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JOURNAL BIBLIOMETRIC ANALYSIS: A CASE STUDY ON THE JASIST

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Abstract
The purpose of this study is to explore the relationship between *Journal of the American Society for Information Science and Technology* (JASIST), and other disciplines by citation analysis. The citation data were drawn from references of each article of JASIST in 1980, 1985, 1990, 1995, 2000 and 2004. The Ulrich's Periodical Directory, Library of Congress Subject Heading, retrieved from the WorldCat and LISA database were used to identify the main class, subclass and subject of cited journals and books. The results of this study revealed that the production rate of JASIST literature doubles and the average number of references cited per paper is also increased 2 to 3 times in a period of about 25 years. Beginning in 1995, there has been a significant increase in the number of electronic resources and constitutes 5% of all document types in 2004. JASIST itself is the most highly cited, and is followed by four library and information science (LIS) journals, namely *Information Processing and Management*, *Journal of Documentation*, *Annual Review of Information Science and Technology* and *Journal of Information Science*. The number of countries publishing the cited journal increases from 9 to 26 within 25 years. The three main classes of journals that were cited by JASIST most are library science (50%), science (22.7%) and social sciences (6.3%). The three subclasses of LIS encompass general bibliography, machine methods of information & retrieval and mechanized bibliographic control and library & information science. The top five most cited books of JASIST are *Smart Retrieval System—Experiments in Automatic Document Processing*, *Introduction to Modern Information Retrieval*, *Information Retrieval*, *Little Science and Big Science*, *Information Seeking in Electronic Environments*, *Information Retrieval: Data Structure and Algorithms*. The most cited books of JASIST are quite dispersive and science is the most cited class followed by LIS, social sciences, philosophy/psychology/religion, and the most cited subject is computerized information retrieval and mechanized bibliographic control.

Keywords: Bibliometrics; Citation analysis; Single journal studies; Journal of the American Society for Information Science and Technology (JASIST);

INTRODUCTION

Meadow and Zaborowsk (1979) conducted some statistical analyses on the author characteristics, the nationality, society memberships and citation patterns of the 1978 edition of the *Journal of the American Society for Information Science* (JASIS) and

found that most of JASIS authors (43 out of 54) came from the United States of America. The top ten most frequent journals cited by JASIS were JASIS itself, *Journal of Documentation*, *Information Processing and Management*, *Communications of the ACM*, *Special Libraries*, *Journal of Chemical Information and Computer Science*, *Annual Review of Information Science and Technology*, *Nature*, *Management Science* and *Social Studies of Science*. The most frequent subjects covered by JASIS authors are library and information science (LIS), computer technology and applications, science: comprehensive works, engineering, medical science, business and economics, physics, political science, education, and history.

By employing a bibliometric approach, Koehler (2001) investigated the demographics of journal articles for American Documentation and JASIS from 1950 to 1999[1]. After analyzing data of authorship (names of authors and each author's specific and general affiliation), citation patterns, funding and funding sources and related bibliometric phenomena, Koehler found that the number of authors has risen from an average 1.2 per article to 1.8 over the fifty year period and the number of articles per author has also increased. In particular, the number of authors from outside the United States of America has increased significantly over time. The contributing authors came from other English speaking countries such as Africa, middle and south America and Asia. Smith (1999) explored how JASIS has developed over the past 50 years. One of her research topics is an analysis of the linkage between JASIS and other publications (which journals JASIS authors most often cite and which journals most often cite JASIS). Smith found that recent JASIS articles cite the following journals most frequently: *JASIS* (journal self-citation); *Information Processing & Management*; *Journal of Documentation*; *Communications of the ACM*; *Scientometrics*; and *Journal of Information Science*. All but *Communications of the ACM* recur in the list of journals which most often cite JASIS, with the addition of *International Forum on Information and Documentation*. In order to study the structure of the field of information science, Persson (1994) explored the intellectual base and research fronts of JASIS based on a citation analysis. Two hundred and nine articles published in the JASIS from 1986 to 1990 were selected as the document set from SSCI CD-ROM. A co-citation analysis was made to find the intellectual base of these articles and bibliographic coupling was applied to the same set of documents in order to define research fronts. His results revealed that an intellectual base is renewing slowly. The intellectual base of information science has two major clusters, bibliometrics and information retrieval. Citation analysis and bibliometric distributions are two groups of bibliometric cluster

[1] *JASIST* started out as *American Documentation* with its first issue in 1950. In 1970, *AD* became *JASIS*. The name changed again in 2000, to the current name, the *Journal of ASIST*, or *JASIST*.

and information retrieval cluster could be subdivided in one 'hard' part working on algorithms and one 'soft' part concentrating on the user-system relation.

