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A Bibliometric Analysis on the Journal of Information Science

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【Abstract】

The purpose of this study is to explore the journal bibliometric characteristics of the *Journal of Information Science* (JIS) and the subject relationship with other disciplines by citation analysis. The citation data were drawn from references of each article of JIS during 1998 and 2008. 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 journal articles are the most cited document, followed by books and book chapters, electronic resources, and conference proceedings, respectively. The three main classes of cited journals in JIS papers are "library science," "social sciences" and "science." The three subclasses of non-LIS journals that were highly cited in JIS papers are "industries. land use. labor", "mathematics. computer science," and "science." The three highly cited subjects of library and information science journals encompass "searching," "information work," and "World Wide Web." The highly cited main classes of books in JIS papers are "Social sciences," followed by "library and information science," "science," "philosophy. psychology. religion." The three highly cited subclasses of books in JIS papers are "books (general). writing. paleography. book industries and trade. libraries. bibliography," "industries. land use. labor," and "mathematics. computer science," and the most cited subject of books is "knowledge management."

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[Keywords]

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1. Introduction

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, p. 118). Indeed, citation analysis is an important area of library and information science. From the studies of citation analysis, one can learn 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).

The purpose of this study is to analyze the characteristics of cited references in the *Journal of Information Science* (JIS), which has been recognized as one of the most important journal sources in the field of information science. Other two information science journals are *Journal of the American Society for Information Science and Technology* (JASIST) and *Information Processing and Management* (IP&M) (McCarthy, 2000). As addressed in the scope of JIS, it has been recognized as a general-purpose journal, which publishes articles about and from most areas of the discipline. As one of leading journals in information science, such a study may help understand the interactions among the disciplines relating to information science.

Indeed, as is well-accepted, information science is an interdisciplinary science evolving from the interaction of many other disciplines. Borko defined that 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." He also commented that information science 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). Saracevic (1999, p. 1052) examined the origin of the field from various perspectives and dealt with the relation of information science to other fields from several aspects, including historical, sociological, philosophical, technological, educational, and interdisciplinary. He also argued that "information science is interdisciplinary in nature," "is connected to information technology" and "is an active participant in the evolution of the information society with a strong social and human dimension, above and beyond technology."

In the literature, there have been some bibliometric studies on the cited reference of a particular journal in information science. *Journal of the American Society for Information Science and Technology* (JASIST) was probably the one most studied.

Meadow and Zaborowski (1979) conducted some statistical analyses on the citation patterns of the 1978 edition of JASIS and found that most of JASIS authors (43 out of 54) came from the United States of America. They also identified the top ten most frequent journals cited by JASIS and the most frequent subjects covered by JASIS authors. Persson (1994) explored the intellectual base and research fronts of JASIS, from 1986 to 1990, based on a citation analysis to study the structure of the field of information science. Two hundred and nine articles published in the JASIS were selected as the document set from SSCI CD-ROM. His co-citation analysis revealed that an intellectual base was renewing slowly. The intellectual base of information science had two major clusters, bibliometrics and information retrieval. Citation analysis and bibliometric distributions are two groups of bibliometric cluster and information retrieval cluster could be subdivided in one "hard" part working on algorithms and one "soft" part concentrating on the user-system relation. Smith (1999, p. 967) explored how JASIS has developed over the past 50 years. One of her research topics was an analysis of the linkage between JASIS and other publications (which journals JASIS authors most often cite and which journals most often cite JASIS). She identified the top

most frequently cited journals by the authors of JASIS. Lipetz (1999) studied many bibliometric aspects of papers in JASIS by examining volume of 1955, 1965, 1975, 1985 and 1995. One of his findings revealed that the number of scholarly papers published per year in JASIS has grown from 21 to 68. From 1955 to 1965, the average number of citations per paper dropped from 8.3 to 7.0; but the ratio increased thereafter to 30.5 in 1995.

