

Structures and patterns of information flow among Chinese-language Library and Information Science journals in Taiwan (2001-2012): A network analysis

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ABSTRACT

This study aimed to examine the hidden structures and patterns of information flow in Chinese-language Library and Information Science (LIS) journals in Taiwan. Thirteen Chinese LIS journals and 2,914 articles published between 2001 and 2012 were selected as subject and an aggregated 13x13 matrix was generated to perform journal-to-journal citation analysis. The twelve-year period was further divided into three individual periods of four years each to conduct journal-to-journal citation analysis for evolutionary comparison. Social network analysis was used to discover the implicit structures and patterns embedded in Chinese-language LIS journals in Taiwan in terms of network structure. The embedded structures and patterns in the Chinese-language LIS journal network were characterized by Bonich's Eigenvector degree centrality, Stephenson and Zelen's information centrality and Freeman's betweenness centrality. These were used to measure journal prominence and role, bottom-up clique to find core journals, and structural equivalence to show alternative publication outlets. The limitations of this study and future research directions are also discussed.

Keywords: Journal citation network; Information flow; Library and information science; Social network analysis; Taiwan

INTRODUCTION

Scholarly journals are the primary means by which knowledge is created and diffused in scientific communities. Authors of journal articles cite other works because other works are of relevance to the topics being studied. Journal citations are not only regarded as evidence of recognition of knowledge attribution to other scholars, but also leave a trail of formal scientific communication in the process of knowledge inquiry. The citations randomly made by articles appearing in journals can be aggregated by journals to generate a journal-to-journal (J2J) network. All networks are composed of individual network nodes and their connected ties. Once a J2J network with ties has been created, it can be used to reveal certain characteristics

of the inter-citations in information flow, and to investigate implicit intellectual structures and citation patterns embedded among journals. In recent years, analysis of journal citation networks has been used to measure the relative standing of journals in J2J networks (Cronin 2008; Feeley 2008; Liu and Wang 2005; Park and Leydesdorff 2009; Polites and Watson 2009). With a richer understanding of the interrelationships among journals, the intellectual structures and metrics of a journal citation network can be employed to evaluate journals in a different way from the impact factors offered by the Journal Citation Reports (Peng and Wang 2013). This type of investigation is also potentially useful to examine the trends over time of the network under consideration (Liu and Wang 2005; Polites and Watson 2009; Wang and Bowers 2016), and to compare the different networks over defined periods (Doreian 1985; Dorerian and Fararo 1985). To the best of our knowledge, no study has examined the structures and patterns embedded in a J2J citation network including both an overview image and evolutionary change at a field level in terms of information flow.

At the field level two approaches are used to investigate the embedded structure and patterns in an aggregated journal citation network. One is to select a specific period to investigate an overview of intellectual structure, and the other is to compare two or more individual time periods with the intention to examine the evolutionary changes in intellectual structure. Using the overview approach, Liu and Wang (2005) grouped 60 demography-related journals into 12 clusters; and Wang and Bowers (2016) generalized 30 journals in education administration into 8 clusters. In addition to the analysis of information senders (i.e., citing), receivers (i.e., cited) and intellectual structure, some studies have investigated journal position in a J2J citation network, including weak ties (Rice, Borgman and Reeves 1988), central-periphery structure (Baker 1992; Feeley 2008), alternative publication outlets (Bieh, Kim and Wade 2006; Polites and Watson 2009), and various bridge roles (Jo et al. 2016; Lee 2015). On the other hand, several studies have addressed the evolutionary change of journal citation pattern, and these studies have also examined the information flow and core-periphery structure among groups of journals and most of them employed the structural equivalence of social network analysis (SNA) approach. Doreian and Fararo (1985) found that five subfields were clustered, and journals of comprehensive sociology occupied the central role by analyzing 11 sociology journals over three periods of two years. Doreian (1985) further classified 21 psychology journals into seven subfields, and journals of general and experimental subfield were positioned in the central role in 1950 and 1960 respectively. Cronin (2008) used 13348 citations from 17 heterodox economy journals between 1995 and 2007 to investigate the hidden citation patterns in terms of SNA's Eigenvector and betweenness centrality, density and clique. In addition to the 4 most citing and cited journals, the study also categorized heterodox economy journals into 3 groups with core and non-core journals each year.

At the journal level, a distinguished journal is often selected as a seed journal to detect hidden structures and patterns in an aggregated journal network through citing to and being cited by the seed journal. Selecting the Journal of Communication (JOC) as the subject with 107 citing journals and 154 cited journals, Park and Leydesdorff (2009) found that journals can be clustered into 3 large components and 3 small components; they also found that communication studies were dominated by American journals and 6 journals were isolates. Using the Journal of International Business Studies (JIBS) and its 166 citing and 645 cited journals as subject 2001-2012, Cantwell, Popenbrink and Shukla (2014) found that JIBS is increasingly acting as an intermediary for other journals in the related social and behavioral

sciences, and is also acting as both an integrator and a source of knowledge in its network of journals.

SNA analyses the citation patterns embedded in journals according to connections and their structures and positions. The citation patterns can be examined using a variety of network measures to uncover the implicit network structures with various descriptions (including centrality, clique and structural equivalence analysis). First, degree centrality represents the number of links a node has with other nodes (Wasserman and Faust 1994). In-degree and out-degree centrality indicates the frequency a journal is cited by and cites other journals, respectively. Studies have often employed degree centrality to measure a journal's prominence and power in a journal citation network (Cronin 2008; Feeley 2008; Liu and Wang 2005; Park and Leydesdorff 2009; Polites and Watson 2009). Bonacich's Eigenvector degree centrality is an indicator of the journal's centrality according to the overall structure of citations (Wasserman and Faust 1994), and studies have used it to measure a journal's overall centrality in a journal citation network (Cronin 2008). Closeness centrality is used to examine how close a node is directly or indirectly to all the other nodes (Wasserman and Faust 1994; Polites and Watson 2009). Betweenness centrality is used to represent the influence over flow through an intermediary (Wasserman and Faust 1994), and it is used to measure the degree that a journal plays a role in bridging with other journals in a journal citation network (Cronin 2008; Rice, Borgman and Reeves 1988).