Employing a bibliometric approach, Harter and Hooten (1992) analyzed nine volumes of the JASIS: 1972-74, 1982-84, and 1988-90, and recorded data of publication year, number of citation, funding agency, subject of the paper and institutional affiliation of the first author. They reported that for the 260 articles from 1972-74 and 1982-84, 18 of them were not cited at all, and 75% were cited nine or fewer times. Among the 391 articles published in JASIS during the nine years of the study, 126 were funded; just under one-third and highly cited articles are as likely to be funded. More than half (206 over 391) of the articles published in JASIS are theoretical, and this proportion has remained constant over the years. The authors from schools of LIS have increased since 1972-74 and authors associated with corporations, government agencies, and libraries have decreased.

Lipetz (1999) studied the aspects of authorship of papers in JASIS by examining volume of 1955, 1965, 1975, 1985 and 1995. The following data were collected and analyzed: number of authors, type of affiliation of each author, author's gender and author's country if not the United States, number of words in the title, number of references cited and number of self-citing in the paper. His findings revealed that the number of scholarly papers published per year in JASIS has grown exponentially from 21 to 68. Authorship has also grown from 34 to 130 with a doubling time of about 20 years which is similar to the growth pattern of JASIS papers. Authors are collaborating in the production of new papers and international authors have increased greatly. Academic affiliation increased from less than 25% in 1955 to 90% in 1995. From 1955 to 1965, the average number of citations per paper dropped from 8.3 to 7.0; but the ratio increased exponentially thereafter to 30.5 in 1995. The percentage of papers containing any self-citations increased more or less linearly from 24% in 1955 to 82% in 1995. Lipetz and Spink (2002) conducted a study of the geographic distribution of foreign authors in the JASIS from 1950-1999. The authors' bibliographic data as well as their geographic locations were analyzed per 5-year. Their research results demonstrated that there were 564 authors who came from 52 geographic locations and the British and Canadian authors were the most frequent foreign authors in the JASIS. This indicates that JASIS attracts authors all over the world.

The literature review above reveals that most previous studies on the bibliometric analysis of JASIST focused on JASIST itself. Therefore, the objective of the present study is to analyze the characteristics of cited references in JASIST for 1980, 1985, 1990, 1995, 2000 and 2004 through a five year interval. The statistics, document type, the most cited ones, country and subject class of the references will be

analyzed and discussed.

METHODOLOGY

Bibliometric techniques using references made to other documents, can be applied to establish statistical models of scholarly communication flow. For example, citations can be used to map relationships between documents, between journals or other channels of scholarly communications. It also can be clustered to identify the flow of topics within and among disciplines (Borgman 1999). Indeed, citation analysis is an important area of LIS. From the studies of citation analysis, one can learn the following: Which scholars from which disciplines cite which articles? Which journals are cited more often? Which disciplines cite the journals of other disciplines? The results of citation analysis are used for many purposes, for example, to determine the impact of specific articles or journals on subsequent research and to document the interdisciplinary applicability of various journals (Desai 2003; Harter 1996).

Journal of the Association of Information Scientists and Technologists (JASIST) is recognized as one of the most important journal sources in the field of information science (Stankus 2002; Bubin 2000).JASIST is a general-purpose journal, which publishes articles about and from most areas of the discipline and it is in many ways a reflection of the disciplines it represents (Nisonger 1999).

In Borko's article "Information science: what is it?", he explained what information science is and how it relates to librarianship. As Borko addressed, information science is "a discipline that investigates the properties and behavior of information, the forces governing the flow of information, and the means of processing information for optimum accessibility and usability. It is concerned with that body of knowledge relating to the origination, collection, organization, storage, retrieval, interpretation, transmission, transformation, and utilization of information. It is an interdisciplinary science derived from and related to such fields as mathematics, logic, linguistics, psychology, computer technology, operations research, the graphic arts, communications, library science, management, and other similar fields" (Borko, 1968, p.3).