DeHart (1992) studied the end-of-article references appeared in issues, published in 1987-1990, of *Information Processing & Management* (IP&M), *Journal of the American Society for Information Science* (JASIS), and *Journal of Documentation* (JD) to identify monographs cited. The percentage of monographic reference to all references in IP&M, JASIS and JD were 21%, 19% and 26%, respectively. He also identified the five most frequently cited authors and subjects, involving 20 different books, are G. Salton, CM. van Rijsbergen, R. Schank, M. Kochen, and F. Machlup. The five subjects appearing most often are information storage and retrieval systems (72 times); artificial intelligence; discourse analysis; database management; and human-computer interaction.

Employing a variety of bibliometric methods, including publication and citation analyses, Bonnevie (2003) investigated a multifaceted portrait of the *Journal of Information Science*, focused on the last quarter of the 20th century. The areas of study included the visibility of the journal in databases, the pattern of authorship, the pattern of self-citation, internalization and scientific impact. The study revealed that 2,140 JIS publications in the SSCI and LISA, with 1,228 (57.4%) in SSCI and 912 (42.6%) in LISA, respectively, and 1,326 different authors, after removing of duplicate, wrote in JIS from 1979 to 2001 that were covered in SSCI and LISA. Comparison with other analyses, the self-citing rate of JIS was 4.8% on average for all years in SSCI. On the other hand, the self-cited rate was found to be high. The journal co-citation analysis shows that JIS is mainly co-cited with journals in the field of LIS. *Journal of Documentation*, *JASIS* and *Scientometrics* are the top three journals closest to JIS.

Tsay (2008) explored the relationship between JASIS(T) and other disciplines by drawing citation data from references of articles of JASIS(T) in 1980, 1985, 1990, 1995, 2000 and 2004. The results of this study revealed that the production rate of JASIS(T) literature doubled 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 was a significant increase in the number of electronic resources and constitutes 5% of all document types in 2004. JASIS(T) itself was the most highly cited, 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 number of countries publishing the cited journal increased from 9 to 26 within 25 years.

Based on analyses of references in journal articles and journal co-citation analyses, Nebelong-Bonnevie and Frandsen (2006) proposed the journal citation identity (i.e., references per different referenced work) and journal citation image as two indicators for journal evaluation. They analyzed *Journal of Documentation* (JOD) by using the data of *Journal of Information Science* (JIS) and *Journal of the American Society for Information Science and Technology* (JASIST) as standard of reference and comparison. The results demonstrated, from 1990 to 2003, the average journal citation identify for JOD, JIS, JASIST were 1.5, 1.44 and 1.88, respectively. Low ratios for JIS and JOD indicate that JIS and JOD have slightly greater diversity of journals in their references compared to JASIST. They also found that JOD has a higher degree of book reviews and thus a lower share of scientific-content documents than JASIST and JIS. For self-citing aspect, JASIST, with an average self-citing rate of 4.3% ranked first, followed by JOD and JIS with rate of 3.9% and 3.4%, respectively. For self-cited rate, JOD showed a lower rate than the two other journals. The journal co-citation analysis indicated that JASIST and JIS were the two journals closest to JOD and the image of JOD was influenced, especially, by JASIST and IP&M with an upward tendency and to a less degree by JIS.

The literature review above reveals that most previous studies were on the bibliometric analysis of JIS, JOD, IP&M, and JASIS(T). However, subject analysis on the references cited had been seldom studied. The objective of the present study is to analyze the characteristics of cited references in JIS from 1998-2008. A review of *Journal of Information Science* (JIS)'s references could be very helpful in understanding the information science discipline and the relations between JIS and other subject disciplines. It would be very interesting to identify (1) the types of document have been cited by JIS; (2)

the main classes and sub-classes of the cited journals; (3) the subjects of the cited journals for library and information science; and (4) the main classes, sub-classes and subjects of the cited books. Moreover, comparison with that revealed from the cited literature of JASIST (Tsay, 2008) will also be made to see the similarity and difference.

2. Methodology

Each JIS volume, from 1998 to 2008, was examined page by page. For each volume, full-length scholarly papers, including research articles and review articles, plus the brief communications were identified. 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.

The references of each article on electronic version were downloaded and processed by the Excel. Some of the data collection activity requires clarification. 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: (1) the 11 JIS volumes examined are a fair sample of JIS; (2) JIS accurately represents the information science discipline.

