Longitudinal Analysis of Information Science Research in *JASIST* 1985-2009*

정보학연구의 25년간 동향 분석: *JASIST* 논문을 중심으로

Eun-Gyoung Seo**

ABSTRACT

In recent years, the changes in information technology have been so dramatic and the rate of changes has increased so much that information science research rigorously evolves with the passage of time and proliferates in diverging research directions dynamically. The aims of this study are to provide a global overview of research trends in information science and to trace its changes in the main topics over time. The study examined the topics of research articles published in *JASIST* between 1985 and 2009 and identified its changes during five 5 year periods. The study found that the most productive area has consistently been 'Information Retrieval', followed by 'Informetrics', 'Information Use and Users', 'Network and Technology', and 'Publishing and Services'. Information retrieval is a predominant core area in Information Science covering computer-based handling of multimedia information, employment of new semantic methods from other disciplines, and mass information handling on virtual environments. Currently Informetric studies shift from finding existing phenomena to seeking valuable descriptive results and researchers of information use have concentrated especially on information-seeking aspects, so adding greater sophistication to the relatively simple approach taken in information retrieval.

초 록

정보공학의 발전이 급속적으로 또 다양한 방향으로 전개됨에 따라 이를 기반으로 하는 정보학분야의 연구 역시 역동적으로 변화하게 되었다. 본 연구의 목적은 25년간 정보학분야 연구동향의 변화를 주제별로 조사하고 그 중 가장 연구가 많이 이루어진 정보학 핵심분야의 연구경향과 그 변화를 세밀하게 살펴보는 데 있다. 이를 위하여 1985년부터 2009년간 *JASIST*에 실린 2,304 연구논문의 주제를 조사한 후 5년을 한 단위로 보고 다섯 기간 동안의 연구 동향의 변화를 분석하였다. 그 결과, 가장 연구가 많이 이루어진 분야는 '정보검색'이며 25년간 계속적으로 정보학자들이 가장 많이 관심을 가진 분야였다. 다음으로 '계량정보학'은 최근에 많은 연구가 이루어진 것으로 나타났고, '정보이용과 이용자'는 계속적으로 연구되는 분야인 반면, '네트워크와 정보기술'과 '출판과 서비스'는 80년대에는 많은 연구가 이루어졌으나 최근 들어 이에 대한 연구가 줄어든 것으로 나타났다. 특히 정보검색 분야는 검색이론 및 탐색전략 연구에서 멀티미디어 및 의미처리, 웹검색 관련 연구로, 계량정보학 분야는 학술적 커뮤니케이션의 종적 또는 횡적 현상을 기술하는 연구에서 학술적 커뮤니케이션의 문맥적 특징을 찾아내는 연구로 변환되고 있다. 또한 정보이용 분야에서는 정보검색과 관련된 이용자의 정보추구 행태 및 인지 모형을 분석하는 연구가 최근에 주를 이루고 있음이 밝혀졌다.

Keywords: information science, information science research, longitudinal analysis, research trends, information retrieval, informetrics, information use and users
정보학, 정보학연구, 종적연구, 연구동향, 정보검색, 계량정보학, 정보이용자연구

---

* This research was supported by Hansung University in 2009.

** Professor, Division of Knowledge & Information, Hansung University(egseo@hansung.ac.kr)

▪ Received : 27 May 2010 ▪ Revised : 4 June 2010 ▪ Accepted : 20 June 2010
▪ Journal of the Korean Society for Information Management, 27(2): 129-155, 2010.
〔DOI:10.3743/KOSIM.2010.27.2.129〕

1. Introduction

As information technology and services, which have been gradually incorporated into our lives, have been developed fast and changed dynamically, the disciplines in applied science and technology also have been changed constantly: their representative field is "Information Science (IS)". In recent years, the changes in information technology have been so dramatic and the rate of changes has increased so much that information science research rigorously evolves with the passage of time and proliferates in diverging research directions dynamically. It seems to be obvious that the relative emphasis of information science research has changed continuously: some topics are researched more and more intensively; some have been studied constantly, while others have disappeared.

Therefore, some researchers have attempted to draw a definitive perimeter around the field of information science and to identify the development and changes of its research areas. This kind of works helps enhance our understanding of the IS knowledge domain and its focal perspectives (Boyce and Kraft 1985; Buckland and Liu 1995; Rayward 1996; White and McCain 1998; Saracevic 1999; Hawkins 2001; Zin 2007a; Zin 2007b; Zhao and Strotmann 2008). The research activities in the IS field and its changes have not been studied as frequently or thoroughly as have its intellectual influences, however. Also, there are a few studies which have identified the changes of research trends for quite a long time period because it might be a gargantuan task to keep abreast of the boundary and changes of information science. The aims of this study are to provide a global overview of research trends in information science and to trace its changes in the main topics over time.

One way to track the changes that have occurred in a field is to analysis the changing nature of research papers published in its leading journals. This study examined the topics of research articles published in *JASIST* between 1985 and 2009 in order to address the following research questions: What is the thematic characteristics of the IS field?; Which areas are the most emphasized?; How has IS research changed between 1985 and 2009?; Which areas are expanding or decreasing sharply?; Are there any changes among the emphasized topics?; and How have research activities evolved over time? The intention has been to conduct a diachronic analysis of the data wherever possible. Rather than take a single snapshot of the scene observable at a given point in time, the aim has been to present a series of such pictures so that they may be compared and their trends identified over time. The fairly arbitrary decision was taken to divide the period under consideration into five 'publication windows' of equal duration: 1985-89, 1990-94, 1995-99, 2000-04, and 2005-09.

That is, for identifying the most emphasized topics by information science researchers and the changing nature of the IS domain, the study, first, reviews intensively research which has attempted to define or identify information science domains comprehensively; second, presents the distribution of research articles over the full range of subject areas in Information Science and its changes during the

respective five 5 year periods; and last, analyzes research activities of main topics and their changes over time. To know where the discipline is going and where it has been is important to scholars and practitioners because it helps them understand knowledge of fundamental bases and emergent issues in the field of discipline. Therefore, drawing a boundary around information science or tracing its research trends by tracking its literature is one way of understanding and capturing knowledge of information science.

2. Boundaries of Information Science

Information science is a field that emerged in the aftermath of the Second World War, along with a number of new fields such as computer science. From about 1960, the phrase, "Information Science" was adopted, largely replacing the older term "documentation" (Buckland and Liu 1995). This phrase represents something that is emergent and unstable in its significance because what is meant by "information" varies, so many researchers have examined the boundaries of information science and its commonly accepted disciplinary nature. Early, Klempner (1969) described information science as "investigating the properties and behavior of information, the forces governing information transfer, and the technology necessary to process information for optimum accessibility" and divided the field into three segments: (1) conceptualization (classification, indexing/abstracting, thesaurus/subject heading, document selection), (2) storage and transmission (storage transmission channels, network), and (3) utilization use (relevance assessment, evaluation/appraisal, satisfaction). Later, White and Griffith (1981) mapped the positions of 39 information scientists in intellectual space on the basis of how their oeuvres had been co-cited by various writers in the journal literature from 1972-1979. The map showed four major research areas of information science: (1) communication in science and technology, (2) bibliometrics deriving from Bradford and concerned with statistical properties of subject literatures, (3) general area concerned with integrative theory for the field, and (4) information retrieval concerned with problems of automated retrieval and information retrieval algorithms. Attempts to define information science appear to have begun in the late 1960s, but there are few numbers of studies until 1980s.

However, since 1990s when the information science began flourishing in its own in a large part and its history was also long enough to analyze and reflect, several researchers had attempted to chart the boundaries of information science. Buckland and Liu (1995) who reviewed the historical writings about the development of information science indicated that interest of information science research extends outwards in many directions because of the need to understand contextual, institutional, methodological, and theoretical aspects. Rayward (1996) also reviewed some of the history of information science and insisted that information science, as a composite of "chunks" of other disciplines, may well go beyond

"narrow" and in fact, cover other specialties and technologies such as communication, classification, bibliometrics, information exchange (networking, telecommunications), access control, regulation, user behavior, and human factors. White and McCain (1998) conducted an extensive domain analysis of information science in terms of its authors. Through co-citation analysis of 120 most-cited authors in information science, they found 12 specialties: (1) experimental retrieval, (2) citation analysis, (3) on-line retrieval, (4) bibliometrics, (5) general library systems, (6) science communication, (7) user theory, (8) OPACs, (9) imported ideas, (10) indexing theory, (11) citation theory, (12) communication theory. They also indicated that there are the two biggest specialties, 'experimental retrieval' and 'citation analysis', concerning with "the human (social, behavioral, and cognitive aspects of users) - literature (bring literatures to people through computers) barrier." Similarly, Ding, Chowdhury, and Foo (1999) examined the subspecialties in information retrieval (IR) and its change over the time by using author cocitation analysis. They found that the 39 highly cited authors could be grouped into the 7 subcategories: (1) IR model, (2) IR techniques, (3) user perspectives of IR, (4) user (on-line) information seeking and retrieving behavior, (5) information seeking and retrieving model (user searching strategies), (6) general IR theory, and (7) IR system design and evaluation.