Second, clique analysis is a bottom-up approach to identify subgroups of nodes connected to each other in a network (Wasserman and Faust 1994). Some studies have used clique analysis to identify core journals among journals (Cronin 2008). Third, structural equivalence is used to discover that some nodes share similar citation patterns (Wasserman and Faust 1994). Structural equivalence has been used in some studies to provide scholars with a useful reference for alternative publication outlets (Baker 1992; Biehl, Kim and Wade 2006; Doreian 1985; Doreian and Fararo 1985; Polites and Watson, 2009). In terms of time frame, most studies selected either two individual years or shorter periods to examine the evolutionary change (Biehl, Kim and Wade 2006; Cronin 2008; Doreian 1985; Doreian and Fararo 1985), or a specified period to investigate the overall structure of citation patterns among journals (Baker 1992; Feeley 2008; Liu and Wang 2005; Polites and Watson 2009; Rice, Borgman and Reeves 1988). To the best of our knowledge, no study has analyzed the citation structures and patterns embedded among journals to examine both evolutionary change and an overview image for J2J network analysis at a field level in terms of information flow.

METHOD

Sample

For this study, the Chinese-language Library and Information Science (LIS) journals (CLIS) in Taiwan were selected as subject, as no study has analyzed the citation structures and patterns embedded in a CLIS journal network in Taiwan. According to the Guide to Periodicals Published in R.O.C. (<http://readopac.ncl.edu.tw/nclJournal/>), there are 16 CLIS journals with ISSN grouped under category of library science and information science. However, two have ceased publication, and five are newsletters consisting of reviews, interviews, visiting reports and news of library activities. One CLIS journal in Taiwan was renamed and continued publishing

articles during the period analyzed (i.e., *Bulletin of the Library Association of China* was renamed as JRN01). Thus, nine journals were selected for this study. Because LIS is an interdisciplinary field, an additional four LIS related journals (i.e., JRN06, 08-10) were included for this study. Therefore, in total, 13 CLIS journals and 2,914 scholarly articles (including Chinese and English) published between 2001 and 2012 were selected as the subject (Table 1). As a result, a 13x13 matrix (Table 2) was generated as a basis for J2J citation analysis. This number also attained the minimal limited sets of 10 for local journal maps (Leydesdorff, de Moya-Anegón and de Nooy 2016).

Table 1: CLIS Journals and Number of Articles Analyzed

Journal Name	Code	Frequency	Publication Year (20-)												Total
			01	02	03	04	05	06	07	08	09	10	11	12	
Journal of Library and Information Science Research	JRN01	Semi-annual	20	24	28	25	41	6	12	10	10	10	10	10	206
Journal of Library and Information Science	JRN02	Semi-annual	19	14	16	24	18	16	20	14	15	13	18	12	199
Journal of Educational Media & Library Sciences	JRN03	Quarterly	29	32	40	39	31	24	23	21	20	20	21	20	320
Journal of Library and Information Studies	JRN04	Semi-annual	9	7	16	18	12	5	5	5	5	12	12	12	118
National Central Library Bulletin	JRN05	Semi-annual	20	20	21	20	18	12	13	14	11	12	12	13	186
University Library Journal	JRN06	Semi-annual	20	19	18	18	18	17	16	16	14	15	17	16	204
Bulletin of Library and Information Science	JRN07	Semi-annual	31	33	25	28	26	27	26	27	23	20	19	11	296
Research of Educational Communications and Technology	JRN08	Quarterly	33	29	26	24	26	24	27	28	24	24	17	18	300
Archives Quarterly	JRN09	Quarterly	11	72	81	56	62	51	43	37	50	53	32	35	583
Journal of Cultural Enterprise and Management	JRN10	Semi-annual	0	0	0	4	0	7	5	5	11	9	14	12	67
Information Management for Buddhist Libraries	JRN11	Semi-annual	23	24	21	23	21	20	18	27	20	9	16	17	239
Journal of Information, Communication, and Library Science	JRN12	Monthly	40	33	10	6	7	11	0	0	0	0	0	0	107
National Cheng Kung University Library Journal	JRN13	Annual	16	11	12	5	9	8	7	6	4	4	2	5	89

Time Frame

The overall structures and patterns hidden among the CLIS journals in Taiwan over twelve years (2001-2012) were examined. This period achieved the minimal requirement of a decade for more reliable J2J network analysis of aggregated journals (Leydesdorff, de Moya-Anegón and de Nooy 2016). In addition to the twelve years in totality, three individual periods of 4 years were identified to conduct an in-depth comparative study. Three individual periods of 4 years qualify for J2J network analysis because they are not only more than three years and two-time minimal interval (Leydesdorff 2015), but can also avoid the incidental citation fluctuation and relations (Vugteveen, Lenders and Van den Besselaar 2014). As a result, an overview image of a longitudinal period, and the evolutionary change and pattern between three short individual periods were investigated.

Processing

Diagonal values of the aforementioned 13x13 matrix were excluded from this study, i.e., self-citations were not included in the SNA. First, Bonacich's Eigenvector degree centrality, information centrality proposed by Stephen and Zelen (1989) and Freeman's betweenness centrality was used to investigate the role of each journal, the closeness centrality of the journal directly or indirectly, and the intermediary degree of each journal with others respectively within a journal citation network. Furthermore, a top-down factions approach was also used to cross check which journals were more isolated from others. Then, a bottom-up clique approach was used to identify the subgroup of journals and core journals in a journal network. Because the minimum strength of a clique is dependent on the targeted network size (Biehl, Kim and Wade 2006; Polites and Watson 2009), in this study the minimum size of the clique was set at 3. Lastly, in this study structural equivalence based on Euclidean distances was employed to examine which journals share an equivalent role in linking with similar journals to discover the alternative publication outlets in a journal citation network. UCInet 6 software was used to conduct the SNA to examine the hidden structures and patterns embedded among the CLIS journals in Taiwan in terms of information flow.

RESULTS

Centrality Analysis

In terms of Bonacich Eigenvector degree centrality of SNA (Table 3 and Figure 1), JRN01, JRN07, JRN06, JRN03 and JRN12 were the top 5 journals that were most cited by others in the LIS journal network in Taiwan between 2001 and 2012. In terms of evolutionary change over the three periods (Table 3 and Figure 2-4), JRN12 was less cited over the periods, and JRN02, JRN03, JRN04 and JRN09 were increasingly cited. JRN01, JRN05, JRN08, JRN11, and JRN13 increased from period 1 to 2, and then decreased from 2 to 3. Contrarily, JRN06 and JRN07 decreased from period 1 to 2, and then increased from 2 to 3. JRN10 had a 0 value for Eigenvector degree centrality both overall over the 12-year period and over the 3 individual periods. Further, three groups (Table 4) were identified by factions algorithm. Combining the analysis of Eigenvector degree centrality with that of the factions revealed that JRN 10 was isolated from the other LIS journals in Taiwan both overall over the 12 years and during the 3 individual periods. JRN08, JRN09, and JRN11 were isolated from other LIS journals in Taiwan over different individual periods.