With the data collected, the total number of articles published in JIS in the study period and the nature of references (total number of references and references per article) cited were analyzed. The present work focuses on the subject of references contained in the papers published in JIS, and reports on a survey of various aspects of JIS published from 1998 to 2008. The present study identified the characteristics of journals and books cited and analyzed the subject matters of these publications. The set of subject matters identified could be seen as a representation of the intellectual influences received by information science.

Furthermore, this study retrieved main classes and subclasses of cited journals from *Ulrich's Periodical Directory* and OCLC WorldCat on the basis of Library of Congress Classification (LCC). The classification was mainly based on LCC, and supplemented with Dewey Decimal Classification (DDC).

In LCC, the first character symbolizes the main class, and second character represents subclass. If journals were classified by DDC, the corresponding LCC number would be examined according to the Dewey-LC Conversion table made by OCLC. If the corresponding LCC number could not be found, the data would not be analyzed. However, the main classes, subclasses and the subjects of cited books were identified by LCC and Library of Congress Subject Headings (LCSH) searching from OCLC WorldCat. In this study, the subject of cited journals for library and information science were examined on the basis of the descriptor field of each record in the Library and Information Science Abstracts (LISA). The descriptor field utilized controlled vocabulary from a thesaurus or from subject headings list that were created by the database producer. As indicated by Lancaster (1986), a controlled vocabulary would control the synonym, nearly synonyms, homographs, and related terms; therefore, the search for a descriptor field would retrieval items with particular and comprehensive subject meanings.

3. Results and Discussion

This study explored the distribution and subjects of references in *Journal of Information Science* (JIS) during 1998 and 2008. There are 556 papers in JIS in eleven selected years, and their document types are shown in Table 1. Since

Table 1. Document Types of Papers in JIS in Eleven Selected Years

Document Type	Papers
Article	426
Review	22
Brief communication	51
Editorial	25
Correction	3
Letter	23
Memorial	3
Reprint	2
Book review	1
Total	556

this study aims to investigate papers with references, such as articles, reviews, and brief communication, 499 papers were selected for further exploration.

(1) Total Published Articles References

Table 2 shows the numbers of references that authors cited in their JIS papers. There were 499 papers with total 16,320 references in JIS in eleven selected years, and the average number of references cited per JIS paper was 33. Averagely there were 1,484 references cited per year, and the total number almost increased yearly.

Table 2. Total References Cited in JIS Papers in Eleven Selected Years

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	Average
References	741	1,152	1,125	975	1,411	1,379	1,568	1,610	1,629	2,047	2,683	16,320	1,483.6
%	4.5	7.1	6.9	6.0	8.6	8.4	9.6	9.9	10.0	12.5	16.4	100.0	

(2) Document Type of Cited Literature

In Table 3, one can observe some aspects of document type for the references cited in JIS in the eleven years covered in this study. Journal articles were the most cited (50.1%), followed by books and book chapters (19.3%), conference proceedings (9.2%), electronic resources (16%). The rest of document types accounted for mere 4.7% of the cited references. The

Table 3. Document Types of Cited Literature for JIS in Eleven Selected Years

Document Type	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	%
Journal	364	486	492	418	520	726	796	733	937	1,197	1,510	8,179	50.1
Book	161	352	212	185	227	254	295	328	312	372	452	3,150	19.3
Conference	29	45	142	129	140	119	126	145	162	202	264	1,503	9.2
Dissertation	11	17	4	5	8	20	12	8	16	13	9	123	0.8
E-resources	105	134	190	192	443	209	251	330	173	208	369	2,604	16.0
Other	71	118	85	46	73	51	88	66	29	55	79	761	4.7
Total	741	1,152	1,125	975	1,411	1,379	1,568	1,610	1,629	2,047	2,683	16,320	100

electronic resources consisted of e-dissertation (0.0%, 4 references), e-book (0.2%, 31 references), e-journal (2.5%, 414 references), e-conference (1.2%, 195 references), and web (12%, 1,960 references). The top four document types also appeared in the cited literature of JASIST (Tsay, 2008) in almost the same order as journal (51.4%), book (23.1%), proceedings (14.6%), e-resources (4.8%). In JIS, e-resources appeared to be cited much often as the decade (1998-2008) studied in the present work has witnessed a tremendous growth of electronic resources.

