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ABSTRACT

The contribution of this paper is a methodology for profiling literature in Information Systems (IS) using a powerful tool for co-citation analysis - *Citespace*. Co-citation analysis provide important insights into knowledge domains by identifying frequently co-cited papers, authors and journals. The methodology is applied to a dataset comprising of citation data pertaining to a leading European journal – the *European Journal of Information Systems (EJIS)*. In this paper we outline the different steps involved in using Citespace to profile literature in IS and use the EJIS dataset as an example. We hope that the readers will employ and/or extend the given methodology to conduct similar bibliometric studies in IS and other research areas.

Keywords

IS Research; Profiling; Turning Points; Citespace Analysis; EJIS

INTRODUCTION

The research presented in this paper describes a literature review methodology that utilises a *Knowledge Domain Co-Citation and Visualisation Tool* for conducting a citation and co-citation-based analysis of citation data. The data set that is being used as an example is citation data pertaining to a leading European journal – the *European Journal of Information Systems*. In a citation-based analysis the significance of an article is often measured on the basis of the number of citations it has had. However, it can be argued that there may exist certain articles that can be considered high-impact even though the number of citations it has received is comparatively less (for example, papers that have been cited a few times but across domains; papers that have been cited consistently through the years; papers that have been published recently). The opposite of this may also be true (for example, self-citations or a group of authors citing each others' work will usually increase the number of citations for a paper). Furthermore, it usually takes at least 5-6 years for a paper to build up its citation count. Using only citation metrics to identify recently published papers would risk excluding articles that hold promise.

Co-citation analysis has the potential to identify important articles, which would otherwise have been overlooked if only conventional citation analysis techniques were used. Our analysis is conducted on both citing articles and the references they cite (cited articles). The data pertaining to cited articles is essential for co-citation analysis. Co-citation analysis identifies clusters of "co-cited" references by creating a link between two or more references when they co-occur in the reference lists of citing articles (Raghuram, Tuertscher and Garud, 2009). Co-citation networks provide important insights into knowledge domains by identifying frequently co-cited papers, authors and journals related to the domains in question. In our research we have used the knowledge domain visualisation software called *Citespace* (Chen, 2004). We employ a literature review methodology based on Citespace to profile literature published in EJIS. *The focus of this paper is on the methodology, EJIS data set is used as an example to demonstrate the use of this methodology.*

There have been several studies that have profiled existing journal and conference publications based on a number of dimensions, e.g., author and institutional productivity, geographical diversity, theoretical/methodological diversity, emergence of research agenda (Avison, Dwivedi, Fitzgerald and Powell, 2008; Avgerou, Siemer and Bjorn-Andersen, 1999; Barki, Rivard and Talbot, 1993; Benbasat and Weber, 1996; Claver, Gonzalez and Llopis, 2000; Dwivedi and Kuljis, 2008; Dwivedi, Kiang, Lal and Williams, 2008; Dwivedi, Lal, Mustafee and Williams, 2009; Dwivedi and Mustafee, 2010; Gallivan and Benbunan-Fich, 2007; Galliers, Whitley and Paul, 2007; Galliers and Whitley, 2002, 2007; Grant and Koop, 1995; Lee, Gosain and Im, 1999; Mingers and Harzing, 2007; Vessey, Ramesh and Glass, 2002; Vidgen, Henneberg and Naude, 2007). The vast majority of these studies (if not all) have employed a citation-based approach. However, in this paper we are interested in presenting a methodology that is based on "co-cited" references. With regard to our EJIS dataset, "co-cited" references refer to articles (co-cited articles), authors (co-cited authors) or journals (co-cited journals) that have been cited by two or more EJIS authors.

The variables that we will analyse in this paper are, (a) articles that are highly cited by EJIS authors, (b) turning point articles (based on co-citations by EJIS authors), (c) highly cited authors (based on co-citations by EJIS authors), (d) highly cited journals (based on co-citations by EJIS authors), (e) most frequently used keywords by EJIS authors. Finally, we will map the evolution of IS based on EJIS-citation data (f). *The reader should take note that we do not claim to present an "authoritative" representation of the evolution of the IS domain (an exercise which, we appreciate, will necessitate analysis of multiple IS journals), our analysis is specific to data contained in our EJIS data set.*

The remainder of this paper is structured as follows. The next section presents the literature review methodology that employs the knowledge domain visualisation software Citespace. Findings are presented in the subsequent section. The "Findings" section is divided into six sub-sections, each of which present analysis (a) to (f) – see above. The concluding section discusses the novelty of the co-citation based approach to profiling literature, discusses its limitations and draws the paper to a close.