Table 2: Relationship between Citing Journal (Vertical Axis) and Cited Journal (Horizontal Axis)

	JRN01				JRN02				JRN03				JRN04				JRN05				JRN06				JRN07				JRN08			
	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12
JRN01	32	13	17	62	9	3	4	16	7	6	5	18	4	7	8	19	15	6	5	26	17	7	5	29	24	5	12	41	2	1	0	3
JRN02	2	11	10	23	4	2	11	17	8	8	6	22	3	3	7	13	6	5	3	14	6	6	7	19	7	1	8	16	10	0	4	14
JRN03	18	16	14	48	7	14	15	36	23	22	31	76	0	13	6	19	7	7	4	18	10	10	12	32	12	5	12	29	18	22	6	46
JRN04	10	3	15	28	5	3	4	12	8	4	11	23	4	6	10	20	3	0	3	6	10	1	6	17	4	1	8	13	2	0	2	4
JRN05	33	15	8	56	6	7	6	19	9	7	5	21	1	1	1	3	17	9	23	49	5	10	2	17	15	8	4	27	0	0	0	0
JRN06	27	24	8	59	10	6	6	22	18	12	18	48	10	2	0	12	4	9	9	22	22	16	15	53	27	16	13	56	6	0	3	9
JRN07	47	28	16	91	7	11	9	27	20	16	14	50	5	3	8	16	12	14	8	34	31	17	18	66	54	22	17	93	1	1	1	3
JRN08	2	6	0	8	2	6	4	12	5	6	13	24	0	1	1	2	0	0	0	0	1	4	3	8	5	4	0	9	73	64	35	172
JRN09	3	1	1	5	2	2	2	6	0	0	5	5	0	0	2	2	0	2	5	7	9	2	8	19	7	6	8	21	0	0	0	0
JRN10	0	0	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1
JRN11	10	0	0	10	3	2	0	5	2	0	0	2	1	0	0	1	0	1	1	2	6	0	0	6	4	0	0	4	0	0	0	0
JRN12	7	0	0	7	2	2	0	2	4	0	0	4	2	0	0	2	0	0	0	0	6	1	0	7	2	1	0	3	3	0	0	3
JRN13	7	1	0	8	0	1	2	3	1	2	1	4	0	0	1	1	1	0	0	1	8	2	0	10	7	1	0	8	0	0	0	0
Total ^a	198	118	91	407	57	59	63	177	105	83	110	298	30	36	44	110	65	53	61	179	131	77	76	284	168	70	82	320	115	89	51	255
Total ^{a*}	166	105	74	345	53	57	52	160	82	61	79	222	26	30	34	90	48	44	38	130	109	61	61	231	114	48	65	227	42	25	16	83

Table 2 (continued)

	JRN09				JRN10				JRN11				JRN12				JRN13				Total ^b				Total ^{b*}			
	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12	01 - 04	05 - 08	09 - 12	01 - 12
JRN01	0	2	0	2	0	0	0	0	1	1	3	5	25	6	0	31	10	0	0	10	146	57	59	262	114	44	42	200
JRN02	0	0	2	2	0	0	0	0	2	2	1	5	12	2	1	15	1	0	1	2	61	40	61	162	57	38	50	145
JRN03	2	3	8	13	0	0	0	0	2	1	2	5	20	11	4	35	3	9	6	18	122	133	120	375	99	111	89	299
JRN04	0	0	0	0	0	0	0	0	0	0	0	0	6	1	4	11	2	1	0	3	54	20	63	137	50	14	53	117
JRN05	8	1	3	12	0	0	0	0	10	4	1	15	9	6	1	16	1	1	1	3	114	69	55	238	97	60	32	189
JRN06	0	14	8	22	0	0	0	0	1	2	3	6	26	4	1	31	1	3	2	6	152	108	86	346	130	92	71	293
JRN07	0	6	7	13	0	0	0	0	5	5	0	10	20	9	7	36	4	8	4	16	206	140	109	455	152	118	92	362
JRN08	0	0	0	0	0	0	0	0	0	0	0	0	4	2	2	8	0	1	0	1	92	94	58	244	19	30	23	72
JRN09	82	63	72	217	0	0	0	0	2	1	1	4	5	1	0	6	0	1	4	5	110	79	108	297	28	16	36	80
JRN10	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	3	4	7	0	3	3	6
JRN11	1	0	0	1	0	0	0	0	27	26	18	71	9	1	0	10	0	0	0	0	63	30	19	112	36	4	1	41
JRN12	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	12	0	0	0	0	38	4	0	40	26	4	0	28
JRN13	0	0	0	0	0	0	0	0	3	0	0	3	1	1	0	2	3	0	0	3	31	8	4	43	28	8	4	40
Total ^a	93	89	100	282	0	0	1	1	53	43	29	125	149	44	20	213	25	24	18	67	1189	785	746	2718				
Total ^{a*}	11	26	28	65	0	0	0	0	26	17	11	54	137	44	20	201	22	24	18	64					836	542	496	1872

a=receiving citations, b=sending citations, *=self-citations excluded

Table 3: Normalized Bonacich's Eigenvector Degree Centrality, Information Centrality and Freeman's Betweenness Centrality of CLIS Journals in Taiwan