In 1999 when the *Journal of the American Society for Information Science (JASIS)* was 50 years old, several special papers focused on "the landscape of 'information science". Buckland (1999) as a president of ASIS, 1998, noted that information science included two fundamentally different traditions: a "document" tradition concerned with signifying objects and their use, and a "computational" tradition of applying algorithmic, logical, mathematical, and mechanical techniques for handling, managing, and manipulating documents. Saracevic (1999) suggested that there are major two branches of information science: (1) information retrieval (IR) which has been researched in terms of system-centered approach and human-centered approach, and (2) relevance which has been investigated in terms of system or algorithmic relevance, topical or subject relevance, cognitive relevance or pertinence, situational relevance or utility, and motivational or affective relevance. He also indicated newly emerging areas such as interaction studies, multimedia and multilanguage information retrieval, digital libraries, and internet searching. Summers and his colleagues (1999), who presented a future direction of the information science discipline in their paper "Information Science in 2010", divided information science into three major areas: (1) information science core area (the theory and practice of creating acquiring, assessing, validating, organizing, storing, transmitting, retrieving, and disseminating information), (2) information management area (the management of the total information resources of organizations), and (3) information technology area (technology that may be used in information science, information management, computer systems, telecommunications, and information technology applications).

Hawkins (2001) reviewed much of the past work

that sought to define "information science" and to map the field in depth in order to develop the fundamental definition of information science and to classify the subject making up it. He listed 12 major IS subject areas such as (1) properties of information, (2) information access, (3) information industry, (4) knowledge organization, (5) publishing, (6) information marketing/economics, (7) database production, (8) electronic information systems, (9) online searching, (10) current awareness, (11) database design, and (12) history. The fields most closely related to information science are also listed such as computing technology, behavioral science, librarianship, statistics, communications, law and government, communication, and other subject disciplines: each of these related disciplines, of course, has its own subject map, a portion of which would overlap information science. Vickery and Vickery (2004) defined information science as the study of communications and information in society. In their development of information science, they identified six major points if focus of the science: (1) the behavior of people as generators, sources, recipients, and users of information, (2) the quantitative study of the population of messages-its size, growth rate, distribution, patterns of production, and use, (3) the semantic organization of messages and of channels that facilitate their identification by sources and recipients, (4) problems particularly associated with the function of information storage, analysis and retrieval, (5) the overall organization of information systems and their performance and transfer, and (6) the social context of information transfer, its economics, and politics.

More recent, Zins insisted that information scientists are required to regularly review and redefine the fundamental building blocks of information science because this field is constantly changing. To figure out how leading scholars and practitioners in the academic milieu defined or mapped the field, he conducted huge Critical Delphi study between 2003 and 2005. That is, the indirect discussions among a panel composed of 57 participants from 16 countries, which were conducted in three successive rounds of structured questionnaires. As a result of this study, Zins presented conceptions of information science, a systematic knowledge map of information science, and classification schemes of information science in a series of papers (Zins 2007a, 2007b, 2007c). First, he concluded that conceptions of information science belong to the six models: the Hi-Tech Model, the Technology Model, the Cultural Model, the Human World Model, the Loving World Model, and the Living and Physical World Model. He commented that understanding the nature of this field is more difficult and somewhat confusing because the six models imply six different bodies of knowledge: all carry the same name, "Information Science". Second, he classified the research areas of information science into 2 major categories: meta-knowledge and subject-based knowledge, which has 10 basic categories such as (1) foundations, (2) resources, (3) knowledge workers, (4) contents, (5) applications, (6) operations and processes, (7) technologies, (8) environments, (9) organizations, and (10) users.

Zhao and Strotmann (2008) employed an enriched author bibliographic coupling analysis and author co-citation analysis methodology for a comparison between the structure of intellectual influences on IS research during the first decade of the Web (1996-2005). They found that there are 12 specialties in the field of information science such as (1) user theory, (2) evaluative citation analysis, (3) experimental retrieval, (4) webometrics, (5) science communication, (6) visualization of knowledge domains, (7) information seeking and context, (8) metadata and digital resources, (9) bibliometrics models and distribution, (10) children's information searching behaviors, (11) users' judgment of relevance, and (12) structured abstracts. They commented that a large new specialty, Webometrics, appears as an effect of the World Wide Web and that the studies on users and use within the large and diverse IR-research community extend well beyond general definitions of IS.

Hjorland (2002) said that classifications always reflect the theoretical and philosophical approach of the field being classified. All research which has tried to make a map of the IS field and to identify its sub-disciplines provides basic notions of what information science is and the current boundaries of IS research activities with theoretical and philosophical viewpoints. As shown in the <Table 1>, it can be found that the common areas mentioned by every classification scheme are "Retrieval" and

〈Table 1〉 Research Areas of Information Science defined by 7 Information Scientists

	Kelmpner (1969)	White and Griffith(1981)	White and McCain(1998)	Hawkins (2001)	Vickery and Vickery(2004)	Zins (2007)	Zhao and Stromann(2008)
1	Conceptual-ization	Scientific communi-cation	Experimental retrieval	Properties of information	Behavior of people	Foundations	User theory
2	Storage Transmission	Information retrieval	Citation analysis	Information access	Quantitative study	Resources	Evaluative citation analysis
3	Utilization	Bibliometrics	On-line retrieval	Information industry/markets	Semantic organization	Knowledge workers	Experimental retrieval
4		General Foundation	Bibliometrics	Knowledge organization	Information retrieval	Contents	Webometrics
5			General library systems	Publishing	Information system	Application	Science communication
6			Science communi-cation	Information marketing	Social context of information transfer	Operations and Processes	Visualization of knowledge domains
7			User theory	Database production		Technologies	Information seeking and context
8			OPACs	Electronic information systems		Environments	Metadata and digital resources
9			Imported ideas	Online searching		Organizations	Bibliometrics models and distribution
10			Indexing theory	Current awareness		Users	Children's searching behaviors
11			Citation theory	Database design			Users' judgment of relevance
12			Communi-cation theory	History			Structured abstracts

"Users" and that research areas have been expanded to the new application fields as new technologies have evolved.

3. Analysis of Information Science Research

3.1 Collecting Data

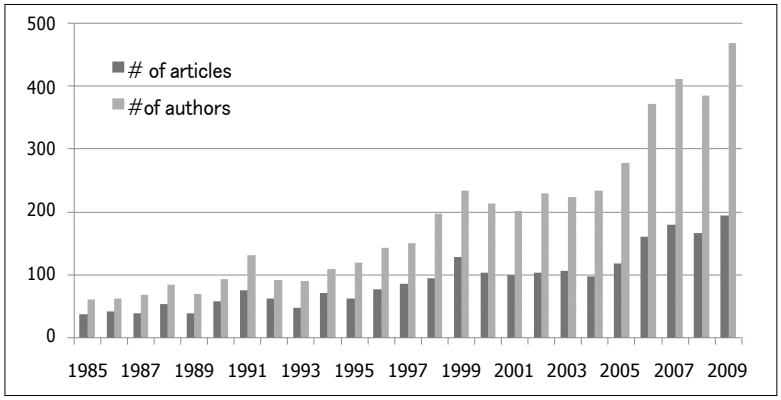
The development of IS research is reflected reasonably well by the changing nature of the research papers published in its leading journals such as *Journal of American Society for Information Science and Technology (JASIST)*. *JASIST* started out as *American Documentation (AD)* with its first issue in 1950. In 1970, *AD* became *Journal of American Society for Information Science (JASIS)*. The name changed again in 2000, to the current name, the *Journal of ASIST*. The contents of *JASIST* cover research areas of the IS field concerning production, discovery, recording, storage, representation, retrieval, presentation, manipulation, dissemination, use, and evaluation of information and the tools and techniques associated with these processes. The journal covers various kinds of works such as empirical, experimental, ethnographic, conceptual, historical, socio-technical, policy-analytic, or critical-theoretical studies.