There are 1,668 journals cited by the JIS, constituting 8,179 cited times. The top five most cited journals, are *Journal of the American Society for Information Science and Technology* (9.2%), *Journal of Information Science, Journal of Documentation*, *Information Processing and Management*, *Scientometrics*. The self-citation rate for the JIS, ranked number two, is 6% of all cited journal literature. This list of most cited journals is quite similar to that of JASIST (Tsay, 2008), in which the most cited journals are JASIST (18.6%), *Information Processing and Management* (5.4%), *Journal of Documentation* (4.7%), *Annual Review of Information Science and Technology* and *Journal of Information Science*. This demonstrates the similarity in the characteristics between JASIST and JIS.

(3) Main Class and Subclass of Cited Journals

Totally there were 19 main classes of journals cited in JIS papers as shown in Appendix 1. The top ten main classes are listed in Table 4 with "library science. information resources" being the most prominent class (42%). The second highly cited journals were those of classified under "social sciences" (19.8%). This table suggests that except for "library science," the cited rates of journals on "social sciences" and "science" were similar. These top three main classes of journals cited in JIS are the same as the top three main classes of journals cited in the JASIST in different order: "library science. information resources" (50%), "science" (22.7%) and "social sciences" (6.3%) (Tsay, 2008). This difference may suggest that JIS is probably deep-rooted in social sciences while JASIST focused on more in science.

Table 4. Main Classes of Journals Cited in JIS Papers

Rank	Main Class	%
1	Library Science. Information Resources (General)	42.0
2	Social sciences (General)	19.8
3	Science	17.2
4	Technology	8.2
5	Medicine	4.6
6	Philosophy. Psychology. Religion	2.0
7	Education	1.6
8	Law	1.2
9	Language and Literature	1.1
10	Geography. Anthropology. Recreation.	0.6
% of 11th-19th main classes		1.7
Total %		100.0

On the other hand, there were 114 subclasses (see Appendix 1) of journals cited in JIS papers. Table 5 presents the top ten subclasses of non-LIS journals cited in JIS papers. The major subclass is "industries. land use. labor" (10.1%), followed by "mathematics. computer science" (7.7%). It should be noted that computer science is classified in the mathematics class. Generally speaking, the result agreed with that of main classes. Papers published in JIS not just cited journals dealing with science, computer science, and technology, but also industries and commerce.

(4) Subjects of Cited Journals for LIS

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 3,518 library and information science papers cited by JIS of this study (see Appendix 1, Main class of Library Science. Information Resources). There were 1,795 unique subject terms contained in these 3,518 LIS articles. Similar to the JASIST, the percentage of each subject is relatively low. The most cited subject was "searching," followed by "information work." "Searching" and "information work" were also the top two most cited subject for the journals

Table 5. Top Ten Subclasses of Non-LIS Journals Cited in JIS Papers

Rank	Subclass	%
1	Industries. Land use. Labor	10.1
2	Mathematics. Computer science	7.7
3	Science (General)	6.0
4	Commerce	5.2
5	Technology (General)	4.4
6	Medicine (General)	2.9
7	Electrical engineering. Electronics. Nuclear engineering. Computer hardware	2.1
8	Chemistry	2.1
9	Psychology	1.7
10	Social sciences (General)	1.2
% of top ten non-LIS subclasses		43.4
% of other subclasses[a]		56.6
Total %		100
Kinds of subclasses		86

[a] including LIS subclasses (42%)

cited in JASIST (Tsay, 2008). From the top 20 cited subjects in JIS papers, as shown in Table 6, one can induce that JIS papers tended to deal with issues related to "information retrieval," "citation analysis," "bibliometrics," "world wide web," and "knowledge management," etc. The "UK" subject perhaps means that articles about UK organizations, such as Thelwall's article in 2002, "The top 100 linked pages on UK university Web sites: high backlink counts are not usually directly associated with quality scholarly content."