Journal	Period (20--)	Degree centrality (rank)	Information centrality (rank)	Betweenness centrality (rank)
JRN01	01-04	0.531(01)	1.521(05)	2.864(02)
	05-08	0.574(01)	19.025(03)	3.916(05)
	09-12	0.449(01)	16.162(04)	2.645(06)
	01-12	1.919(01)	47.839(01)	2.968(01)
JRN02	01-04	0.188(07)	1.505(07)	2.478(05)
	05-08	0.304(04)	17.204(06)	4.567(03)
	09-12	0.323(05)	15.474(05)	5.436(03)
	01-12	0.931(06)	42.927(07)	1.794(04)
JRN03	01-04	0.286(05)	1.516(05)	4.852(01)
	05-08	0.342(03)	19.262(02)	3.519(06)
	09-12	0.424(02)	17.132(01)	10.739(01)
	01-12	1.247(04)	47.546(03)	2.968(01)
JRN04	01-04	0.108(09)	1.494(08)	0.722(09)
	05-08	0.211(08)	13.756(10)	0.260(10)
	09-12	0.231(07)	15.150(06)	2.942(05)
	01-12	0.610(08)	39.047(08)	0.870(08)
JRN05	01-04	0.201(06)	1.511(06)	2.092(06)
	05-08	0.274(05)	17.278(05)	4.170(04)
	09-12	0.246(06)	14.353(07)	8.807(02)
	01-12	0.873(07)	43.693(05)	0.437(09)
JRN06	01-04	0.362(04)	1.519(03)	2.864(02)
	05-08	0.343(02)	18.739(04)	7.873(01)
	09-12	0.382(04)	16.253(03)	3.068(04)
	01-12	1.321(03)	46.909(04)	2.968(01)
JRN07	01-04	0.385(03)	1.520(02)	2.864(02)
	05-08	0.276(06)	19.266(01)	7.062(02)
	09-12	0.412(03)	16.528(02)	1.559(07)
	01-12	1.338(02)	47.776(02)	1.794(04)
JRN08	01-04	0.141(08)	1.488(10)	0.000(11)
	05-08	0.156(10)	15.753(07)	2.507(07)
	09-12	0.108(11)	11.476(09)	0.095(09)
	01-12	0.512(09)	36.528(09)	0.904(07)
JRN09	01-04	0.026(12)	1.480(11)	0.000(11)
	05-08	0.166(09)	13.762(09)	0.108(12)
	09-12	0.197(08)	13.578(08)	0.221(08)
	01-12	0.412(11)	36.234(10)	0.095(12)
JRN10	01-04	0.000(13)	0.130(13)	0.000(11)
	05-08	0.000(13)	3.015(13)	0.000(13)
	09-12	0.000(13)	2.956(13)	0.000(11)
	01-12	0.000(13)	33.111(13)	0.000(13)
JRN11	01-04	0.070(11)	1.493(09)	1.858(07)
	05-08	0.090(12)	10.991(12)	0.884(08)
	09-12	0.075(12)	7.721(12)	0.000(11)
	01-12	0.301(12)	32.699(12)	1.093(06)
JRN12	01-04	0.484(02)	1.517(04)	1.266(08)
	05-08	0.265(07)	15.483(08)	0.613(09)
	09-12	0.123(09)	10.510(11)	0.000(11)
	01-12	1.237(05)	43.681(06)	0.433(10)
JRN13	01-04	0.099(10)	1.478(12)	0.108(10)
	05-08	0.133(11)	12.946(11)	0.126(11)
	09-12	0.116(10)	10.525(10)	0.095(10)
	01-12	0.416(10)	33.111(11)	0.343(11)

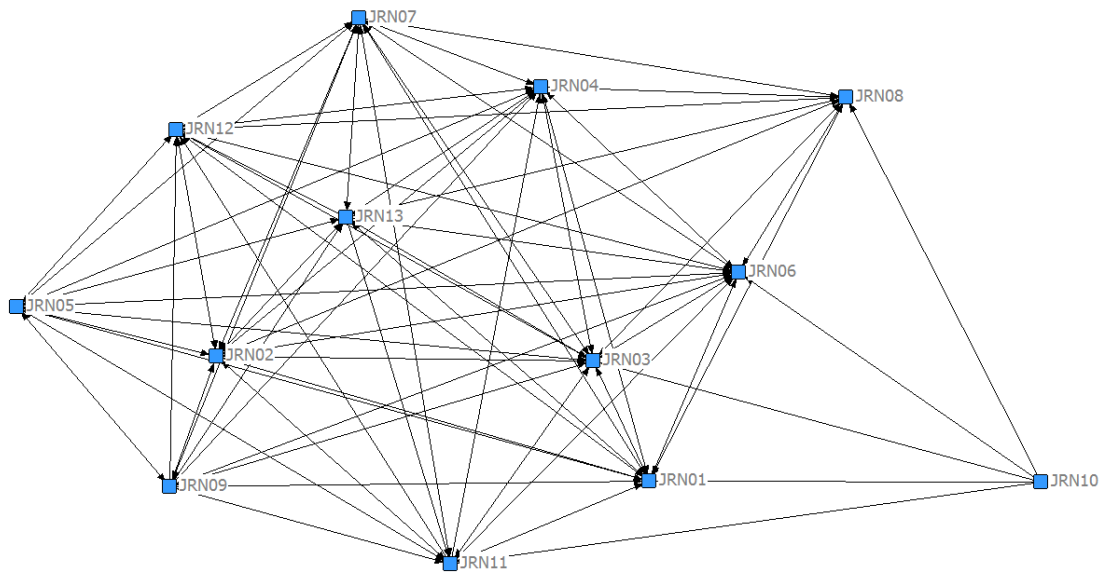


Figure 1: Sociogram of the J2J Network between 2001 and 2012, Journal's Self-citations Excluded

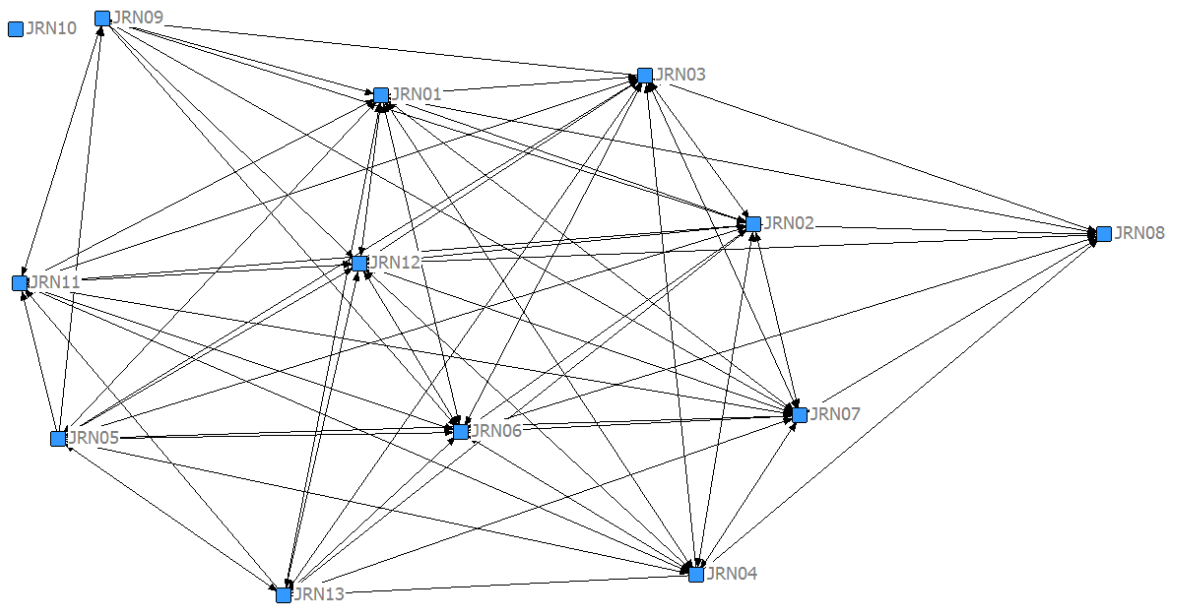


Figure 2: Sociogram of the J2J Network between 2001 and 2004, Journal's Self-citations Excluded