A review of JASIST's references could be very helpful in understanding the information science discipline. The present work focuses on the subject of references contained in the papers published in JASIST, and reports on a survey of various aspects of JASIST published in the following six years, 1980, 1985, 1990, 1995, 2000 and 2004. The present study will identify the amount of journals and books cited and analyze the subject matter of these publications. The research

problems include:

a) What types of document have been cited by JASIST?
b) What journals have been cited most in JASIST and what their host countries are?
c) What are the main class, sub-class and subject for the cited journals?
d) What books are cited most in JASIST and what are the main class, sub-class and subject for the cited books?

The volumes selected from the last 25 years published in JASIST form the sample of this study. The volumes selected were those for 1980, 1985, 1990, 1995, 2000 and 2004 to observe changes through a five year interval. Since this study was conducted in 2004, thus the volume for 2004 was selected instead of 2005. *Journal of the American Society for Information Science* (JASIS) changed its name to the *Journal of the American Society for Information Science and Technology* (JASIST) in 2001; consequently, the term JASIST included both JASIS and JASIST in the present study. Each of the selected volume was examined page by page. For each volume, full-length scholarly papers, including research articles and special topic articles, plus the brief communications were identified. Special issues focus on a specific research domain or question; were treated as regular research articles. Other type of materials, such as bibliographies, abstracts sections, book reviews, letters, obituaries, announcements, news items, conference reports, committee reports, features, and editorials were excluded in the analysis.

Some of the data collection activity requires clarification. However, there still remained a small percentage whose document type was unknown could only be listed as “unknown” (as shown in Table 2). For subject analysis, only journal and book references are considered. References other than these two types, such as theses or reports are not considered. Moreover, there are two assumptions for this study: (a) the six JASIST volumes examined are a fair sample of JASIST; (b) JASIST accurately represents the information science discipline.

With the data collected, the total number of articles published in JASIST in the study period and the nature of references (total number of references and references per article) cited were analyzed. The characteristics explored in this study include statistics on document type of cited literature, the most cited journals, country of cited journals, main class and subclass of cited journals and books, subjects of cited books and subjects of cited journals for LIS.

RESULTS AND DISCUSSION

Total Published Articles References Cited

Table 1 shows that from 1980 to 2004, the number of scholarly papers published in six selected years in JASIST has grown steadily, from 56 to 111. In general, the journal has experienced growth in the number of articles over time. However, the published papers dropped slightly from 56 to 47 for 1985, and from 111 to 104 for 2004. Volumes of 1980, 1985, and 1990 consist of six issues each, whilst volume 1995 had ten issues and volumes 2000 and 2004 had 14 each. There was a trend toward a more issues and more articles per volume (year). The data suggests that the production rate of JASIST literature doubles in a period of about 25 years. This is almost consistent with Lipetz's (1999) study for the year of 1955, 1965, 1975, 1985 and 1995. JASIST has also added special topic articles to its publications of regular research articles. In fact, the percentage of special topic articles is quite significant over the time span of this study, from 15% to 29%. The brief communication comprises 9 papers in 1980 and this number dropped to 1 paper in 1990.

Table 1: Total Article and References Cited in Six Selected Years

Year	Research article Ref (article)	Ref per article	Special topic ref(article)	Ref per article	Brief comm Ref(article)	Ref per article	Total ref (article)	Ref per article
1980	633(36)	17.6	109(11)	9.9	60(9)	6.7	802(56)	14.3
1985	626(23)	27.2	389(21)	18.5	97(3)	32.3	1112(47)	23.7
1990	1258(51)	24.7	153(9)	17.0	10(1)	10.0	1421(61)	23.3
1995	1623(48)	33.8	293(17)	17.2	70(6)	11.7	1986(71)	28
2000	2751(72)	38.2	877(37)	23.7	6(2)	3.0	3634(111)	32.7
2004	2638(69)	38.2	1129(30)	36.4	67(5)	9.6	3834(104)	36.9
Total	9529(299)	31.9	2950(125)	23.6	310(26)	11.9	12789(450)	28.4

Simultaneously, the references that authors cited in their JASIST papers has also grown rapidly from 802 in 1980 to 3834 in 2004 (an increase of about 4 times). The average number (as can be seen from Table 1) of references cited per JASIST paper changed from 14.3 in 1980 to 28 in 1995 and 36.9 in 2004. A study of reference distribution in JASIS over 1955 to 1995 showed a very similar pattern of increase in references per paper (Lipetz 1999).

Both total cited references and the average cited reference number have been increasing significantly. There has been an increase in citing practice over the last 25

years. This may be due to several reasons such as, that there are more related works in the literature as time goes; JASIST authors refer to more various literature than before, and literature has exploded rapidly and partly because of the fast and convenient web-based access to subject databases.