Each *JASIST* issue features a number of different types of publication including research articles, editorials, brief communications, book reviews, and letters to the editor. In this study, only full-length research articles were collected for analysis. A total of 2,304 distinct articles have been collected from Volumes 36-60, 1985-2009. <Table 2> shows the number of articles, the number of authors, sole-authored articles and coauthored articles collected over five 5-year periods. The total number of authors is 4,272 so that the number of authors per article is 1.93. During the 25 years covered in this study, 962(42%) of all articles were single-authored while the remaining 1342(58%) were coauthored. From <Table 2>, it can be observed that the number of authors per paper has increased from 1.64 to 2.34. The solo-authored articles dominate the period between 1985 and 1994: however, coauthored articles dominate from 1995 to 2004 and during the most recent 5 years, 2005-2009, the coauthored articles have become increasingly predominant.

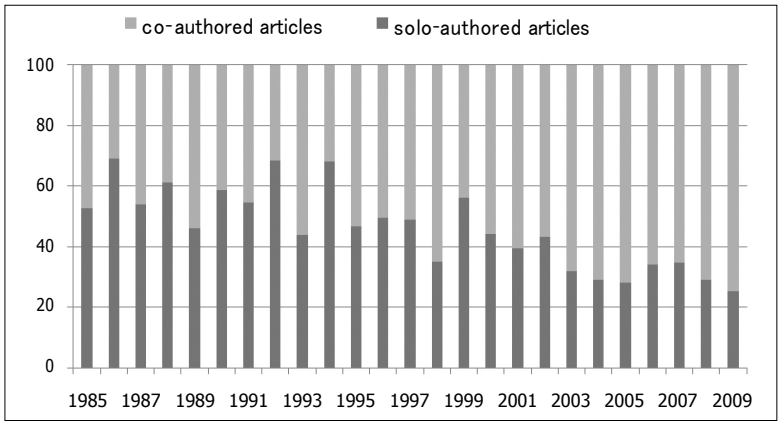
To provide a more granular perspective, the number of papers and authors were captured on a yearly basis as was the ratio of solo-authored and coauthored articles. The number of research papers published per year in *JASIST* has grown steadily, from 38 to 194. The data suggest that the production of the literature of information science has nearly quadrupled over the past 25 years. Counting authors is another way to measure the growth a journal. Authorship in *JASIST* has grown from 61 to 469. This parallels the growth in the number of *JASIST* papers, but the rate of increase in the number of authors is much higher: the linear regression slope of papers is 5.654 whereas that of authors is 14.915 (See Figure 1). <Figure 2> shows the percentages of sole authors and coauthors by year. Over the

〈Table 2〉 Number of Articles and Authors of *JASIST* between 1985 and 2009

	1985-89	1990-94	1995-99	2000-04	2005-09	Total
No. of articles	212	316	447	511	818	2304
No. of authors	347	516	846	1103	1915	4272
No. of authors per articles	1.64	1.63	1.89	2.16	2.34	1.93
No. of solo-authored articles	121(57%)	188(60%)	214(48%)	192(38%)	247(30%)	962(42%)
No. of co-authored articles	91(43%)	128(40%)	233(52%)	319(62%)	517(70%)	1342(58%)



〈Figure 1〉 Growth of JASIST in Papers and Authors per Year



〈Figure 2〉 Percentages of Solo-authors and Co-authors

25-year period, the median ratio of coauthored articles grew by 64% from 0.47 to 0.73 and the linear regression slope was 1.465. This is not surprising: collaborative authorship is increasing in many other disciplines, especially, in the field of social science and applied science (Chua and Yang 2008).

3.2 Building Information Science Taxonomy

The themes of research articles published in *JASIST* between 1985 and 2009 were examined in order to present the subject distribution of all articles. Therefore, the study, first of all, developed the IS taxonomy based on the preceding works which researched the boundaries of Information Science and current subject classification schemes of Information Science Abstract (ISA)[1] and Encyclopedia of Library and Information Science (ELIS)[2]. Main subject areas for the taxonomy were collected such as basic concepts of information, foundation of information science, informetrics, information user behavior, information organization, information searching, information retrieval experiments, data and text processing, multimedia and multi-language processing, information system design, use of information systems, information resource management, networks and www, information systems and industries, IT applications and social relations in IT, societal issues, publishing and distribution, information profession, and information services.

After observing and checking the postings of each category, the study selected distinct subject categories which reflect all the IS fields as they exist today and then organized them. The Information Science taxonomy developed for this study has 12 main subject categories and 50 subcategories (See Table 3). The main categories which have an average of 4 subcategories cover all specialties such as 1) Basic Concepts, 2) Informetrics, 3) Information Use and Users, 4) Knowledge Organization, 5) Data and Information Processing, 6) Information Retrieval, 7) System Design and Evaluation, 8) Information Systems and Industry, 9) Information Resource Management, 10) Network and Technology, 11) Societal Issues, and 12) Publishing and Services.

〈Table 3〉 Information Science Taxonomy

	Main Categories	Sub Categories
1	BASIC CONCEPTS	1.1 Definition, Theories, Methodologies
		1.2 Value, Quality, and Properties of Information
		1.3 History, Research Areas

1) The current IS taxonomy of ISA contains 11 main categories with 61 sub-categories such as 1) IS research, 2) Knowledge organization, 3) Information profession, 4) Societal issues, 5) Information industry, 6) Publishing and distribution, 7) Information technology, 8) Electronic information system and services, 9) Subject, 10) Libraries and library services, and 11) Government and legal information issues.

2) In ELIS, Information Science is divided by 6 categories such as 1) Information Architecture, 2) Information Behavior, 3) Information Management, 4) Information Retrieval Experimentation, 5) Informetrics, and 6) User-centered Design of Information Systems. It also classifies Research Specialties into 9 categories such as 1) Bibliometrics, 2) Information behavior and searching, 3) Information organization and description, 4) Information retrieval, 5) Information system and design, 6) Legal and ethical issues, 7) Social life of the cultural records, 8) Social relations in information technology, 9) Social studies of information.

〈Table 3〉 Information Science Taxonomy(continued)

	Main Categories	Sub Categories
2	INFORMETRICS	2.1 Evaluative Analysis
		2.2 Relative Analysis: Co-Citation Analysis
3	INFORMATION USE & USERS	3.1 Information Need, Information Use, Cognitive Process
		3.2 Information Seeking Behavior, Information Searching Behaviors
		3.3 User Studies, User Perception, User Surveys
4	KNOWLEDGE ORGANIZATION	4.1 Classification Theory, Cataloging Theory
		4.2 Tagging, MARC, FRBR, Metadata, DC, Descriptors
		4.3 Thesauri, Taxonomies, Ontologies, Semantic Network
		4.4 Indexing, Automatic Indexing, Abstracting, Automatic Summarizing
5	DATA & INFORMATION PROCESSING	5.1 Database, DBMS, File Organization, Image Databases
		5.2 Compression, Filtering, Imaging, Scanning
		5.3 Data mining, Visualization / Mapping
		5.4 Multimedia & Multilanguage Processing, Pattern & Character Recognition
6	INFORMATION RETRIEVAL	6.1 IR Model: Boolean, Vector, Fuzzy Set, Probabilistic
		6.2 Automatic Document Analysis, NLP, Test set
		6.3 Searching/Browsing, Search Strategies, Query Formulation
		6.4 Performance: Precision/Recall, Ranking/Relevance, Feedback
		6.5 Neural Networking, Semantic Process, Collaborative IR
		6.6 Image / Music Retrieval, Full-text Retrieval, Content-based Searching
		6.7 Web Searching, Search Engine, Robot, Agent, Knowledge Discovery
7	SYSTEM DESIGN & EVALUATION	7.1 System Design Issues, Web Page Design, Collaborative Design, IA
		7.2 HCI, User-Centered / Human Factor, Search Interface
		7.3 Systems Analysis and Evaluation, Web Site Usability, Accessibility
		7.4 Database Quality Evaluation, Web Resource Evaluation
8	INFORMATION SYSTEMS & INDUSTRY	8.1 Digital Libraries, Customized Information System, Expert System
		8.2 KM/KMS, Integrated Library System, Decision Supported System
		8.3 Information Centers, Information Agents, Information Providers
		8.4 Economics / Prices, Markets, E-Commerce
9	INFORMATION RESOURCE MANAGEMENT	9.1 Digitization, SGML / HTML / XML, OCR
		9.2 Digital Archiving, Digital Repository, Web Archiving, Open Access
		9.3 Digital Preservation, Risk Management, Preservation Technology
		9.4 Record Management, ERM, DRM
		9.5 Security, Access control, Authentication, Encryption
10	NETWORK & TECHNOLOGY	10.1 Telecommunication, LAN/WAN, Data Transmission Protocol
		10.2 Library Network, Library Portal, Gateway, Pathfinders
		10.3 Internet, Browsers, Web, Web site
		10.4 Social Networking, Collaborative in Web, OpenURL, Web Linking
		10.5 H/W, S/W, IT Adaptation, Open Source Software
11	SOCIETAL ISSUES	11.1 Information Policies, Information Ethics, Credibility Issues
		11.2 Information Literacy, Information Society
		11.3 Legal Issues, Intellectual Property Protection, Copyright
		11.4 Filtering, Censorship, Information Flows
12	PUBLISHING & SERVICES	12.1 Print / Publishing, E-journal / E-book, Information Sources
		12.2 Scholarly Communication
		12.3 Information Professionals, Education, Organization/ Societies
		12.4 Information Services, Document Delivery Services
		12.5 Librarianship, Library Services