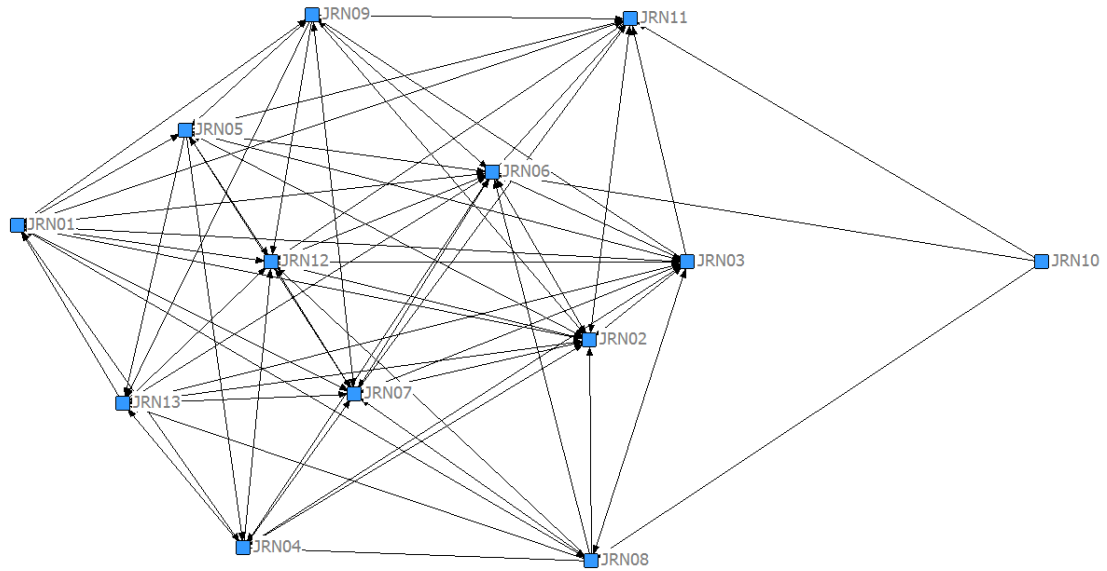


Figure 3: Sociogram of the J2J Network between 2005 and 2008, Journal's Self-citations excluded

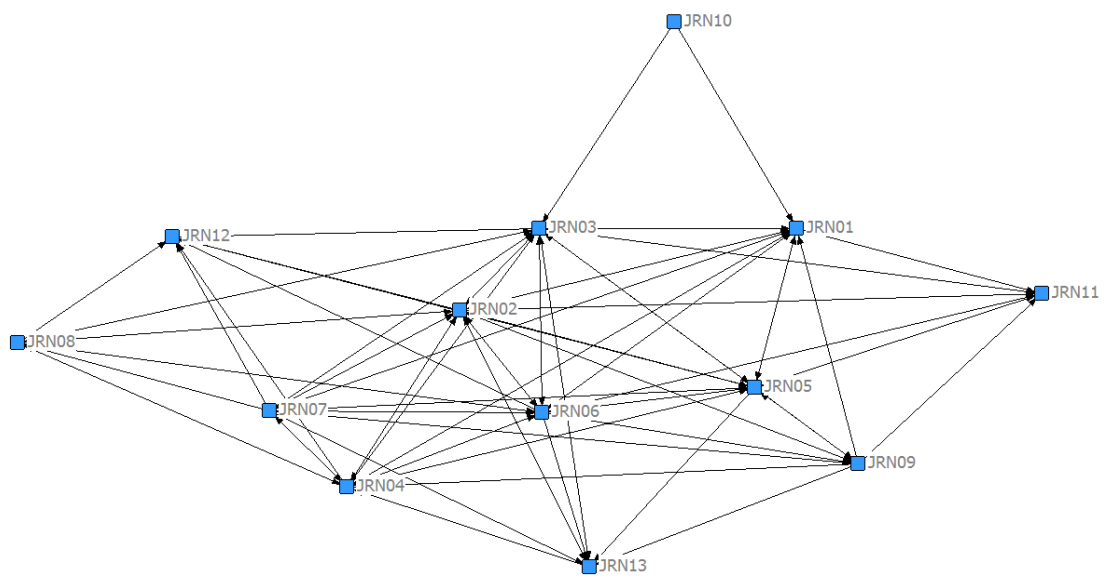


Figure 4: Sociogram of the J2J Network between 2009 and 2012, Journal's Self-citations Excluded

Table 4: Groups of CLIS Journals in Taiwan Identified by Factions Algorithm

Period	Group 1	Group 2	Group 3
2001-2004	JRN01-08, & JRN11-13	JRN10	JRN09
2005-2008	JRN01-09, & JRN12-13	JRN10	JRN11
2009-2012	JRN01-09, & JRN13	JRN10-11	JRN12
2001-2012	JRN01-07, JRN09, & JRN11-13	JRN10	JRN08

Several interesting points arose from the analysis. First, only JRN01 and JRN03 are LIS journals indexed by the Taiwan Social Science Citation Index (TSSCI) since 2009. However,

it seems that the TSSCI attracted more citations made to JRN03 than JRN01 over periods 2 to 3. Second, JRN12 continued to receive citations from other LIS journals in Taiwan over the years even though it ceased publication in 2007. This reveals that articles published by JRN12 are still valuable and have a lasting influence in attracting article citations from other LIS journals in Taiwan. Third, the reason for the isolation of JRN08, JRN09, JRN10 and JRN11 from the other LIS journals in Taiwan may be related to their editorial policy of topic coverage. In addition to the LIS field, JRN08, JRN09, JRN10 and JRN11 also cover topics in specialized areas of educational technology, archival studies, publishing studies, and Buddhism studies, respectively.