(5) Analysis of Cited Books

There are 2,869 titles of book cited for 3,150 times by JIS for the eleven selected years under study as shown in Table 7. On average, every title was cited 1.1 times. All these book references can be divided into 18 main classes, 96 subclasses and 2,021 subjects.

Table 6. Top 20 Subjects of JIS's Cited Journal Papers on LIS Discipline

Rank	Subject	%
1	Searching	3.1
2	Information Work	3.0
3	World Wide Web	2.9
4	Online Information Retrieval	2.8
5	Citation Analysis	1.8
6	Information Storage and Retrieval	1.5
7	Subject Indexing	1.5
8	Internet	1.4
9	Periodicals	1.4
10	Bibliometrics	1.2
11	Research	1.2
12	Technical Services	1.2
13	Library Materials	1.2
14	Web Sites	1.1
15	Evaluation	1.1
16	UK	1.1
17	Articles	1.1
18	Information Seeking Behaviour	1.0
19	Information Science	0.9
20	Knowledge Management	0.8
% of top 20 subjects		31.3
% of other subjects		68.7
Total %		100
Kinds of subjects		1795

Table 7. Numbers of Cited Book Titles in JIS Papers in Eleven Selected Years

Year	Times cited	Book title
1998	161	141
1999	352	335
2000	212	202
2001	185	158
2002	227	211
2003	254	226
2004	295	273
2005	328	309
2006	312	277
2007	372	334
2008	452	403
Total Paper	3,150	
Total Title		2,869

(6) Main Classes and Subclasses of Cited Books

Based on the Library of Congress Classification (LCC), all books that were cited by JIS were grouped into 18 main classes as shown in Appendix 2. Table 8 shows that "social sciences" (35.4%) is the most cited class, followed by "library science. information resources" (18.5%), "science" (16.6%), "philosophy, psychology and religion" (6.5%), and "technology" (6.3%). The top four main classes are the same as the four main classes of books cited in the JASIST (Tsay, 2008), except that "science" (27%) is the most cited class, while "social sciences" (14%) is ranked the third. If we take the cited literature as evidence of intellectual influences, this again demonstrates that JIS emphasizes more on social sciences, while JASIST focuses more on science. Most books on social sciences cited in JIS papers were about knowledge management and working knowledge, such as *The Knowledge-Creating Company: How Japanese Companies Create the Dynamic of Innovation* by Nonaka and Takeuchi, which was cited 18 times, and *Working Knowledge: How Organizations Manage What They Know* by Davenport and Prusak, which was cited 11 times.

Table 8. Main Classes of Books Cited in JIS Papers

Rank	Main Class	%
1	Social sciences (General)	35.4
2	Library Science. Information Resources (General)	18.5
3	Science	16.6
4	Philosophy. Psychology. Religion	6.5
5	Technology	6.3
6	Language and Literature	4.8
7	Education	2.7
8	Medicine	2.1
9	Law	2.0
10	Political Science	1.8
% of 11th-18th main classes		3.38
Total %		100

Table 9 demonstrates the top ten subclasses of books cited in JIS papers. Among the 96 kinds of subclasses (see Appendix 2) of books cited in JIS papers, the most cited one is "books (general). writing. paleography. book industries and trade. libraries. bibliography" (16.6%), followed by "industries. land use. labor" (15.9%). It shows that JIS paid more attention to issues on library and information science, industry, sociology, business, economics, etc.

(7) Subjects of Cited Books

Through data retrieved from the WorldCat, 2,399 books cited by JIS contained 2,021 unique subject headings. Subjects cited once were 1,163 kinds, and subjects ranking after 20 and cited twice accounted for 63.9% (838 kinds, and 4,148 cited times). Table 10 displays top 20 subjects of JIS's cited books. Most of them were about "knowledge management," "information storage and retrieval systems," "information science," "information society," and "organizational learning and change," etc. It shows that JIS tended to discuss issues related to knowledge management, information society, industrial management, communication in organizations, organizational behavior, etc. As for subjects of books cited in the JASIST papers, "information storage and retrieval system" (3.8%) also appears to be the most cited, while "science"