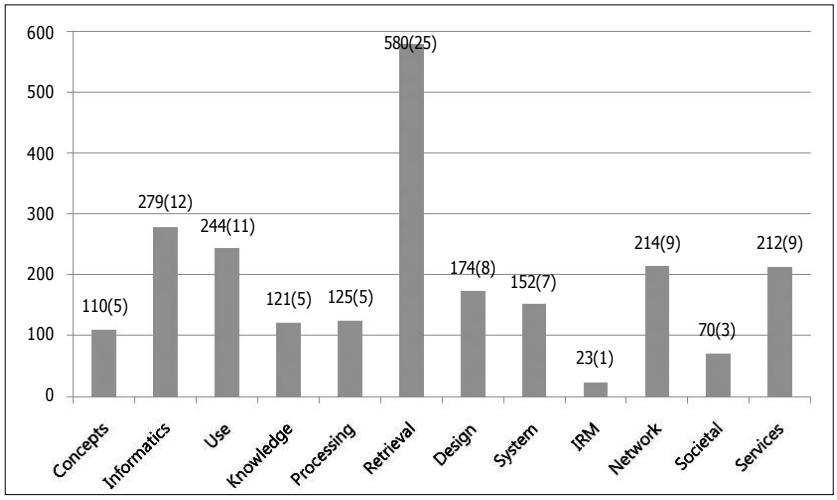
3.3 Tracing IS Research

The main purpose of this study is to analyze themes of each research article, rather than authors or citations, and to trace the change of IS research. First of all, 2,304 research articles published in *JASIST* between 1985 and 2009 were classified according to IS taxonomy scheme by year. The theme of each article was primarily analyzed based on its title, but the abstracts were also used if the titles do not represent their main concepts. In results, there are a number of heavily posted categories as well as a number with only a few postings.

The most highly posted subject category, that is, the most productive area was 'Information Retrieval'. IR articles (580 postings) made up 25 percent of all articles. The next productive areas were 'Informetrics' (279), 'Information Use and Users' (244), 'Network and technology' (214) and 'Publishing and Services' (212). In relation to the subjects of information systems or libraries, the development of information technologies and communication technologies has brought studies connected with these areas into the heart of research activity. It can be assumed that the development of the Internet as a technological tool has caused a profound change in activities connected with information and documentation and has caused further research on this new information environment including information retrieval and user or use studies. The third ranked group includes 'System Design and Evaluation' (174), 'Information Systems and Industry' (152), 'Data and Information Processing' (125), 'Knowledge Organization' (121) and 'Basic Concepts' (110). IS research usually exists to develop new information designs and systems and to evaluate their usability and effectiveness in market. Meanwhile, IS research also deals with typical areas which are overlapped with computer science and library science such as database, data storage, automatic document processing, classification and cataloging, subject representation etc. The lowest posting areas are 'Societal Issue' (70) and 'Information Resource Management (IRM)' (23). It was surprising that the research on IRM dealing with digitization, digital archiving, digital preservation, access control and so on were so low: only 23 articles (1%) have been published over 25 years (See Figure 3).

In summary, over the 25 years covered in this study, emphasis was placed on aspects such as information retrieval and processing connected with user seeking behaviors and perception. Other subjects, such as informetrics,, stand out in the present study. It is hardly surprising that these three categories have been highly productive and the essence of the IS field as earlier research has mentioned (Hawkins et al. 2003; Meadows 2008; Zhao and Strotmann 2008).

For tracing overall research trends, the study conducted a diachronic analysis based on five 'publication windows'; 1985-89, 1990-94, 1995-99, 2000-04, and 2005-09. The aim has been to present a series of such pictures so that they may be compared and trends identified over time. <Table 4> shows the number of papers and its portion within each main category and <Figure 4> shows the change of subject portion by five periods. In general, the research patterns are



〈Figure 3〉 Subject Distribution by Main Categories

very similar over time. From the <Figure 4>, it can be observed that "Information Retrieval" continues to play a prominent role during the five periods, most notably in the 4th period where the research of IR reaches its peak (32%). In contrast, the little research on "Societal Issues" and "Information Resource Management" has been consistently marked as 11th and 12th. However, the second productive research area is somewhat different over the time: "Publishing and Services" for the 1st and 3rd periods, "Informetric" for the 2nd and 5th periods, and "Information Use and Users" for the 4th period. The third productive areas are "Network and Technology" for the 1st and 3rd period, "Publishing and Services" for the 2nd period, and "informetrics" and "Information Use" for the 4th and 5th period respectively(See Table 5).

Between 1985 and 1989, the most productive area was "Information Retrieval" (42 of 212 articles), followed by "Publishing and Services" (39), "Network" (25), "Information System" (21), and "Informetrics" (20). It can be found that in the 80's the emphasis was placed on aspects such as information retrieval and the delivery of information services using new environments such as network and automated systems. After 5 years, that is, between 1995 and 1999, the most and predominant productive area was "Information Retrieval" (115 of 447 articles), followed by "Publishing and Services" (51), "Network and Technology" (45), and "Information Use and Users" (38). At that time when the DLI project was launched and Web/Internet was becoming more common, it wasn't surprising that studies on IR, Electronic publishing and services, and Network were dominant. In 2000's, the advent of new information environment such as Digital libraries, web 2.0, semantic web etc, facilitated interactive information sharing, interoperability, user-centered design, and collaboration and allowed its users to interact with each other, in contrast to old environments where users were limited to the passive viewing of information that was provided

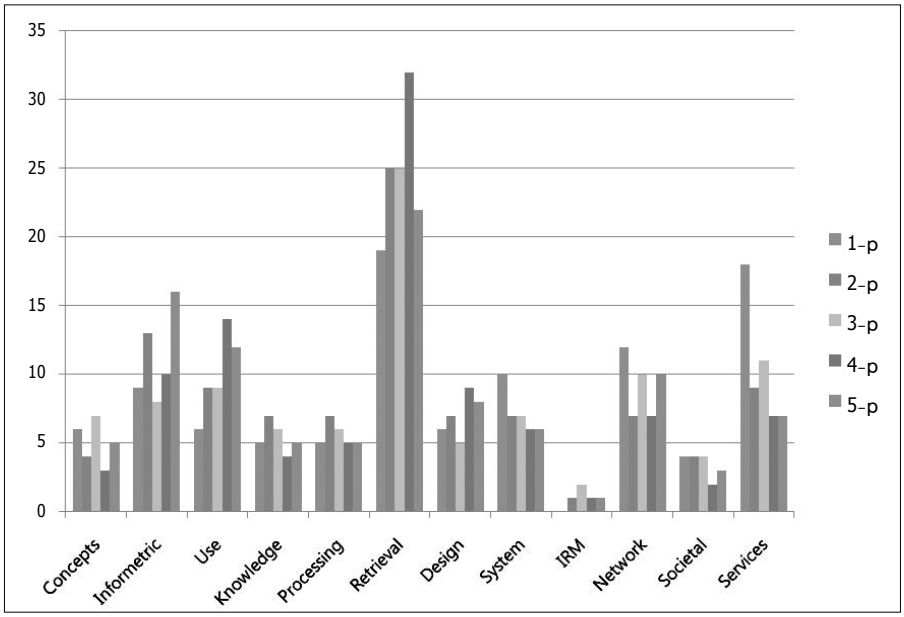
〈Table 4〉 Number of Articles and Its Portion within Each Main Category

No. of articles (%)

	1985-89	1990-94	1995-99	2000-04	2005-09	Total
Basic Concepts	12(6)	14(4)	30(7)	16(3)	38(4)	110(5)
Informetrics	20(9)	40(13)	37(8)	52(10)	130(16)	279(12)
Information Use and Users	12(6)	27(9)	38(9)	72(14)	95(12)	244(11)
Knowledge Organization	11(5)	21(7)	28(6)	21(4)	40(5)	121(5)
Data & Information Processing	10(5)	20(7)	26(6)	25(5)	44(5)	125(5)
Information Retrieval	42(19)	79(25)	111(25)	163(32)	185(22)	580(25)
System Design & Evaluation	12(6)	21(7)	24(5)	48(9)	69(8)	174(8)
Information Systems & Industry	21(10)	24(7)	30(7)	32(6)	45(6)	152(7)
IRM	0(0)	4(1)	11(2)	3(1)	5(1)	23(1)
Network & Technology	25(12)	24(7)	45(10)	37(8)	83(10)	214(9)
Societal Issues	8(4)	13(4)	16(4)	8(2)	25(3)	70(3)
Publishing & Services	39(18)	29(9)	51(11)	34(7)	59(7)	212(9)
Total	212(100)	316(100)	447(100)	511(100)	818(100)	2304(100)