Articles published in JASIST consist of research articles, special topic articles and brief communications. For research articles and special topic papers, the average number of reference cited per article generally shows an increasing trend. For 1995, the average rate of reference per article in the two types of papers double the rate measured in 1980.

For brief communication article, the number of reference per paper is no more than 10 for four study years, 1980, 1990, 2000 and 2004. The year 1985 is an exceptional year for brief communication publications. JASIS published 3 brief communications and each cited 32 references on average. Brief communications are usually more specific and short and long literature review is usually not necessary and the number of references is fewer than that for regular articles.

Document Type of Cited Literature

In Table 2, one can observe some aspects of document type for the references cited in JASIST for the six particular years of this study. Journal articles are the most cited document (51%), followed by books and book chapters (23%), conference proceedings (15%), electronic resources (5%). The rest of document types accounts for 6% of the cited references only. Notably, from 2000 to 2004, book citations declined with a significant number from 939 to 672. Electronic resources begin to appear in the cited references and increases rapidly after 1995. The electronic resources consist of e-journal, WWW resources, e-conference, e-report, electronic newspaper and search engine. There was only one (0.1% of the total journal literature) e-journal cited in 1995 and the cited electronic resources jumped to 2.4% in 2000 and 5% in 2004. In 2004, the number of conference paper was 10 times of the 1980, of those 64 are e-conference literature. The remaining document types cover technical/research report, theses/dissertation, patent, newspaper, menu, personal communication, research proposal, archival material, unpublished paper, class note, preprint, and bibliographies.

As discussed previously, the journal article and books or book chapters are the two most prevalent forms of citation. It is therefore interesting to investigate the publication country, the main class, subclass and the subject of the cited journals and books in detail.

Table2 Document Types of Cited Literature for JASIST in Six Selected Years

	1980	1985	1990	1995	2000	2004	Total	%
Journal	374	586	856	1113	1782	1980	6691	51.4
Book	251	305	317	531	939	672	3015	23.1
Proceedings	77	97	137	230	575	782	1898	14.6
E-resource*	0	0	0	12	203	410	625	4.8
Report	51	74	41	38	81	49	334	2.6
Theses	14	22	42	41	66	63	248	1.9
Other	30	14	17	18	31	30	140	1.1
Newspaper	3	12	8	4	20	12	59	0.4
Unknown	2	2	3	1	6	1	15	0.1
Total	802	1112	1421	1988	3703	3999	13025*	100

*Journal published in printed version and in electronic version will be counted once for each, therefore, the total number will be greater than 12789.

The Most Cited Journals

Based on the citation count in the journals' references, JASIST is the most highly cited journal in the six years studied. JASIST contributes 18.6% of the total cited references. *Information Processing and Management* (IPM) comes next (5.4%) and ranked in the top 3 for the sic years under study except for the year 2000. Other cited journals are *Journal of Documentation* (JOD) (4.7%), followed by *Annual Review of Information Science and Technology* (ARIST) and *Journal of Information Science*. Each of the last two journals constitutes no more than 2% of the total cited journal literature. In total, these five journals contribute 32% of all journal literature and may be considered as the core referenced journals for articles published in JASIST. There are 17 journals ranked as on the top 50% cited journals, ten of which are LIS oriented and constitute 37% of the total journal citations. This suggests articles published in JASIST are likely to cite journals covering the theory and application of LIS.

On the other hand, the seven journals which do not contain articles of relevance to LIS are: *Communications of the ACM* (CACM) (337 times, 5% of the total journal citations), *Scientometrics* (177 times, 2.7% of the total journal citations), *Science*, *International Journal of Human-Computer Studies*, *ACM Transactions on Information Systems*, *Journal of the American Medical Association (JAMA)*, and *IEEE Computer*.

Clearly, the four non-LIS journals are computer science journals and cover all aspects of computing, such as artificial intelligence, programming, human and social aspects of computing, operational research and information system. Of the three remaining non-LIS journals, two are general science journals (*Scientometrics* and *Science*), and the other is a medical science journal. The subject areas of the cited journals have been dispersed into non-LIS. In general, the citation rate of non-LIS journals was less than 1%. These non-LIS journals cover multidisciplinary subject fields, including LIS.