Table 9. Top Ten Subclasses of Books Cited in JIS Papers

Rank	Subclass	%
1	Books (General). Writing. Paleography. Book industries and trade. Libraries. Bibliography	16.6
2	Industries. Land use. Labor	15.9
3	Mathematics. Computer science	9.3
4	Sociology (General)	5.8
5	Science (General)	5.4
6	Commerce	4.9
7	Psychology	4.1
8	Philology and linguistics (General)	3.1
9	Technology (General)	3.0
10	Economic history and conditions	2.4
% of top 10 subclasses		70.5
% of other subclasses		29.5
Total %		100
Kinds of subclasses		96

(3.5%) is the second most cited subject demonstrating its science nature (Tsay, 2008).

4. Summary and Conclusions

The present study conducts a bibliometric analysis of JIS publications for volumes published in recent eleven selected years and compares with that of JASIST for six selected earlier years (Tsay, 2008). The study reveals the following findings.

Both JIS and JASIST are information science oriented journals. For both journals, journal, book, e-resources, and conference proceedings appeared to be most cited document types. Journal contributes about 50% of the cited literature and book about 20%. E-resources are much more cited in JIS (16%) than in JASIST (4.8%). This may be due to the fact that more recent issues of JIS were studied in the present work. Moreover, the most cited journals in both JIS and JASIST were also quite similar. JASIST, JIS, JOD and IP&M were

Table 10. Top 20 Subjects of Books Cited in JIS Papers

Rank	Subject	%
1	Knowledge Management	1.6
2	Information Storage and Retrieval Systems	1.6
3	Information Science	1.3
4	Information Society	1.2
5	Information Technology	1.1
6	Information Resources Management	1.1
7	Industrial Management	1.1
8	Organizational Learning	1.1
9	Management Information Systems	0.9
10	Indexing	0.8
11	Information Technology -- Social Aspects	0.8
12	Science -- Abstracting and Indexing	0.7
13	Organizational Change	0.7
14	Communication in Organizations	0.7
15	Organizational Behavior	0.6
16	Communication in Science	0.6
17	Knowledge, Theory of	0.6
18	Information Retrieval	0.6
19	Decision Making	0.6
20	Internet	0.5
% of top 20 subjects		18.2
% of other subjects		81.8
Total %		100
Kinds of subjects		2,021

within the top five cited journals for both JIS and JASIST. This demonstrates the similarity in nature between two journals.

Further exploration on the main class and subject of cited journals and books reveals the difference between JIS and JASIST. “Library science. information resources” was the core main class of journals cited in both JIS and JASIST. However, for JIS, “social sciences” was the second and “science” coming as the third; while for JASIST, “science” was the second main class

and "social sciences" ranking the third. The main class of books cited in both JIS and JASIST also shows the similar nature. This demonstrates that JIS is more social science oriented and JASIST is more science in nature. The most cited subjects for journals and books that cited in LIS and JASIST papers were quite same. These subjects included "searching," "information work," "information storage and retrieval systems." However, "knowledge management" appeared as a new subject of books cited in JIS. The above subjects painted the picture of the major intellectual influences of the discipline of information science.

Results of the present research reveal that information science, as represented by JIS in the present study and JASIST in the previous study (Tsay, 2008), is an evolving disciplinethat draws on literature from a relative wide range of subject areas. Increasingly, there has been great growth in the citing of previous literature in "information science" as well as "social science" and "science" papers. Our analyses of the literature cited in JIS and JASIST, widely recognized as the core journal in information science, revealed the interdisciplinary nature of information science envisioned by Borko's (1968) and Saracivic's (1999). The findings of the present study on JIS and the previous study on JASIST (Tsay, 2008) should have great interest for citation study in library and information science in order to understand the nature of information science. In addition, it would be helpful for the journal editor to obtain the bibliometric portrait of the studied journal (JIS) and recognize its interaction with other subject disciplines.

