FRONTIERS ELECT COMM
3	30	MAES P, 1999, COMMUN ACM, V42, P81
4	29	ZWASS V, 1996, INT J ELECTRON COMM, V1, P3
5	28	DAVIS FD, 1989, MIS QUART, V13, P319
6	27	KALAKOTA R, 1997, ELECT COMMERCE MANAG
7	26	HOFFMAN DL, 1999, COMMUN ACM, V42, P80
8	26	PORTER ME, 2001, HARVARD BUSINESS MAR, P63
9	23	BAKOS JY, 1991, MIS QUART, V15, P295
10	23	BAKOS Y, 1998, COMMUN ACM, V41, P35
11	22	MAYER RC, 1995, ACAD MANAGE REV, V20, P709
12	21	BAKOS JY, 1997, MANAGE SCI, V43, P1676
13	21	IACOVOU CL, 1995, MIS QUART, V19, P465
14	21	SHAPIRO C, 1999, INFORMATION RULES ST
15	20	BENJAMIN R, 1995, SLOAN MANAGE REV, V36, P62

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Table 3. Author Citation Frequency (Frequency ≥ 20)

Author	Frequency
Bakos, J.Y.	103
Jarvenpaa, S. L.	84
Porter, M. E.	73
Kalakota, R.	69
Hoffman, D. L.	62
Gefen, D.	53
Davis, F. D.	49
Malone, T. W.	49
Williamson, O. E.	35
Maes, P.	34
Zwass, V.	30
Brynjolfsson, E.	29
Shapiro, C.	29
Riggins, F. J.	27
Straub, D.	26
Chircu, A. M.	25
Lohse, G. L.	25
Rayport, J. F.	25
Alba, J.	23
Nunnally, J. C.	23
Mayer, R. C.	22
Turban, E.	22
Iacovou, C. L.	21
Resnick, P.	21
Rogers, E. M.	21
Benjamin, R.	20
Clemons, E. K.	20
Guttman, R. H.	20
Hagel, J.	20
Mcknight, D. H.	20
Poon, S.	20
Timmers, P.	20

than or equal to ten co-citations shown in the network. This was produced using UCINET software (Borgatti, Everett, & Freeman, 2002) and 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 to each other. These factions can be interpreted as concentrating on the interaction between strategy, electronic marketplace, consumer behavior, and electronic shopping.

Whilst the diagram in Figure 1 is very telling and provides a clear picture, its focus is only on the very core area and a limited amount of the data available. By taking the co-citation matrix and grouping the authors using factor analysis of the correlation between the entries determines which authors are grouped together and there for share a common element. According to this, the closeness of author points on such maps is algorithmically related to their similarity as perceived by citers. We use 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 (White & McCain, 1998).