Meadow (1979) and Smith (1999) also investigated the most frequently cited journals in JASIS. Table 3 shows a comparison of top 10 most cited journals among these two previous studies and the present study. All the three studies, JASIST (self citation) itself is the most cited journals and the present study indicates that it accounts for 18.6% of total cited references. IPM and CACM, JOD appear in the top five most cited reference of all the three studies though the relative ranking may be changed. *Scientometrics* began to appear in the top 5 most cited reference in Smith study in 1999 and remains no. 5 in the present study. This is conceivable as the bibliometrics has become an important subject on information science during two decades. Significantly, most cited journals ranking from 6 to 10 changes quite dramatically. Only ARIST appears in Meadow (1979) and the present study and the rest four most cited journals in the present study are all different from Meadow's list.

Table 3: Ten Most Cited Journals for JASIST in Meadow, Smith and this Study

Meadow (1979)	**Smith* (1999)**	**Tsay (2004)**
Journal of the ASIS	Journal of the ASIS	Journal of the ASIST
Journal of Documentation	Information Processing and Management	Information Processing and Management
Information Processing and Management	Journal of Documentation	Communications of the ACM
Communications of the ACM	Communications of the ACM	Journal of Documentation
Special Libraries	Scientometrics	Scientometrics
Journal of the Chemical Information and Computer Science	Journal of Information Science	Annual Review of the information Science & Technology
Annual Review of the Information Science and Technology	Not available	Journal of Information Science
Nature	Not available	Science
Management Science	Not available	International Journal of Human-Computer Studies
Social Studies of Science	Not available	ACM Transactions on Information System

* Ranking based on the list order given by Smith.

Country of Cited Journals

The journals cited by JASIST are published in 38 countries in the world. Table 4 provides the country distribution of cited journals. As one may expect, the United States of America (USA) is the predominant country that published the major portion of cited journals. Above 63% (622 out of 983 titles) of the cited journals comes from USA. The United Kingdom (20%) and the Netherlands (6%) contribute the second and the third followed by Germany, Canada, France, Japan and the Australia. Japan and Australia journals began to show non-single citations since 2000. The number of country for cited journals is increasing over time, from 9 to 26, demonstrating that the research interest of JASIST authors have been broaden from local sites to global ones. This reflects that the JASIST is becoming more global in character. More of its cited journals are published from countries other than the United States of America and other English speaking countries. Moreover, over time the distribution of those countries is becoming more diverse.

Table 4: Country of Cited Journal for JASIST in Six Selected Years

Country	1980	1985	1990	1995	2000	2004	Total
USA	89	99	109	203	241	298	622
UK	18	32	49	57	89	91	192
Netherlands	4	8	9	14	31	25	60
Germany	3	5	2	4	7	11	20
Canada	2	4	2	8	6	6	18
France	2	2	3	2	3	3	13
Japan	0	0	1	0	4	5	10
Australia	1	1	1	1	4	5	10
Brazil	0	1	4	0	1	0	6
India	0	2	3	1	0	1	4
28 other countries				983 total journals			

Main Class and Subclass of Cited Journals

It is possible to retrieve various main class and subclass data about a journal from *Ulrich's Periodical Directory* on the basis of Library of Congress Classification (LCC). For example, the classification number of *D-Library Magazine* ZA4080 denotes the main class for the Journal is "library and information science" (Z) and its subclass is "library science" (ZA).

Table 5 shows that, over the six study years, the total number of main class and subclass for all cited journals are 19 and 97, respectively. It can be seen that JASIST published articles in various disciplines in the LIS field with library science constituted about 50% of the total cited journal literature. The second most cited journals were that of classified under science (22.7%). Among them, two major subclasses are science in general and mathematics. It should be noted that computer science is classified in the mathematic class. The third most cited works dealt dealing with social sciences (6.3%). Business, sociology and economics are the three subclasses constituting the prominent part of social science citations. The following three main classes in order are technology, medicine and psychology. To obtain further information about subclasses and subjects of LIS, general science and mathematics journals further analysis is carried out and the results is indicated in Table 5.

Subclasses and Subjects of Cited Journals for LIS, General Science and Mathematic

The analysis of thematic classification by LCC showed that, for LIS (Z class) the three most cited subclasses encompass general bibliography (51%), machine methods of information & retrieval and mechanized bibliographic control (20%), and LIS (16%). In a study on the evaluation of LIS journals, McCarthy (2000) divided the LIS journals into 24 subdivisions. Based on her classification, the total number of subdivisions that JASIST cited for this study is 22. Of those, JASIST cited three prominent information science journals most, including *JASIS, Information Processing and Management, Journal of Information Science*. The total cited times were 1861. Other most cited subdivisions and their corresponding journals are as follows: classification and cataloging (330 times, *Cataloging and Classification Quarterly* and *Journal of Documentation*); library research and practice (*Library and Information Science Research, Library Quarterly, Library Trends*); electronic and online resources in libraries (*Online, Online and CD-ROM Review*).