From 2001 to 2012, JRN01, JRN07, JRN03, JRN06 and JRN05 had the top 5 normalized information centrality in SNA. This means that these five journals are closely linked with other LIS journals in Taiwan. In terms of evolutionary change over the three periods, JRN04 ascended over the periods. The other LIS journals in Taiwan showed an increase from period 1 to 2, and then a decrease from period 2 to 3. Apparently only JRN04 maintained steady growth in close connection with other journals, whereas the other journals in Taiwan showed less connection with other journals over time. This reveals that links with other journals decreased for most of the LIS journals in Taiwan from 2009 to 2012. The most interesting point is that JRN03 rose to the highest-ranking position from period 2 to 3. The reason for this may be classified as TSSCI's journal after 2009.

In terms of normalized Freeman's betweenness centrality of SNA, JRN01, JRN03, JRN06, JRN02 and JRN07 have played the top five bridging roles to facilitate inter-citation among the CLIS journals in Taiwan. In terms of evolutionary change over the three periods, JRN02, JRN05 and JRN09 ascended, whereas JRN11 and JRN12 descended over the periods. JRN03 and JRN04 decreased from period 1 to 2, and then rose from period 2 to 3. Contrarily JRN01, JRN06-08 and JRN13 rose from period 1 to 2, and then declined from period 2 to 3. JRN10 had 0 betweenness centrality both overall over the 12 years and over the 3 individual periods. According to degree, information and betweenness centrality, JRN10 is the most isolated from other LIS journals in Taiwan. Furthermore, JRN12 maintained a steady decrease in values of degree, information and betweenness centrality between 2009 and 2012, owing to its ceased publication in 2007.

Clique Analysis

From 2001 to 2012, four subgroups were identified (Table 5), JRN01, JRN03 and JRN06 are jointly shared in all four subgroups. From 2001 to 2004, three subgroups were identified, and JRN01-03, JRN06-07, and JRN12 are jointly shared in all three subgroups. Moving to the second period, six subgroups were identified, and JRN01-03, JRN06-07 and JRN12 are again jointly shared in all six subgroups. During the third period, six groups were identified, and JRN02-03 and JRN06 jointly shared in all six subgroups. According to the results of clique analysis, a journal can be regarded as "core to a group if it is particularly connected to other journals in that group for the major part of the period" (Cronin 2008). As a result, JRN03 and JRN06 are classified as the core members of the LIS journals in Taiwan both overall over the twelve years and over the three individual periods.

In addition to the 12-year period as a whole, JRN01 is categorized as a core member between period 1 and 2. JRN2 is classified as core member over three individual periods, whereas JRN07 and JRN12 are categorized as core members between period 1 and 2. The clique analysis echoes the results of the centrality and factions analyses to reveal that JRN12 has gradually decreased its importance in the LIS journal network in Taiwan. Either over time evolving from the first to the third period or over the longitudinal period of

twelve years, core journals became fewer among LIS journals in Taiwan. According to the discussion, core members of the LIS journals in Taiwan can also be divided into two groups as follows: research (e.g., JRN01-03, and JRN12) and evidence (e.g., JRN06-07) orientation, according to the topics of published journal articles.

Table 5: Distribution of Clique-based Core and Non-Core Members

Period	No. of subgroup	Core members	Non-core members
2001-2004	3	JRN01-03, 06-07, & 12	JRN04-05, 11, & 13
			JRN05, 09, & 11
			JRN04, & 08
2005-2008	6	JRN01-03, 06-07, & 12	JRN05, 09, & 11
			JRN05, 09, & 13
			JRN04-05, & 13
			JRN04, 08, & 13
			JRN08, & 10
			JRN10, & 11
2009-2012	6	JRN02, 03, & 06	JRN01, 04-05, 07, & 09
			JRN04-05, 07, 09 & 13
			JRN04-05, 07 & 12
			JRN04, 07-08, & 12
			JRN01, 05, 09, & 11
			JRN01, & 10
2001-2012	4	JRN01, 03, & 06	JRN02, 04-05, 07, 09, & 11-13
			JRN02, 04, 07-08, & 12-13
			JRN08, & 10
			JRN08, & 11

Structural Equivalence Analysis

According to analysis of structural equivalence, each cluster is composed of two member journals (Table 6 and Figure 5 to Figure 8). Several interesting points arise. First, the closer to the present, the more clusters of structural equivalence there are. On the other hand, 10 out of the 13 journals were classified as structural equivalent clusters of two members between 2009 and 2012, meaning that more Taiwan LIS journals gradually share similar citation patterns each other, but citation patterns are diverged (i.e., five distinctive citation patterns). Obviously, members of the evidence-based LIS group (i.e., JRN06-07) also remained unchanged over the twelve years and over the three periods.

During the first period, clusters of LIS in Taiwan were inclined toward special libraries and archives (JRN09 and JRN11), education and technology (JRN02 and JRN08), and core LIS and communication (JRN03 and JRN12). Moving to the second period, the focus of clusters changed toward special libraries and culture (JRN10-11), general LIS and communication (JRN12-13), and general LIS and archives (JRN02 and JRN05). During the third period, JRN02 and JRN04 integrated as another core LIS group, JRN05 and JRN09 merged as an archive group, and JRN10-11 and JRN12-13 remained unchanged. Second, JRN03 and JRN08 were excluded from clusters of structural equivalence both in the second and the third period, whereas JRN05, JRN10 and JRN13 were excluded during the first period. It seems that JRN03 and JRN08 had gradually more distinctive citation patterns from the other LIS journals in Taiwan, whereas JRN05, JRN10 and JRN13 kept similar citation patterns that were closer to the other LIS journals in Taiwan based on analysis of evolutionary change.

Third, JRN01 was not classified into any structural equivalent clusters, both the twelve years and over the three individual periods. Thus, JRN01 had the most unique citation patterns when compared with other LIS journals in Taiwan. On the other hand, JRN06 and JRN07 were classified into the same cluster for both the twelve years and over the three individual periods. The reason for this may be that these two journals shared the characteristic of evidence-based LIS in the Taiwan journal network. Fourth, in terms of aggregated analysis of structural equivalence over the twelve years, only three clusters were generated and can be classified as three categories as follows: core LIS (JRN02 and JRN04), evidence-based LIS (JRN06-07), and special libraries and general LIS (JRN11 and JRN13). Lastly, it seems that TSSCI impacted JRN01 and JRN03 creating distinctive citation patterns.