〈Table 5〉 Highly Posted Subject Categories by the Five Periods

Rank	1st Period	2nd Period	3rd Period	4th Period	5th Period	Total
1	Information Retrieval	Information Retrieval	Information Retrieval	Information Retrieval	Information Retrieval	Information Retrieval
2	Publishing & Services	Informetrics	Publishing & Services	Information Use	Informetrics	Informetrics
3	Network & Technology	Publishing & Services	Network & Technology	Informetrics	Information Use	Information Use
4	Information Systems	Information Use	Information Use	System Design	Network & Technology	Network & Technology
5	Informetrics	Information Systems	Informetrics	Network & Technology	System Design	Publishing & Services
6	Basic Concepts	Network & Technology	Basic Concepts	Publishing & Services	Publishing & Services	System Design
7	Information Use	Knowledge Organization	Information Systems	Information Systems	Information Systems	Information Systems
8	System Design	System Design	Knowledge Organization	Information Processing	Information Processing	Information Processing
9	Knowledge Organization	Information Processing	Information Processing	Knowledge Organization	Knowledge Organization	Knowledge Organization
10	Information Processing	Basic Concepts	System Design	Basic Concepts	Basic Concepts	Basic Concepts
11	Societal Issues	Societal Issues	Societal Issues	Societal Issues	Societal Issues	Societal Issues
12	IRM	IRM	IRM	IRM	IRM	IRM



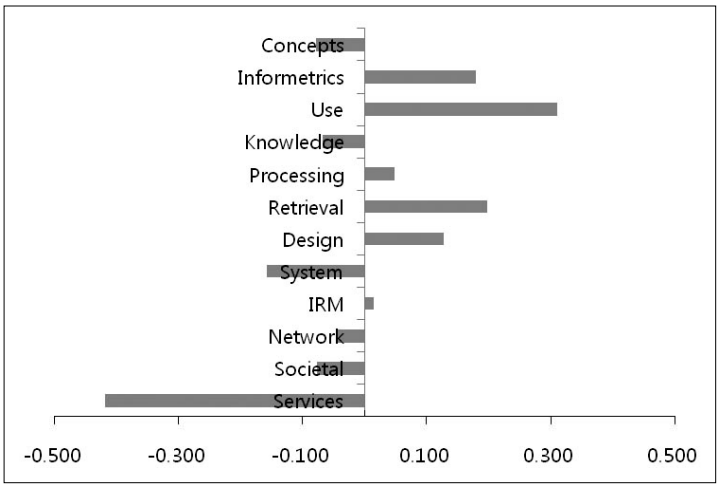
〈Figure 4〉 Changes of Subject Percentage by the Five Periods

to them. During these periods, it is natural that the research core of information science was information retrieval connected with information seeking studies and new technologies. Regardless of the changes of information technologies and environments, interest in informetric studies grew until early 1990s, but then diminished. It has, however, grown sharply in recent years because of the availability of new significant sources of information about scholarly communication.

The study also analyzed whether the research of each subject category is increasing or decreasing over the time. For this analysis, the study used the Linear Regression Slope value. <Figure 5> shows the increasing/decreasing areas. Over the time, the research on "Information Use and Users", "Informetrics", "Information Retrieval", and "Information system Design and Evaluation" increasing, while the research on "Publishing and Services" are largely decreasing, followed by "Information System and Industry", "Societal Issues"' and "Knowledge Organization". This indicates that 'Information Use and Users' has recently been researched more by information scientists but "Publishing and Services" has not. However, they have continuously and increasingly researched "Information Retrieval' and "Informetrics".

4. Research Trends of Major IS Topics

Information science has matured to the stage where even the study of its history has become a legitimate topic for research (Black et al. 2007). It was in the



〈Figure 5〉 Increased / Decreased Rate of Main Subject Categories over 25 Years

last quarter of the twentieth century that systematic research in this field - and, indeed, the name itself - became fully established, and that the amount of research began to grow rapidly (Meadows 2008). Activities that were relatively marginal years ago are now at the heart of major growth. The areas which have received greater funding support are nowadays often more narrowly focused than in the past. There has, however, been greater agreement on what important topics information scientists should study. The dominant major topic is information retrieval. This is now followed by research in informetrics and in the general area of information seeking and user studies. In this chapter, the development and change of these three major topics over 25 years are discussed.

4.1 Information Retrieval

Information retrieval (IR) might be, in the academic field of study, defined as finding material of an unstructured nature that satisfies an information need from within large collections (Manning et al. 2008). As defined in this way, IR is only concerned with an activity of searching. However, as the world has changed, IR is fast becoming the dominant form of information access, overtaking traditional database style searching, dealing with other kinds of data just beyond documents or texts, and supporting users in browsing and filtering document collections or further processing a set of retrieved documents. Thus, the meaning of the term “information retrieval” has become very broad and the IR research has subsequently developed in diverging directions.

In general, the most productive area in IR is ‘automatic document processing’ (25%), whereas the least productive area is ‘AI application’ (5%) as shown in the <Table 6>. During the 1st period when various IR experiments in the SMART system were conducted, the most productive area was ‘IR model’

〈Table 6〉 Number of Articles and Its Percentage within Highly Posted Subcategories

No. of articles (%)

Subject Category	Sub-category	1985-89	1990-94	1995-99	2000-04	2005-09	TOTAL
Information Retrieval	IR model	12(27)	13(17)	12(11)	14(9)	16(9)	67(12)
	Doc. processing	10(24)	20(25)	30(27)	28(17)	57(31)	145(25)
	Searching	11(26)	14(18)	22(20)	31(19)	30(16)	108(19)
	Relevance	7(17)	22(28)	22(20)	25(15)	15(8)	91(16)
	AI-IRI	2(5)	4(5)	8(7)	10(6)	7(4)	31(5)
	Multimedia IR	0(0)	5(6)	7(6)	33(20)	16(9)	61(11)
	Web-IR	0(0)	1(1)	10(9)	22(16)	44(24)	77(13)
	Sub-Total	42(100)	79(100)	111(100)	163(100)	185(100)	580(100)
Informetrics	Evaluative analysis	14(70)	31(78)	31(84)	41(79)	114(88)	231(83)
	Relational analysis	6(30)	9(23)	6(16)	11(21)	16(12)	48(17)
	Sub-Total	20(100)	40(100)	52(100)	52(100)	130(100)	279(100)
Information Use & users	Information needs	5(42)	5(19)	7(18)	12(17)	18(19)	47(19)
	Information seeking	3(25)	9(33)	16(42)	31(43)	41(43)	100(41)
	User studies	4(33)	13(48)	15(40)	29(40)	36(38)	97(40)
	Sub-Total	12(100)	27(100)	38(100)	72(100)	95(100)	244(100)

and ‘searching’. After then the number of ‘IR model’ research has decreased gradually, but that of ‘searching’ research has been consistent. The most productive area of the 2nd period was ‘relevance’ which was related with the evaluation of IR experiments. Over the 3rd period, so-called classical IR areas such as ‘document processing’, ‘searching’, and ‘relevance’ were dominant, but ‘multimedia IR’ was among the most productive during the 4th period when a lot of image or multimedia retrieval experiments were conducted in the DLI project. ‘Web-IR’ research which got shown on the face in the 4th period had been increased sharply in the 5th period.

Since the term “information retrieval” was coined by Calvin Mooers in 1950 (Mooers 1950), the early IR research was concerned with methods of retrieving information, automatic document analysis, query processing, and measure of retrieval performance. Retrieving methods (information retrieval models) have been discussed by specialists in the field since the idea of using Boolean operators for searching was implemented in practice. Specifically, a series of early IR experiments were conducted rigorously on the SMART systems by Gerard Salton and colleagues (Salton 1991). After that, various IR experiments were concerned with assigning a weight for each term in a document, automatic weighting schemes, relevance feedback and query expansion, query and document representation, routing and filtering under the rubric of text classification, the ranking function based on probable relevance or a document classifier, and various clustering algorithms. Further topics have been conducted widely and in depth.