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Appendix 1 Main Class and Subclass of Cited Journals on the JIS

Main class	Subclass	Cited times
General Works	Academies and learned societies	4
	History of scholarship and learning. The humanities	1
	Museums. Collectors and collecting	1
	Newspapers	3
	Periodicals	28
Philosophy. Psychology. Religion	Aesthetics	1
	Ethics. Social usages. Etiquette	3
	Philosophy (General)	12
	Practical theology	4
	Psychology	145
	Religions. Mythology. Rationalism	1
	Speculative philosophy	4
Auxiliary Sciences of History	Diplomatics. Archives. Seals	7
	History of civilization	2
History (General) and History of Europe	Africa	2
	Asia	5
	Europe	1
	History (General)	4
	Oceania (South Seas)	1
	Russia. Soviet Union. Former Soviet Republics -- Poland	1
History: America		8
Geography. Anthropology. Recreation.	Anthropology	9
	Geography (General). Atlas. Maps	36
	Human ecology. Anthropogeography	2
	Mathematical geography. Cartography	4
	Oceanography	1
	Recreation. Leisure. Sports	1

Social Sciences (General)	Commerce	439
	Communities. Classes. Races	7
	Economic history and conditions	43
	Economic theory. Demography	57
	Finance	38
	Industries. Land use. Labor	848
	Public finance	1
	Social history and conditions. Social problems. Social reform	6
	Social pathology. Social and public welfare. Criminology	9
	Social sciences (General)	100
	Socialism. Communism. Anarchism	3
	Sociology (General)	79
	Statistics	15
	The family. Marriage. Woman	5
	Transportation and communications	11
Political Science	General legislative and executive papers	15
	International relations	1
	Local government. Municipal government	1
	Political institutions and public administration -- Asia, Arab countries, Islamic countries, Africa, Atlantic Ocean islands, Australia, New Zealand, Pacific Ocean islands	2
	Political institutions and public administration -- Canada, West Indies, Mexico, Central and South America	1
	Political institutions and public administration -- Europe	5
	Political institutions and public administration -- General	1
	Political institutions and public administration -- United States	4
	Political science (General)	12
	Political theory	3

Law	Law in general. Comparative and uniform law. Jurisprudence	80
	Law of nations	2
	Law of Europe	10
	Law of the United States	6
Education	College and school magazines and papers	3
	Education (General)	25
	History of education	7
	Individual institutions -- United States	2
	Special aspects of education	3
	Student fraternities and societies, United States	2
	Theory and practice of education	96
Music	Literature on music	5
Fine Arts	Architecture	5
	Decorative arts	1
	Visual arts	4
Language and Literature	English language	7
	Literature (General)	17
	Modern languages. Celtic languages	4
	Philology and linguistics (General)	61
	Romanic languages	1
Science	Astronomy	2
	Botany	1
	Chemistry	172
	Geology	2
	Human anatomy	2
	Mathematics. Computer science	642
	Microbiology	4
	Natural history -- Biology	48
	Physics	46
	Physiology	18
	Science (General)	504
	Zoology	1

Medicine	Dentistry	4
	Dermatology	2
	Gynecology and obstetrics	1
	Internal medicine. Practice of medicine	30
	Medicine (General)	241
	Nursing	16
	Pathology	12
	Pediatrics	6
	Pharmacy and materia medica	33
	Public aspects of medicine	24
	Surgery	7
	Therapeutics. Pharmacology	12
Agriculture	Agriculture (General)	1
	Forestry	1
Technology	Building construction	4
	Chemical technology	16
	Electrical engineering. Electronics. Nuclear engineering. Computer hardware	177
	Engineering (General). Civil engineering (General)	87
	Environmental technology. Sanitary engineering	8
	Home economics	1
	Manufactures	9
	Mechanical engineering and machinery	6
	Mining engineering. Metallurgy	2
	Motor vehicles. Aeronautics. Astronautics	5
	Photography	1
	Technology (General)	369
Military Science	Artillery	1
	Maintenance and transportation	1
	Military engineering. Air forces. Air warfare. Space surveillance	1
	Military science	3

Library Science. Information Resources (General)	Books (General). Writing. Paleography. Book industries and trade. Libraries. Bibliography	3,395
	Information resources (General)	123
Total		8,379[a]

[a] Each journal may have more than one subclass; consequently, the total number of subclass is greater than the total cited times, i.e., 8,179, of journals cited by JIS in the study period.