Table 6: Clusters and their Structurally Equivalent Members

Period	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
2001-2004	JRN09, 11	JRN02, 08	JRN06, 07	JRN03, 12	
2005-2008	JRN10, 11	JRN12, 13	JRN02, 05	JRN06, 07	
2009-2012	JRN10, 11	JRN12, 13	JRN05, 09	JRN02, 04	JRN06, 07
2001-2012	JRN11, 13	JRN02, 04	JRN06, 07		

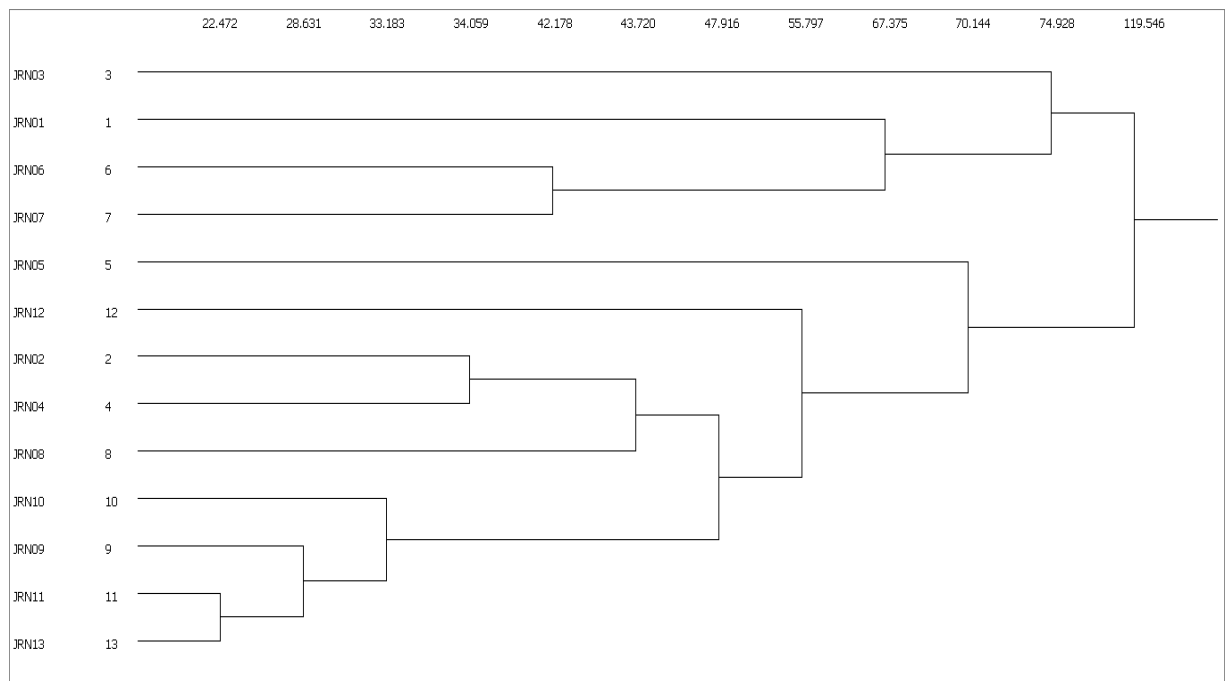


Figure 5: MDS of Clusters and their Structurally Equivalent Members between 2001 and 2012, Journal's Self-Citations Excluded

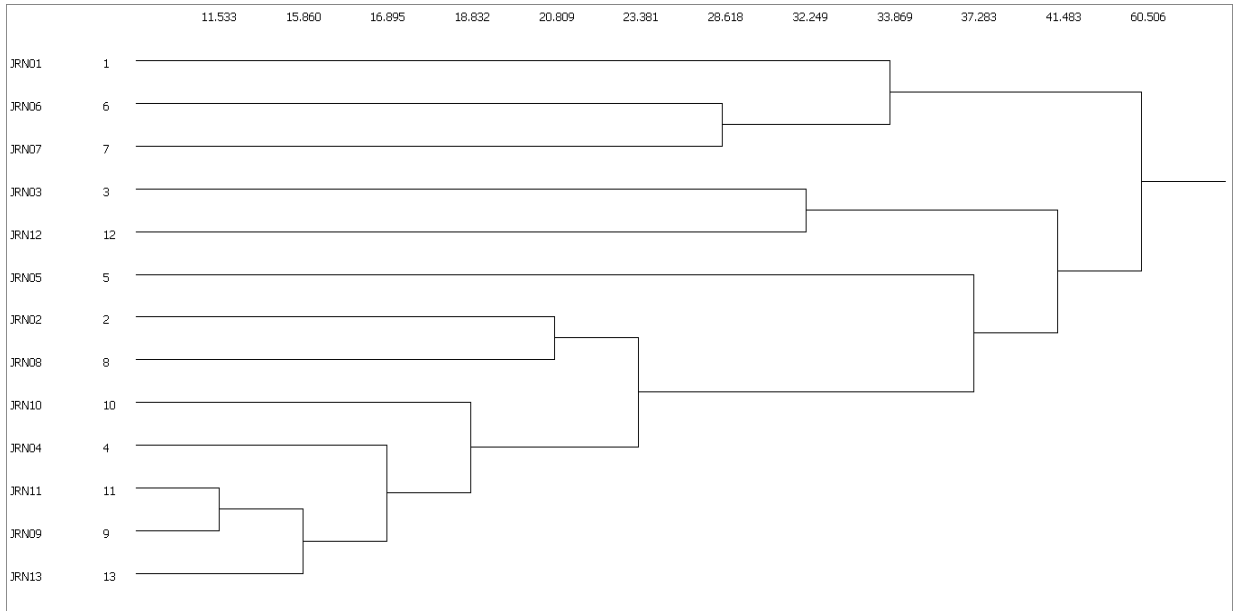


Figure 6: MDS of Clusters and their Structurally Equivalent Members between 2001 and 2004, Journal's Self-Citations Excluded