These IR experiments were also evaluated in order to validate their results. The formal testing of IR

was first completed in the Cranfields experiments, beginning in the late 1950s (Cleverdon 1991). However, evaluation of IR experiments was conducted in earnest using by TREC (Text Retrieval Conference), a large IR test bed, which NIST has run since 1992. The emphasis here was on large-scale retrieval using a vast collection of documents. In the 1990's, research on IR experiments and its evaluation has been performed more actively using various test beds such as GOV2, NTCIR, CLEF, Reuters and Newsgroups. Commonly, the performance of IR systems or IR Models is measured using by the notion of recall and precision which were first used by Kent's study (Kent et al. 1955). These notions have been emphasized as important parameters in such evaluation or numerical comparison of the different systems, but in recent years, other measures such as MAP (mean average precision), precision at k, and R-precision have become more common. Assessing relevance is always a hot topic in IR evaluation, but its methods and interpretations have been a continual matter of dispute. There is a lot of research which has examined the concept of relevance, stability and sensitivity of relevance judgments, relevance measures, and more.

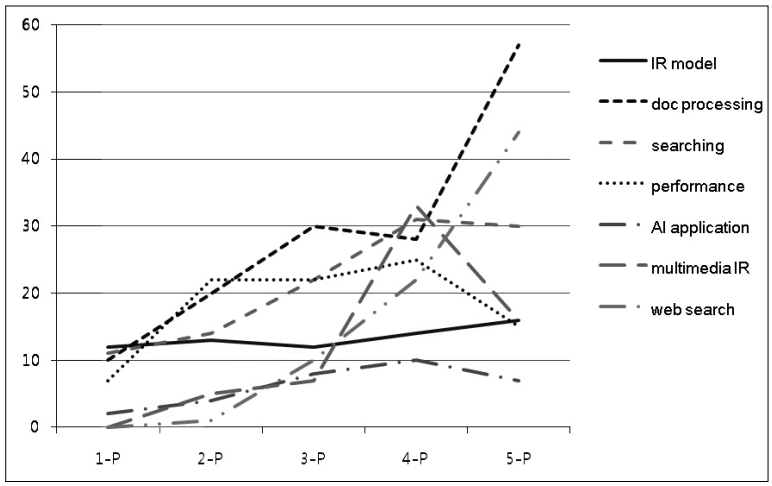
On the other hand, language identification for document processing was perhaps first explored in cryptography; for example, Konheim (1981) presents a character-level k-gram language identification algorithm. With the advent of widespread digital text, many researchers have explored the character n-gram techniques and other methods such as looking for particular distinctive function words and letter combinations (Beesley 1998, Dunning 1994). Written language identification is regarded as a fairly easy problem, whereas spoken language and image identification remain more difficult (Hugh et al. 2006). The rapid growth in computer-based handling of multimedia information over the past two decades has led to a lot of research and a closer linkage between the conceptual and practical considerations of representation/indexing, natural language processing, content-based retrieval, semantic indexing/retrieval and so on. In particular, the content-based image retrieval paradigm and the experimental systems which it spawned have been responsible for a marked upsurge in the rate of publications about image indexing and retrieval after 1990 (Chu 2001). By the late 1990s, automatic annotation techniques came to the fore as a means of trying to achieve semantic image retrieval application. Automatic annotation techniques have been researched in two basic approaches: one seeking to discover links between regions and words by statistical inference, and the other using a supervised learning technique which echoes document vector analysis in text-based information retrieval. Recently, the content-based image retrieval adopted semantic web technologies, which allow generation of semantic inference rules that link low-level visual features to domain concepts (Enser 2009). There have been many attempts to ontologically support experimental semantic retrieval as enhancing functionality with lexical expansion and generating high-level reasoning. Also for handling retrieval problems, some studies employed techniques from the developing world of artificial intelligence.

As the mass of information on the web has been published or produced, web search has become a standard and often preferred source of information finding. In academic IR environments, new attempts and approaches to web search, have been conducted; such as challenging the scale on indexing, query serving, and ranking of tens of millions of documents; producing high quality search results; distributing, indexing and connecting services; collaborating and linking on IR, and so on. Also, web searching and browsing by end-users and retrieval based on user experiences has meant a change of emphasis in terms of information retrieval. For example, relentless optimization of information retrieval effectiveness has driven web search engines to new quality levels at which most people are satisfied most of the time. Providing information access rather than searching certain content becomes more important and predominant. Also, much of the research deals with approaches to search using Web search engines, using similar conceptual frameworks to those used in information seeking. This subfield has been subject to similar levels of growth to that experienced by information seeking research, and with the increasing digitization of the outputs of research and scholarship, its significance is likely to grow (Meadows 2008).

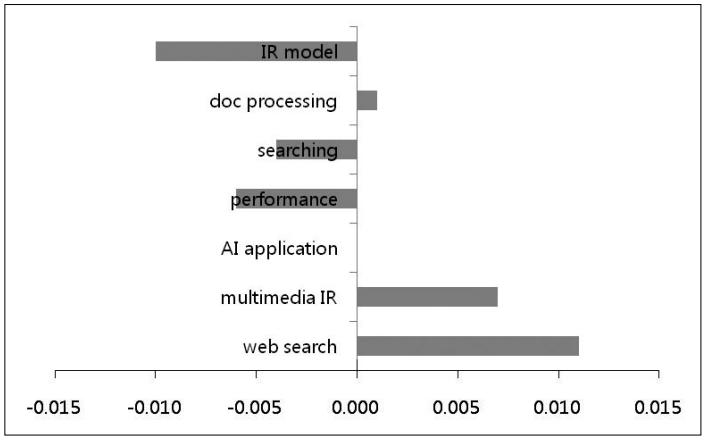
<Figure 6> indicates that studies in all IR research areas increased between 1985 and 2009: there is considerable growth in 'automatic document processing' and 'Web searching' in the 2000's. However, during the latest period, IR research areas such as 'multimedia IR', 'performance', 'Al application', and 'searching' have declined somewhat, compared to those of the 4th period. Therefore, it can be inferred that current IR research focuses on automatic document processing which is dealing with text classification, filtering and clustering and Web-related IR such as web search engine, web search, knowledge discovery and so on. <Figure 7> shows the increasing or decreasing rates of research of each IR subfield using Linear Regression Slope values over 25 years. It is obvious that research on 'Web searching' and 'multimedia IR' is increasing considerably because there were very few studies until the 2000's. This figure indicates that interest in 'IR models', 'performance', and 'searching and query processing' has decreased, compared to other subfields. However, it is clear that the growing emphasis on all kinds of information retrieval means that the whole field has now become a mainline research topic.

4.2 Informetrics

Informetrics which was coined by Nacke in 1979 is the study of quantitative aspects of information (Thelwall 2009). This includes the production, dissemination and use of all forms of information, regardless of its form or origin. As such, now, informetrics encompasses the fields of bibliometrics which studies quantitative aspects of recorded information, webometircs which studies quantitative aspects of the web, and scientometrics which studies quantitative aspects of science (Bar-Ilan 2008). Especially, bibliometrics encompasses the measurement of 'properties of documents and of document-related processes'. The range of bibliometrics techniques includes word frequency



〈Figure 6〉 Changes of Information Retrieval Research during the Five Periods



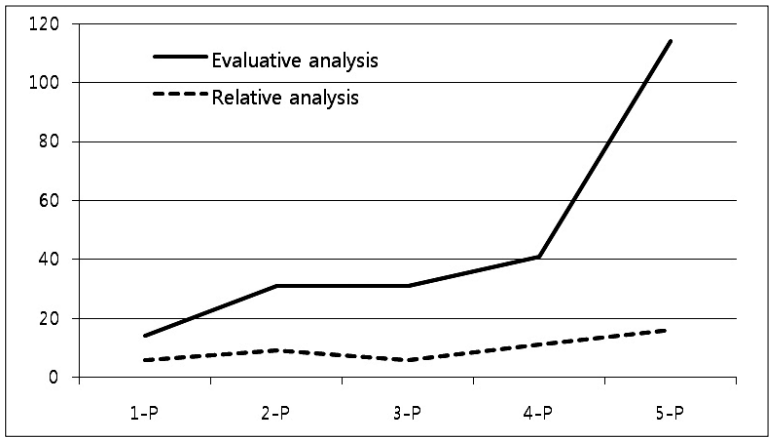
〈Figure 7〉 Increased / Decreased Rate of IR Research Areas over 25 Years

analysis, citation analysis, co-word analysis, and simple document counting, such as the number of publications by an author, research group or country. Webometrics is concerned with measuring aspects of the web: web sites, web pages, words in web pages, hyperlinks, web search engine results and its research includes link analysis, web citation analysis, search engine evaluation, and online impact and ranking. Webometrics was given its accepted definition as "the study of web-based phenomena using quantitative techniques and drawing upon informetric method" (Bjorneborn and Ingwersen 2004). Recently as the growth in volume of web content created by ordinary users has been noticeable, there have been many analytic studies of web 2.0 site using by informetric and data mining methods in order to find

some patterns, predict reactions, draw network, and/or explain user behavior. Today, informetrics has expended and become more useful and its research also has increased.