By examining the descriptor field of each record in the *Library and Information Science Abstract* (LISA) database, Table 6 illustrates the percentage, in descending order, of cited frequency for each subject term of 3411 LIS papers cited by JASIST of this study. There are 1511 unique subject terms contained in these 3411 LIS articles. Subjects that were cited more than 200 times consist of searching, information work, subject indexing, information storage and retrieval, technical services, online information retrieval, computerized information storage and retrieval, computerized information retrieval, library materials, bibliometrics and strategies. However, the major subclasses of general science and mathematics include computer science, general science, cybernetics, computer software, information theory and probabilities.

Table 5: Main Classes, Subclasses and Cited Times of Cited Journal in JASIST

Main class	Subclass	1980	1985	1990	1995	2000	2004	Total
General works		2	0	1	2	7	0	12
Philosophy; psychology and religion		8	28	28	53	65	43	225
	Psychology	8	26	28	52	63	40	217
Auxiliary sciences of history		0	1	0	1	1	0	3
General and old world history		0	1	0	1	2	0	4
American history		1	0	0	0	1	0	2
Geography; maps; anthropology; recreation		0	4	0	1	4	4	13
Social sciences		28	62	48	43	113	130	424
	Economics	3	12	6	8	17	42	88
	Business	9	2	7	18	30	31	97
	Sociology	1	20	9	5	31	29	95
Political science		4	6	0	0	8	3	21
	Political institutions and public administration	4	4	0	0	2	0	10
Law		2	6	4	1	1	17	31
	Law (general)	1	5	1	1	1	14	23
Education		1	15	6	39	54	36	151
	Education (general)	0	7	1	7	10	10	35
	Theory and practice of education	0	5	1	31	38	23	98
Music		0	0	0	0	0	6	6
Fine arts		0	0	0	3	0	0	3
Language and literature		1	3	8	17	42	30	101
	Philology and linguistics (general)	1	3	8	15	27	20	74
Science		87	109	200	187	545	388	1516
	Science (general)	21	53	98	78	160	202	612
	Computer science; Electronic data processing	50	35	84	95	355	149	768
Medicine		2	4	5	159	31	100	301
	Medicine(general)	0	1	3	126	20	43	193

	Public aspects of medicine	0	0	0	15	1	9	25
	Other system of medicine	2	0	2	3	6	12	25
Agriculture		0	1	6	0	7	1	15
Technology		25	29	27	60	70	142	353
	Technology(general)	10	19	6	13	11	36	95
	Engineering(general); civil engineering (general)	4	4	11	26	33	28	106
	Electrical engineering; Electronics; Nuclear engineering	9	4	7	17	23	77	137
Military science		0	1	0	2	0	0	3
Bibliography; Library science		206	304	508	528	812	1053	3411
	Libraries and library science	206	304	508	528	785	1025	3356
	Other	0	0	0	0	27	28	55

Table 6 Subjects of JASIST's Cited Journal Papers on LIS Discipline

Rank	Subject	Cited times	%	Rank	Subject	Cited times	%
1	searching	802	5.7	13	Models	160	1.1
2	information work	788	5.6	14	computerized subject indexing	154	1.1
3	subject indexing	675	4.8	15	Periodicals	150	1.1
4	information storage and retrieval	657	4.7	16	Evaluation	144	1
5	technical services	604	4.3	17	world wide web	128	0.9
6	online information retrieval	521	3.7	18	Research	127	0.9
7	computerized information storage and retrieval	442	3.2	19	Relevance	116	0.8
8	computerized information retrieval	383	2.7	20	mathematical models	111	0.8
9	library materials	240	1.7	21	Services	105	0.8
10	bibliometrics	236	1.7	22	user services	105	0.8
11	strategies	223	1.6	23	information seeking behavior	104	0.7
12	citation analysis	188	1.3	total	1511 subjects	14052	100

Analysis of Cited Books

There are 2082 titles of book cited for 3015 times by JASIST for the six selected years under study. All these book references can be divided into 18 main classes, 92 subclasses and 1372 subjects. The top five most cited books are *Smart Retrieval System—Experiments in Automatic Document Processing* (37 times), *Introduction to Modern Information Retrieval* (33 times), *Information Retrieval* (31 times), *Little Science and Big Science* (18 times), *Information Seeking in Electronic Environments* (14 times), *Information Retrieval :Data Structure and Algorithms* (14 times). Most of these books deal with information storage and retrieval system, human-machine interaction, data structure and information behavior except *Little Science and Big Science*, which is a general science book. The cited times of the above most cited books contributes no more than 1.2% of the total cited times of books. This demonstrates that the distribution of book citation for JASIST is more scattered compared with of journal citations.