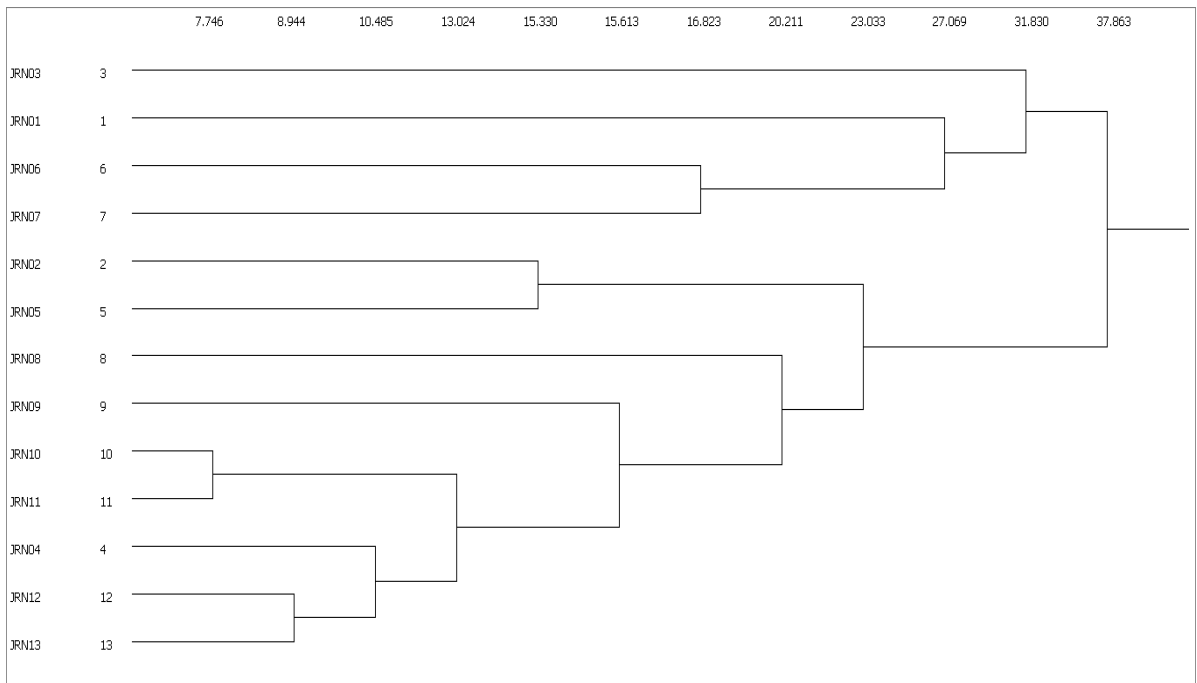


Figure 7: MDS of Clusters and their Structurally Equivalent Members between 2005 and 2008, Journal's Self-Citations Excluded

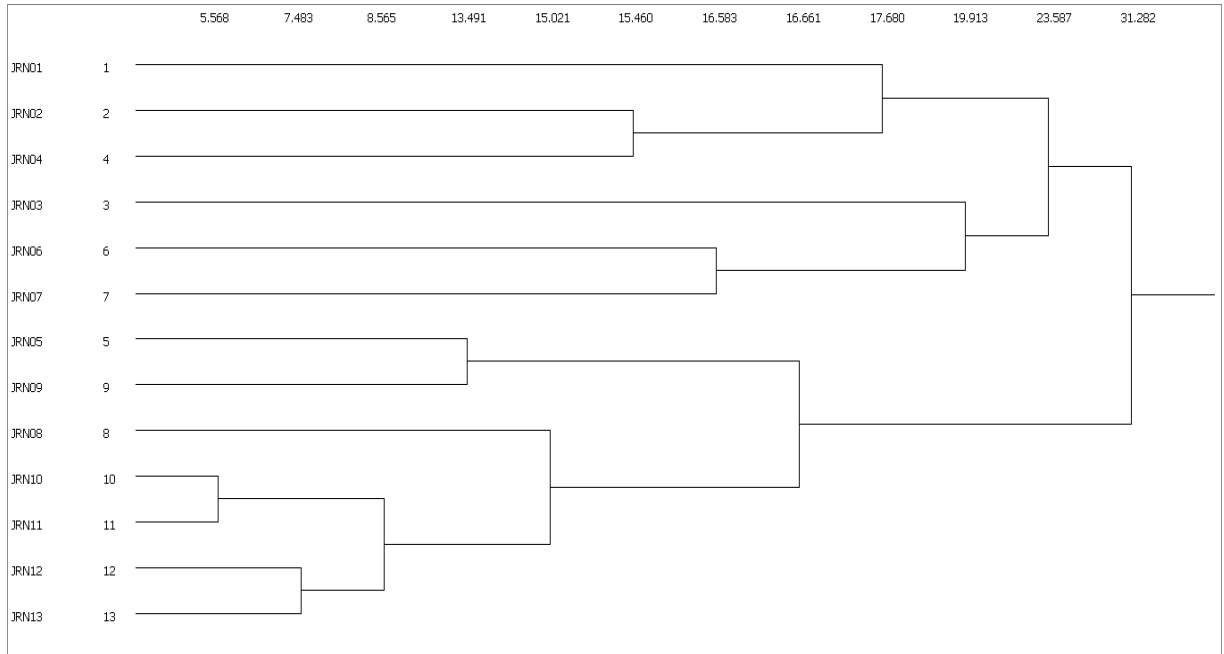


Figure 8: MDS of Clusters and Their Structurally Equivalent Members between 2009 and 2012, Journal's Self-Citations Excluded

CONCLUSION

The results outlined above bring new insights into the J2J citation network. First, in terms of degree, information and betweenness centrality, the results of this study offer an indicator of the role of central, closeness and intermediary in a journal citation network. They also reveal that some LIS-related journals in Taiwan are almost totally isolated from others (i.e., JRN10), and that can be used to discern which journals are more appropriately classified into the LIS field in Taiwan. Secondly, the clique clustering groups are not only employed to identify core LIS journals in Taiwan, but are also useful to categorize Taiwan LIS journals into various finer grained subfields. Thirdly, the results of structural equivalence clustering are useful as a decision-making reference for scholars who wish to resubmit a paper once a paper has been rejected. Furthermore, the results not only tell journal editors which journals are rival competitors by sharing similar citation patterns, but also reveal which highly cited journals (i.e., JRN01) have unique citation patterns in the LIS journal network without any rivals in Taiwan.

To the best of our knowledge, this is the first study to examine the structures and patterns embedded among CLIS journals in Taiwan using varied SNA analyses and their descriptions both over the twelve-year period and over the three individual periods. This study does not only provide an overview image of a longitudinal period, but also shows the evolutionary change over three short periods. Further, the results of this study are also a useful basis for a comparative J2J network study between Chinese-language and English-language LIS journals. One limitation of this study is that citations from English language journals and other non-LIS Chinese-language journals in Taiwan are not included. If those citations were included, the various results and meanings from this study would be enriched.

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