In general, two types of informetrics application have arisen: evaluative and relational (Borgman and Furner 2002). Evaluative informetrics seeks to assess the impact of scholars to compare the relative scientific contributions of two or more individuals or groups. These evaluations are sometimes used to inform research policy and to help direct research funding (Moed 2005). In contrast, relational informetrics seeks to illuminated relationships within research, such as the cognitive structure of research field, the emergence of new research fronts, or nations and international-co-authorship patterns. Most evaluative techniques use citations as their raw data for identifying impact factors. In fact 'impact' is now accepted as appropriate for that which citations measure or indicate (Bensman 2007). The core citation-based impact measures are still in place, but are newly supplemented by a range of complementary techniques such as the *h*-index, which means that a scientist has at least *h* publications cited at least *h* times. A high *h* index indicates that a scientist has published a considerable body of highly cited work. There have been a number of studies of *h* index for evaluating itself, proposing new versions, or applying it to other datasets because this technique is easily calculated and intuitive to understand (Cronin and Meho 2006, Oppenheim 2007). On the other hand, the relational informetric research in the early days was somewhat constrained because of difficulties on counting citation and visualizing the connections. However, since the 1980's when the ISI citation database was utilized easily, research using co-citation as a measure of similarity has increased (White and Griffith 1981; White and McCain 1998). Author co-citation analysis (ACA) operates at a high enough level of aggregation to be a practical tool for mapping the structures of fields (Chen 2006, Zhao and Strotmann 2008). Another change in informetircss is to use new source data about scholarly communication, such as patterns, web pages, and digital library usage statistics. Current research on informetrics focuses to improve the quality of results and their interpretation and to develop new measurement and visualization techniques, so that the amount of research has increasingly grown.

<Figure 8> shows that the research of informetrics has been increased sharply between 2005 and 2009: especially there is considerable growth in 'evaluative analysis'. Surprisingly, the number of articles on evaluative informetric research between 2005 and 2009 is 114, which is unquestionably the highest posting number among subcategories. The number of articles on 'automatic document processing', which is the next highly posted subdiscipline, is only 57 and that of relational informetric articles is 16 (See Table 6. It is very difficult to explain the reason why so many researchers are in this field recently, but it is clear that they are beginning to pay attention to analyzing social phenomena, cultural issues, and online academic communication using quantitative techniques with huge amounts of data, not by qualitative techniques which lead to the risk



〈Figure 8〉 Changes of Informetric Research during the Five Periods

of missing the big picture due to their necessarily small-scales.

In summary, the current wide range of relational informetric studies opens up new ways of understanding the scholarly communication process and the structure of science through citation relationships between journals, between scholars and between papers. Moreover, citation analysis in conjunction with visualization also helps to understand the structure of developing important research areas. Webometrics has expanded from its initial focus on bibliometrics-style investigations to more descriptive and social science-oriented research. It seems likely that informetric techniques will continue to evolve in response to new developments in information environments, seeking to provide valuable descriptive results.

4.3 Information Use and Users

Every development in the IS field has been concerned with making it easier for the user to access documents or information. In the early years, the principal research methods employed for information use studies were questionnaire-based surveys and interviews and overall, there was little or no attention to theoretical conceptualization. In fact, specific theories in relation to the information user did not appear until the 1980's. Not only has a definition of "information" proved difficult to establish, describing exactly how it influences human behavior has also been controversial (Case 2008).

As shown in <Table 6>, during the 1st period, the portion of studies on 'information needs' is relatively high (42%), and after then the portion has been declined to 19%. By the late 1970's, some researchers had tried to identify the meaning of "information need", which is a fundamental concept, building on a primitive notion of "information". It seems that there are four dominating models which explain the conception of how information needs arise, ranging from Taylor's (1968) "vague of sort of dissatisfaction", Belkin's (1978) "state of knowledge", and Kuhlthau's (1988) "the idea of

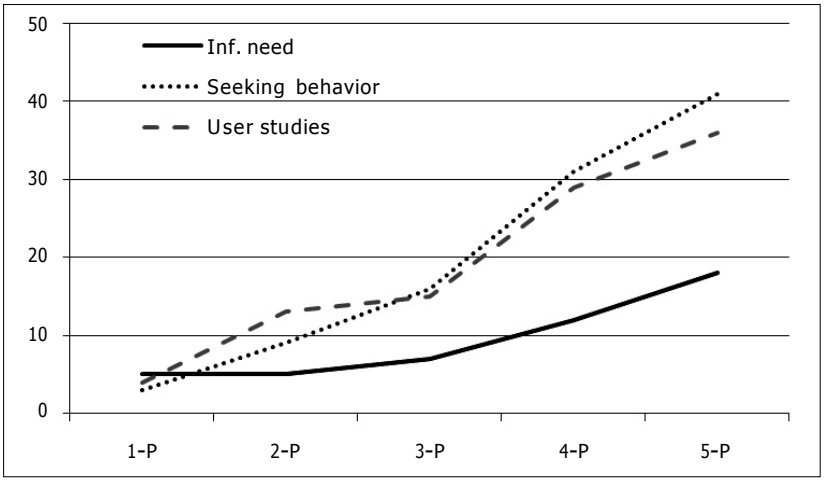
uncertainty" to Dervin's (1992) "sense-making". After that, there was a proliferation of papers on various aspects of these theories and models. Research on the topic of information needs have investigated the nature of information needs which constantly changes with new and relevant sensory input, unlike a basic human need for food, shelter, or security. In the 1990's, the interest in information needs declined somewhat. Researchers paid attention to looking at the methods whereby users actually seek information as well as looking at its usage.

By contrast, research on 'information seeking behaviors' has increased sharply up to 43% since 1995 (See Table 6). The second major category of information use research was information seeking which can be defined as "the purposive acquisition of information from selected information carriers" (Johnson 1996). Information seeking is a taken-for-granted concept that encompasses a variety of behaviors seemingly motivated by the recognition of "missing" information (Case 2008). A broad range of research has been conducted on human use of information and their intentional behavior. A recent trend among information behavior research has been to embrace theories originating in the Humanities and Social Sciences and in particular, to adopt the theoretical basis for empirical work on information needs and uses. Information needs and information seeking are related to a host of information use notions. Therefore, information use research explored other concepts that are closely related to information seeking: decision making, relevance, salience, selective exposure, browsing, serendipity, knowledge gaps, information poverty, information overload, information anxiety, and entertainment (Case 2008). Many researchers explored the condition or distractions of user behaviors and the degree of preferences which may emerge in the information seeking process (for example, a tendency, a feeling, affection etc) and factors or contexts which may determine one's perceptions during information seeking (for example, a person's situation, background, and environment).

On the other hand, another category of information use research is 'user studies'. <Table 6> shows that the peak period of 'user studies' is the 2nd and then the amount of user studies has been decreased a little. The large amount of user studies had been mainly carried out in library contexts in the early period. Most fields, including science, technology and medicine and most information systems have been the subject of some investigation for user studies. The majority of user studies employed survey-based quantitative approaches; now, emphasis on a qualitative approach is growing. However, most user studies have been on a smaller scale and, though the results may be of potentially wider application, they have sometimes been limited by the relatively small number of respondents involved. In more recent years, these studies have particularly concentrated on the use of electronic resources or digital environments. One great advantage of these is that the characteristics of the usage can be derived from statistics provided by the system itself. Consequently, the activities and habits of large numbers of users can be examined simultaneously and conveniently (Nicholas et al. 2005).

Research interests in recent decades has concentrated especially on information-seeking aspects, so adding greater sophistication to the relatively simple approach taken in information retrieval (Meadows 2008). For a proper understanding of human information seeking and retrieval, much research has been conducted by examining cognitive factors such as the users' perceptions of where they have an information problem, analyzing the relationship between the backgrounds of end-users and the detailed characteristics of the information-seeking process, and by revealing considerable similarities in such basic activities. These research results help to find some interactive input items, to identify the limitations of the information system used, and to suggest the best way to bridge the gap in the retrieval interface. Also, much of the research deals with the Internet and Web on human behavior.

<Figure 9> shows that studies in "Information Use and User" increased throughout the 25 years covered in this study, with considerable growth in 'seeking behaviors' and 'user studies' during the 2000's. In the past, conducting "traditional" information behavior studies on new information systems or user groups required a considerable amount of work. With the rising prominence of the web, information use or seeking has been evolving in the digital environment. Identifying user perception or user satisfaction through user studies has been applied in the fields of IR performance evaluation, online searching, system evaluation, and human-computer interaction. Whatever the future holds, it seems that the need to understand how people search for and use information is likely to continue. Further, the understanding of information use and users may become increasingly important for the effective design of systems and services, as technologies change and information services continue to develop (Wilson 2002).