Appendix 2 Main Class and Subclass of Cited Books on the JIS

Main class	Subclass	Cited times
General Works	History of scholarship and learning. The humanities	6
	Museums. Collectors and collecting	2
	Dictionaries and other general reference works	1
	Academies and learned societies	1
Philosophy. Psychology. Religion	Psychology	110
	Philosophy (General)	32
	Speculative philosophy	25
	Ethics. Social usages. Etiquette	3
	Logic	2
	Christian denominations	1
	Religions. Mythology. Rationalism	1
Auxiliary Sciences of History	History of civilization	4
	Diplomatics. Archives. Seals	2
History (General) and History of Europe	History (General)	7
	Asia	2
	Europe	2
History: America		8
Geography. Anthropology. Recreation.	Geography (General). Atlas. Maps	19
	Anthropology	7
	Mathematical geography. Cartography	4
	Recreation. Leisure. Sports	1
	Environmental sciences	1

Social Sciences (General)	Industries. Land use. Labor	429
	Sociology (General)	157
	Commerce	131
	Economic history and conditions	65
	Social sciences (General)	50
	Economic theory. Demography	45
	Transportation and communications	23
	Social history and conditions. Social problems. Social reform	17
	Statistics	13
	Social pathology. Social and public welfare. Criminology	8
	Finance	6
	Communities. Classes. Races	4
	Socialism. Communism. Anarchism	3
	The family. Marriage. Woman	3
Political Science	Political theory	16
	Political institutions and public administration -- General	12
	Political institutions and public administration -- Europe	9
	Local government. Municipal government	4
	Political science (General)	3
	Political institutions and public administration -- United States	3
	General legislative and executive papers	1
	Political institutions and public administration -- Asia, Arab countries, Islamic countries, Africa, Atlantic Ocean islands, Australia, New Zealand, Pacific Ocean islands	1
Law	Law in general. Comparative and uniform law. Jurisprudence	30
	Law of the United Kingdom and Ireland	16
	Law of the United States	5
	Law of Europe	2
	Law of Canada	1

Education	Theory and practice of education	55
	Special aspects of education	9
	Education (General)	3
	History of education	3
	College and school magazines and papers	2
	Individual institutions -- United States	2
Fine Arts	Visual arts	5
	Architecture	3
	Decorative arts	1
Language and Literature	Philology and linguistics (General)	84
	Literature (General)	20
	English literature	6
	American literature	5
	Romanic languages	4
	French literature -- Italian literature -- Spanish literature -- Portuguese literature	3
	English language	3
	Uralic languages. Basque language	1
	Fiction and Juvenile belles letters	1
	Oriental languages and literatures	1
Science	Mathematics. Computer science	250
	Science (General)	146
	Chemistry	26
	Natural history -- Biology	13
	Physics	7
	Physiology	3
	Geology	1
Medicine	Medicine (General)	23
	Pharmacy and materia medica	14
	Public aspects of medicine	13
	Internal medicine. Practice of medicine	3
	Therapeutics. Pharmacology	2
	Surgery	1

Agriculture	Plant culture	3
	Agriculture (General)	3
Technology	Technology (General)	82
	Electrical engineering. Electronics. Nuclear engineering. Computer hardware	62
	Engineering (General). Civil engineering (General)	11
	Motor vehicles. Aeronautics. Astronautics	5
	Manufactures	4
	Mining engineering. Metallurgy	2
	Environmental technology. Sanitary engineering	1
	Mechanical engineering and machinery	1
	Home economics	1
Military Science	Military science	4
	Military administration	4
	Maintenance and transportation	1
Library Science. Information Resources (General)	Books (General). Writing. Paleography. Book industries and trade. Libraries. Bibliography	446
	Information resources (General)	51
Total		2,692[a]

[a] Some of books may not be found in the WorldCat; consequently, the total number of subclass is less than the total cited times, i.e., 3,150, of books cited by JIS in the study period.