LITERATURE REVIEW METHODOLOGY

Citespace is a knowledge domain co-citation and visualisation tool for conducting a citation and co-citation-based analysis of citation data. Citespace identifies turning points associated with articles from citation data downloaded form the ISI Web of Knowledge (Thomson Scientific Solutions, 2010). We have used Citespace in our research in order to demonstrate the significance of co-citation analysis with regard to cited articles (to identifying significant papers being cited by EJIS authors), cited authors (to identifying significant authors being cited by EJIS authors) and cited journals (to identifying significant journals being cited by EJIS authors). We have also analysed landmarks pertaining to keywords and noun phrases (noun phrases are discussed in the section on "Findings") being used by the EJIS authors. However, with these variables we were more interested in the frequency of their occurrences. This is different from our approach for cited articles and cited authors, wherein we were interested in the identification of significant articles and authors based on the co-citation analysis of references cited by EJIS authors. For this we have used the full feature set of Citespace, including visual identifications of significant articles and important authors through innovative visualisation techniques. These significant articles and authors are also referred to as "turning point" articles and authors. The research method that has been employed to conduct this study is presented in Table 1 as a sequence of steps.

Steps	Description
Step 1	Download citation data from ISI Web of Knowledge. The data downloaded is in ISI format. In this format meta-data tags are appended to qualify citation-specific fields. For example, tags "AU", "TI", "SO" and "CR" are used to qualify the author(s), the title, the journal and the cited references respectively. Citespace is programmed to parse ISI format data.
Step 2	Create a new project in Citespace and map directories assigned to (a) citation data downloaded from step 1, and (b) files created by Citespace.
Step 3	Select Citespace options related to the time interval of analysis (e.g., 1970-1990); the unit of analysis (e.g., 5 years); threshold selection pertaining to citation counts (C), co-citation counts (CC), and co-citation co-efficients (CCV) and applied to the earliest, the middle and the last time slice (interpolated thresholds for the remaining time slices); pruning and merging; and visualisation (Chen, 2006).

Step 4	Select the type of analysis to be performed, namely, cited references, cited authors, cited journals, noun phrases, keywords, institutions and countries. Start processing.
Step 5	Analyse the results. This is specific to the type of analysis that is to be performed.

Table 1: Research Method

We now describe each of the steps in more detail.

In **Step 1**, citation data specific to EJIS was downloaded from the ISI Web of Knowledge (WoK) database. For EJIS, ISI WoK archives citation data from 1995 onwards. Only citation data from articles and reviews were downloaded. In total, 387 records from 1995-2008, consisting of 375 articles and 12 reviews, were considered for EJIS.

In **Step 2**, a new Citespace project was created for analysis of EJIS data.

In **Step 3**, various Citespace options (described in the subsequent paragraph) were selected for analysis of data pertaining to EJIS:
[a] Time interval of analysis: 1995-2008
[b] The unit of analysis: 3 years per time slice
[c] C, CC, CCV for the earliest time slice: 2,2,15
[d] C, CC, CCV for the middle time slice: 3,3,20
[e] C, CC, CCV for the last time slice: 3,3,25
[f] Pruning and merging: Pathfinder network scaling (Chen, 2006) is used to prune individual co-citation networks.
[g] Visualisation: A merged network cluster view has been selected for majority of the analysis.

The various Citespace options are now briefly discussed. An extensive discussion of these variables is outside the scope of this paper and the reader is referred to Chen (2006). A total of five individual co-citation networks are created in our study since we have selected the unit of analysis to be 3 years [b] and the time span of our study is from 1995 to 2008 [a]. Thus, co-citation networks for 1995-1997, 1998-2000, 2001-2003, 2004-2006 and 2007-2008 are created by Citespace. However, since we have selected a merged network cluster view [g], we will be presented with a single cross-cluster co-citation network visualisation, each of the five different co-citation networks being merged would have previously been pruned using the pathfinder network scaling algorithm [f]. The C, CC and CCV values in [c], [d] and [e] refer to the *citation threshold* (for example, C=2 for [c] implies that only those papers that have been cited at least two times will be considered in the co-citation network for 1995-1997), the *co-citation threshold* (for example, CC=3 for [e] implies that for any two papers to be included in the co-citation network for 2007-2008, they should have been co-cited at least three times), and the *co-citation co-efficient threshold*. A comparison of the threshold values for [c], [d] and [e] shows an increasing trend. This is in line with the generally accepted fact that the number of citations for an article usually increases with time.