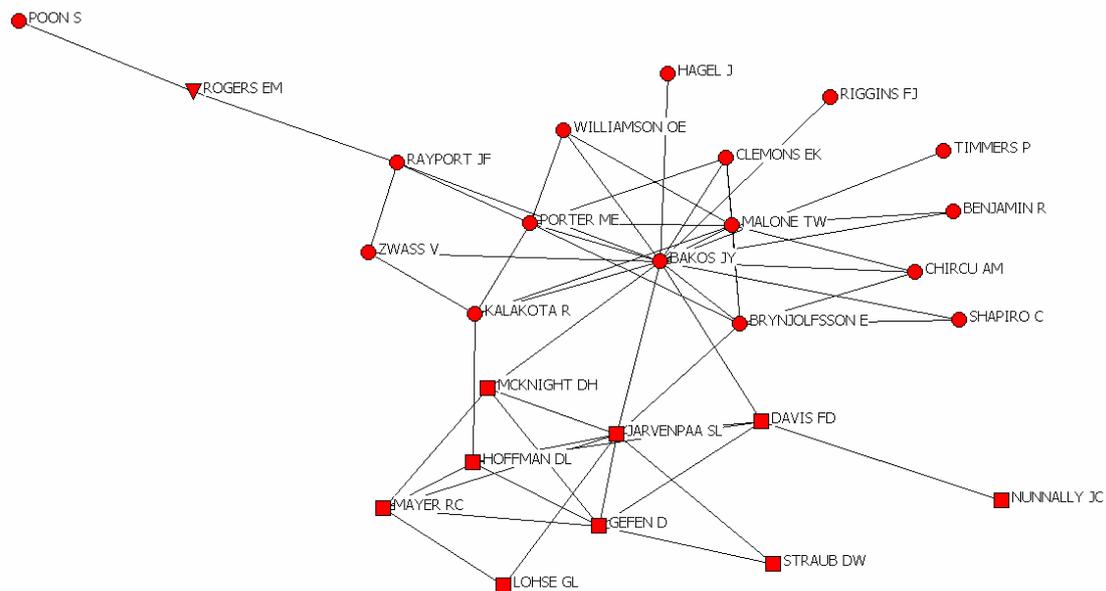
The co-citation correlation matrix was factor analyzed using varimax rotation, a commonly used procedure, which attempts to fit (or load) the maximum number of authors on the minimum number of factors. The diagonals were considered it missing data and apply the criterion of omitting the two cases (*pairwise delete*) (McCain, 1990).

Three factors were extracted from the data and together they explain over 70% of the variance in the correlation matrix. Table 4 lists the three most important factors along with the authors that had a factor loading of at least 0.4. As is usual in this type of analysis, authors with less than a 0.4 loading were dropped from the final results (White & Griffith, 1981). We tentatively assigned names to the factors on the basis of our own interpretation of the authors with high associated loadings. Implicitly, our interpretation of the analysis results is that the electronic commerce field is composed of at least three different sub-fields: strategy and electronic marketplace, consumer behavior in electronic commerce, and implications of electronic shopping. We made no attempts to interpret the remaining factors on account of their relative small eigenvalues (<8.5%). They have similarly been excluded from Table 4.

Figure 1 and Table 4 clearly indicated that the most influential scholars in electronic commerce studies between 2000 and 2006 clustered together. The main research focused on strategy and electronic marketplace. Porter (2001) submitted five forces model applied to B2B e-marketplaces. According to Porter, the most important determinant of a marketplace's profit potential is the intrinsic power of the buyers and suppliers in the product area. Bakos (1991) presented a more circumscribed view of the electronic marketplace as a facilitator of information about prices and products and argued that electronic marketplace reduce the costs incurred to acquire information. Advanced, Bakos (1997) concluded that lowering the buyer's search costs enables buyers to find low-cost sellers, and that electronic marketplace will therefore promote price competition among sellers. Bakos's theory appeared to be consistent with Malone Malone, Yates, and Benjamin (1987). Malone et al. has predicted that with information technology's ability to reduce transaction costs, increasingly firms would be operating in a market. Meanwhile, Clemons, Reddi, and Row (1993) emphasized that IT system has the capability to lower external coordination costs without increasing the contractual risks associated with market transactions and proposed that an IT system reduces transaction risks such as the contractual hazards

Table 4. Author Factor Loadings (varimax rotation) at 0.4 or higher

Factor 1: strategy and electronic marketplace	40.5% variance	Factor 2: consumer behavior in electronic commerce	24.4% variance	Factor 3: implications of electronic shopping	8.5% variance
PORTER ME	0.945	GEFEN D	0.963	ALBA J	0.785
CLEMONS EK	0.944	MCKNIGHT DH	0.948	RESNICK P	0.741
BAKOS JY	0.919	MAYER RC	0.945	TURBAN E	0.581
MALONE TW	0.912	JARVENPAA SL	0.930		
CHIRCU AM	0.909	STRAUB TW	0.896		
BRYNJOLFFSSON E	0.893	DAVIS FD	0.880		
SHAPIRO C	0.874	HOFFMAN DL	0.840		
WILLIAMSON OE	0.852	LOHSE GL	0.798		
TIMMERS P	0.838	NUNNALLY JC	0.677		
BENIAMIN R	0.829				
RAYPORT JF	0.786				
HAGEL J	0.759				
RIGGINS FJ	0.757				
ZWASS V	0.674				
KALAKOTA R	0.624				
POONS S	0.484				

Fig. 1. Core Disciplines-Co-citation Network of ≥ 10

of shirking and opportunism through improved monitoring and reduced specificity in coordination.