〈Figure 9〉 Changes of Information Use Research during the Five Periods

5. Conclusion

Any attempt to trace the development of one discipline helps researchers to discover new paradigms and perimeters in their fields. If the field evolves dynamically and its concepts are plenty, such an attempt is inevitable. This study was conducted to trace the IS research covering the years from 1985-2009. That is, the study identified the most emphasized topics by information science researchers and scrutinized the changes of research activities of three main topics over the time. The study found that the most productive area is consistently 'Information Retrieval', followed by 'Informetrics', 'Information Use and Users', 'Network and Technology', and 'Publishing and Services'. In particular, a sharp increase of informetrics and information use studies during the 5th period indicate that the growth of the digital world has made it necessary to re-examine the information chain phenomena and use patterns. 'System Design and Evaluation', 'Information Systems and Industry', 'Data and Information Processing', 'Knowledge Organization' and 'Basic Concepts' belong to the third ranked group. The lowest posting areas are 'Societal Issue' and 'Information Resource Management'.

Information retrieval is a predominant core area in Information Science. The main early concerns in information retrieval were retrieving and searching methods and evaluation. These led to a range of models and experiments until the 1990's, but interest has now broadened to include computer-based handling of multimedia information, employment of new methods from other disciplines, and mass information handling in virtual environments. Furthermore, the highest increased subject area during the latest period is 'Informetrics'. The current wide range of informetric studies does not open up new ways of understanding the scholarly communication process, its impact and intellectual structure alone, but also investigates social phenomena, cultural issues, and social networking. That is, informetric studies have shifted from finding existing phenomena to seeking valuable descriptive results. Last, 'Information use and Users' studies have been conducted consistently with every development in the IS field. Many researchers have tried to examine the nature of information needs, a variety of behaviors seemingly motivated by the recognition of "missing" information, other concepts that are closely related to information seeking: decision making, relevance, salience, selective exposure, browsing, serendipity, knowledge gaps, information poverty, information overload, information anxiety, and entertainment. Nowadays, they have concentrated especially on information-seeking aspects, so adding greater sophistication to the relatively simple approach taken in information retrieval.

As expected, this study found that information science research has constantly changed. The ongoing effort of this study is to elucidate the progress and direction of changes and new academic phenomena in IS. These findings should be viewed as indicative rather than authoritative because the scope of the data collected was confined to *JASIST*.

References

Bar-Ilan, Judit. 2008. "Informetrics at the beginning of the 21st century - A review." *Journal of Informetrics,* 2(1): 1-52.

Belkin, N.J. 1978. "Information concepts for information science." *Journal of Documentation,* 34: 55-85.

Bensman, S.J. 2007. "Garfield and the Impact Factor." *Annual Review of Information Science and Technology,* 41: 93-155.

Bjorneborn, L. and P. Ingwersen. 2004. "Toward a basic framework for webometrics." *Journal of the American Society for Information Science and Technology,* 55(14): 1216-1227.

Borgman, C.L. and J. Furner. 2002. "Scholarly communication and bibliometrics." *Annual Review of Information Science and Technology,* 36: 3-72.

Boyce, B.R. and D.H. Kraft. 1985. "Principles and theories in information science." *Annual Review of Information Science and Technology,* 20: 153-178.

Buckland, M. 1999. "The landscape of information science: The American Society for Information Science at 62." *Journal of the American Society for Information Science,* 50(11): 1970-1974.

Buckland, M and Z. Liu. 1995. "History of information science." *Annual Review of Information Science and Technology,* 30: 385-413.

Case, D.C. 2007. *Looking for Information: A Survey of Research on Information Seeking, Needs and Behavior.* UK: Emerald.

Cleverdon, Cyrill W. 1991. "The significance of the Cranfield tests on index languages." In: *Proceedings of SIGIR,* 3-12. ACM Press.

Chu, H. 2001. "Research in image indexing and retrieval as reflected in the literatures." *Journal of the American Society for Information Science and Technology,* 52(12): 1011-1018.

Ding, Y., G. Chowdhury, and S. Foo. 1999. "Mapping the intellectual structure of information retrieval studies: An author co-citation analysis, 1987-1997." *Journal of Information Science,* 25(2): 67-78.

Dervin, B. 1992. "From the mind's eye of the user: The sense-making qualitative-quantitative methodology." In: J. Glazier and R. Powell. eds. *Qualitative Research in Information Management.* Englewood, CO: Libraries Unlimited.

Gilchrist, A. ed. 2009. *Information Science in Transition.* London: Facet Publishing.

Hawkins, D.T. 2001. "Information Science Abstracts: Tracking the literature of information science. Part 1: definition and map." *Journal of the American Society for Information Science,* 52(1): 44-53.

Hjorland, B. 2002. "Domain analysis in information science: eleven approaches-traditional as well as innovative." *Journal of Documentation,*

58(4): 422-62.

Hughes, B. et al. 2006. "Reconsidering language identification for written language resources." In: *International Conference on Language Resources and Evaluation,* 485-488.

Johnson, J.D. 1996. *Information Seeking: An Organizational Dilemma.* Westport, CT: Quorum Books.

Kuhlthau, C.C. 1988. "Developing a model of the library search process: cognitive and affective libraries." *Reference Quarterly,* 28: 232-242.

Kent, A. et al. 1955. "Machine literature searching VIII: Operational criteria for designing information retrieval systems." *American Documentation,* 6(2): 93-101.

Klempner, I.M. 1969. "Information science unlimited?" *American Documentation,* 20: 339-343.

Konheim, A.C. 1981. *Cryptography: A Primer.* New York: John Wiley & Sons.

Manning, C.D., P. Raghava, and H. Schutze. 2008. *Introduction to Information Retreival.* Cambridge: Cambridge University Press.

Meadows, J. 2008. "Fifty years of UK research in information science." *Journal of Information Science,* 34(4): 403-444.

Moed, H.F. 2005. *Citation Analysis in Research Evaluation.* New York: Springer.

Mooers, Calvin. 1961. "From a point view of mathematical etc. techniques." In: T.A. Fairthorne ed. *Towards Information Retrieval,* xvii-xxiii. Butterworths.

Nicholas, D., P. Huntington, and A. Watkinson. 2005. "Scholarly journal usages: the results of deep log analysis." *Journal of Documentation,* 61(2): 248-80.

Oppenheim, C. 2007. "Using the h-index to rank influential British researchers in information science and librarianship." *Journal of the American Society for Information Science and Technology,* 58(2): 297-301.

Rayward, W.B. 1996. "The history and historiography of information science: Some reflections." *Information Processing and Management,* 32(1): 3-17.

Salton, G. 1991. "The SMART project in automatic document retrieval." In: *Proceedings of SIGIR,* 356-358. ACM press.

Saracevic, T. 1999. "Information Science." *Journal of the American Society for Information Science,* 50(12): 1051-1063.

Summers, R., C. Oppenheim, J. Meadows, C. McKnight, and M. Kinnell. 1999. "Information science in 2010: A Loughborough University view." *Journal of the American Society for Information Science,* 50(12): 1153-1162.

Taylor, R.S. 1968. "Question-negotiation and information seeking in libraries." *College and Research Libraries,* 13: 391-396.

Thelwall, M. 2009. *Introduction to Webometrics: Quantitative web Research for the Social Science.* Morgan & Claypool Publishers.

White, H.D. and B.C. Griffith. 1981. "Author Co-citation: A literature measure of intellectual structure." *Journal of the American Society for Information Science,* 32(3): 163-171.

White, H.D. and K.W. McCain. 1998. "Visualizing

a discipline: An author co-citation analysis of information science, 1972-1995." *Journal of the American Society for Information Science,* 49(4): 327-355.

Zhao, D. and A. Stromann. 2008. "Information science during the first decade of the web: An enriched author co-citation analysis." *Journal of the American Society for Information Science and Technology,* 59(6): 916-937.

Zins, C. 2007a. "Conceptions of information science." *Journal of the American Society for Information Science and Technology,* 58(3): 335-350.

Zins, C. 2007b. "Knowledge map of information science." *Journal of the American Society for Information Science and Technology,* 58(4): 524-535.

Zins, C. 2007c. "Classification schemes of information science: Twenty-eight scholars map the field." *Journal of the American Society for Information Science and Technology,* 58(5): 645-672

Wilson, T.D. 2002. "The nonsense of knowledge management." *Information Research,* 8(1), paper no. 144. [cited 2010.6.4]. <http://information.net/ir/8-1/paper144.html>