Main Classes and Subclasses of Cited Books

Based on the Library of Congress Classification (LCC) all books that were cited by JASIST were grouped into 18 main classes. Science (27%) is the most cited class followed by LIS (24%), social sciences (14%), philosophy, psychology and religion (10%). For the class of science, the cited books can be further subdivided into 12 subclasses and, among them, the subclasses computer science, general science, probabilities and cybernetics were cited more than 50 times. For the cited books on LIS, the most cited subclasses include machine methods of information retrieval and mechanized bibliographic control (37%), LIS (11%), indexing and abstracting (8%), and cataloging (7%).

Subjects of Cited Books

Unlike the cited journal articles, which concentrated on the subject of LIS, the books that JASIST cited were dispersed in various different subjects. The most cited subject is computerized information retrieval and mechanized bibliographic control. However, the cited frequency was decreasing gradually after 2000. In terms of subject headings, that were assigned based on Library of Congress Subject Headings (LCSH) and retrieved from the WorldCat, 3015 books cited by JASIST contained 1487 unique subject headings. Table 7 demonstrates that information storage and retrieval systems is the most frequently cited subject (258 cited times, 3.8% of total subject cited times), followed by sciences (240 cited times, 3.5%) and social sciences (134 cited times, 2%). The cited subjects can be grouped into certain categories. For example, information storage and retrieval, indexing, subject headings, indexing and abstracting, user interface, information behavior, libraries, library science, library statistics, documentation, information services, information science, online bibliographic searching can be designated as the LIS category.

Table 7: Subjects of JASIST's Cited Books

Rank	Subject heading	Cited times	%	Rank	Subject heading	Cited times	%
1	information storage and retrieval systems	258	3.8	23	information technology	34	0.5
2	science	240	3.5	24	psychology of learning	32	0.5
3	social sciences	134	2	25	communication of technical information	31	0.5
4	information retrieval	100	1.5	25	computational linguistics	31	0.5
5	cognition	99	1.5	25	online bibliographic searching	31	0.5
6	information science	90	1.3	26	documentation	29	0.4
7	artificial intelligence	77	1.1	26	expert systems (computer science)	29	0.4
8	research	77	1.1	26	machine learning	29	0.4
9	human-computer interaction	75	1.1	26	Telecommunication	29	0.4
9	libraries	75	1.1	27	Classification	28	0.4
10	communication	65	1	27	computer programming	28	0.4
11	library science	62	0.9	27	English language	28	0.4
12	technology	60	0.9	27	information behavior	28	0.4
13	information services	58	0.9	27	theory of knowledge	28	0.4
13	information storage and retrieval	58	0.9	27	text processing (computer science)	28	0.4
14	database management	55	0.8	28	indexation (documentation)	27	0.4
15	statistics	54	0.8	28	Psycholinguistics	27	0.4
16	communication in science	51	0.8	28	Psychology	27	0.4
17	indexing	43	0.6	28	Scientists	27	0.4
17	subject headings	43	0.6	29	abstracting and indexing	26	0.4
18	human information processing	42	0.6	29	computer algorithms	26	0.4
19	computers	41	0.6	29	mathematical statistics	26	0.4
20	sociology	40	0.6	30	library statistics	25	0.4
20	user interfaces (computer systems)	40	0.6	subject of cited two times		259	3.8
21	SMART (information retrieval system)	37	0.5	subject of cited once		777	11.4
22	semantics	35	0.5	total	1487 subject headings	6829	100

Computer science and information technology encompasses the subjects of artificial intelligence, human-computer interaction, database management, human information processing, computers, expert systems, machine learning, telecommunication, computer programming, text processing and computer

algorithms. Other categories involve psychology (cognition, psycholinguistics), science and technology (technology, communication in science, statistics) and sociology. The breadth of subjects of the books cited reflects the range of interests of JASIST authors and readers.