Based on Figure 1 and Table 4, the consumer behaviors in electronic commerce permeate the authors in the second group. Jarvenpaa and Todd (1996) suggested that the most important perceived benefit of Internet shopping was convenience, while poor customer service, poorly designed Websites, and that perceived risk were cited by online shoppers as the negative factors and observed that the most influential factors that lures customers to the internet is discount price: therefore, creative pricing is the core business model of many

internet companies. Trust is vital to the consumer behavior in electronic commerce. According to Mayer, Davis, and Schoorman (1995) trust and risk perception are very strongly interrelated. They regarded risk as an essential component of trust; one must take a risk in order to engage in trusting action. In a related strain research, Gefen (2000) empirically revealed that individual's general trusting propensity, which is the product of lifelong socialization process, is positively related to individual's trust. Advanced, Gefen, Karahanna, and Straub (2003) proposed a variable ('trust') for studying electronic commerce acceptance. Extending trust factor into the

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Technology Acceptance Model (TAM) enable better explanation of electronic commerce usage behavior. The importance of trust in electronic commerce can hardly be overestimated. McKnight and Chervany (2001) distinguished trusting beliefs from trusting intentions in the concept of trust toward Web vendors. In electronic commerce, trusting beliefs include competence, benevolence, integrity, and predictability exhibited by Web vendors when they interact with consumers. Another, trusting intentions include the consumer's willingness to depend on and the subjective profitability of depending on the Web vendors when making a transaction.

Implications of electronic shopping permeate the authors in the third group. In examining the implications of electronic shopping, Alba, Lynch Jr., Weitz, Janiszewski, Lutz, and Sawyer (1997) argued that response time is a key factor of interactive shopping. The response of electronic commerce has to be immediate as in face-to-face communications in physical stores. Another, using the Internet enables consumers to, fairly easily, access information about merchandise, gather vertical information at a low cost, to efficiently screen the offerings, and easily locate a low price for a specific item (Alba et al.). Reputation is another important characteristic of electronic shopping. Resnick, Zeckhauser, Friedman, and Kuwabara (2000) stated that to operate at all, reputation systems require three properties at a minimum; entities are long-lived so that there is an expectation of future interaction, feedback about current interactions is captured and past feedback guides decisions.

V. CONCLUSIONS

This paper has investigated electronic commerce using citation and co-citation data published in SSCI and SCI between 2000 and 2006. A factor analysis of the co-citations suggested that the field is organized three different concentrations of interest: strategy and electronic marketplace, consumer behavior in electronic commerce, and implications of electronic shopping.

The authors have profiled the major themes, concepts and relationships which discussed within each domain. We found that the scope of electronic commerce research has been broad and there are many research opportunities emerging in the coming evolution of electronic commerce. Firms and consumers continue to innovate and adopt electronic commerce rapidly and extensively. The contribution of this paper is to provide a valuable research direction in the electronic commerce area and propose an objective and systematic mean of determining the relative importance of different knowledge nodes in the development of the electronic commerce field.

VI. LIMITATIONS

Even though this body of research has the undeniable merit of offering valuable insights into the intellectual structure of electronic commerce studies, it has some limitations. First, our search criteria may be incomplete, and many good papers that do not have the terms electronic commerce explicitly in the article title may not have been included. Second, the sample articles chosen from 2000 to 2006, which might affect the generalization of this study.

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