To see the evolution of subjects of the books cited, Table 8 shows the top three subjects for each year under study. It demonstrates information storage and retrieval systems had been the most cited subject since 1980 which peaked in 1990 (6.6%) and then decreased slowly after. 'Science' was the highly cited subject after 1980. It is interesting to note that the cited frequency is actually higher in 2000 (66) than 1990 (46), though the percentage is significantly small. 'Computer programming' and 'library information networks' were two other popular cited subjects in 1980. 'Information services' appears for the first time in 1985 and was replaced by 'information retrieval' in 1990. In 1995, 'artificial intelligence' and 'cognition' came up as highly cited subjects and the latter remained highly cited in 2000. The subject of 'information storage and retrieval systems' still remained the most cited subject in 2004 although the percentage of its cited times dropped significantly, possibly due to more scattering of subjects being cited. In 2004, 'research' became one of the highly cited subjects.

Table 8: Top Three Subjects of Cited Book for Six Study Years

Year	Rank	Subject	Cited times	%
1980	1	information storage and retrieval systems	22	5
	2	computer programming	17	3.9
	3	library information networks	9	2.1
1985	1	Science	36	6
	2	information storage and retrieval systems	31	5.2
	3	information services	18	3
1990	1	information storage and retrieval systems	46	6.6
	2	Science	31	4.5
	3	information retrieval	22	3.2
1995	1	information storage and retrieval systems	44	3.6
	2	artificial intelligence	34	2.8
	3	Cognition	28	2.3
2000	1	information storage and retrieval systems	66	3
	2	Cognition	51	2.3
	3	Science	46	2.1
2004	1	information storage and retrieval systems	49	2.9
	2	Science	39	2.3
	3	Research	31	1.9

In summary, the list of specific subjects of the cited books highlights those areas of computer science, such as information retrieval, cognition, artificial intelligence, expert systems, human-computer interaction, and network design, currently of the greatest relevance to the information science.

SUMMARY AND CONCLUSIONS

The present study conducts a bibliometric analysis of JASIST publications for volumes published in six selected years. The study reveals the following findings:

a) The production rate of JASIST literature doubles and the average number of references cited per paper is also increased 2 to 3 times in a period of about 25 years.
b) Journal articles are the most cited document, followed by books and book chapters, conference proceedings, electronic resources, respectively. Beginning in 1995, there is a significant increase in the number of electronic resources and constitutes 5% of all document types in 2004.
c) JASIST itself is the most highly cited, and is followed by four LIS journals, namely *Information Processing and Management*, *Journal of Documentation*, *Annual Review of Information Science and Technology* and *Journal of Information Science*. The seven non-LIS journals highly cited are: *Communications of the ACM*, *Scientometrics*, *Science*, *International Journal of Human-Computer Studies*, *ACM Transactions on Information Systems*, *Journal of the American Medical Association*, and *IEEE Computer*.
d) The number of countries publishing the cited journal has increased from 9 to 26 in 25 years, demonstrating that the research interests of JASIST authors have been broaden from local journals in the USA to global ones.
e) The three main classes of journals that were cited most by JASIST are library science (50%), science (22.7%) and social sciences (6.3%). The three subclasses of LIS encompass general bibliography, machine methods of information & retrieval and mechanized bibliographic control and LIS.
f) The top five most cited books of JASIST are *Smart Retrieval System—Experiments in Automatic Document Processing*, *Introduction to Modern Information Retrieval*, *Information Retrieval*, *Little Science and Big Science*, *Information Seeking in Electronic Environments*, *Information Retrieval :Data Structure and Algorithms*.
g) The most cited books of JASIST are quite diverse and science is the most cited class followed by LIS, social sciences, philosophy/psychology/religion, and the most cited subject is computerized information retrieval and mechanized bibliographic control.

Results of the present research found that information science, as represented by JASIST is a developing discipline with an expanding literature. Increasingly, there has been tremendous growth in the citing of previous literature in information science papers. This findings support the assumption that JASIST accurately represents the information science discipline on the basis of Borko's (Borko 1968) definition. Moreover, JASIST was renamed in 2001 to reflect its expanded interests and new realities on the development of information technology. However, the results revealed that it published less papers in 2004 than in 2000, whereas with more references than in 2000. The document types that JASIST cited in 2004 are more than in 2000 except for books. In 2004, only the Netherlands published fewer journals that were cited by the JASIST than in 2000. It is noteworthy that papers published in journal of computer science, psychology, sociology, political science, education, language and literature were cited fewer times in 2004 than in 2000.

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