In **Step 4** we have used Citespace to perform the following six analyses (presented in the section on "Findings"):
(A) Articles that are highly cited by EJIS authors.
(B) Turning point articles (based on co-citations by EJIS authors)
(C) Highly cited authors (based on co-citations by EJIS authors)
(D) Highly cited journals (based on co-citations by EJIS authors)
(E) Most frequently used keywords by EJIS authors
(F) Mapping the evolution of IS using EJIS data

FINDINGS

A. Articles that are highly cited by EJIS authors

Nodes and links are the building blocks of a co-citation network. Citespace supports a total of eight different Node Types (NTs). In this section we are interested in NT "references". Thus when option NT "references" is selected (refer to Step 4 of the research methodology), then each node in the resultant co-citation network generated by Citespace refers to an article (see Figure 1). The different time-sliced co-citation networks are distinguished by their colour. The colours indicate time and through the use of the VIBGYOR spectrum (Violet-Indigo-Blue-Green-Yellow-Orange-Red) they

represent the entire time interval of the analysis (1995-2008). For example, in our analysis the time slice 1995-1997 is shown in indigo, 1998-2000 is represented in blue, time slice 2001-2003 is shown in green, and so on and so forth. As can be seen in Figure 1, the nodes are connected through links. The links can visually represent various characteristics of the underlying network, for example, the colour of the link represents the year in which a connection between two nodes was first established (in this analysis it is the year in which the two articles were first co-cited), the strength of connection between any two nodes is represented by the thickness of the link (in this analysis, the thicker the connection between two nodes, the greater the number of times that the articles were co-cited). From the diameter of the nodes of the resultant visualisation of NT "references", we can visually identify the highly cited papers since each node represents a well-defined article. The co-citation network visualisation allows the user to identify important relationships among the papers. For example, a "thick" link (high frequency of co-citation) between two nodes, both of which also have a relatively large diameter (high citations) and are made up of rings of several colours (cited in many years), would identify two papers that as equally important to the subject matter in question. The top ten references cited by EJIS authors are presented in Table 2.

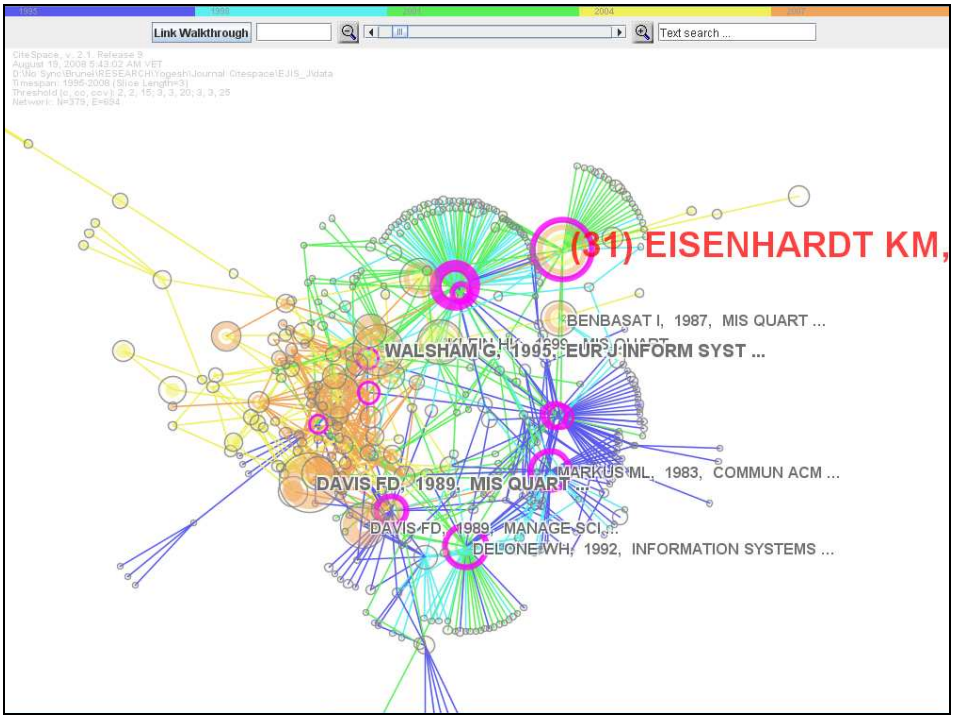

Figure 1: Citespace identifying the highly cited articles in EJIS

Freq	Author	Year	Source	Volume	Page	Paper title
31	EISENHARDT KM	1989	ACAD MANAGE REV	V14	P532	Building Theories from Case Study Research
29	DAVIS FD	1989	MIS QUART	V13	P319	Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology
26	WALSHAM G	1995	EUR J INFORM SYST	V4	P74	Interpretive case studies in IS research: nature and method
23	MARKUS ML	1983	COMMUN ACM	V26	P430	Power, politics, and MIS implementation
23	DELONE WH	1992	INFORMATION SYSTEMS	V3	P60	Information Systems Success: The Quest for the Dependent Variable

22	KLEIN HK	1999	MIS QUART	V23	P67	A set of principles for conducting and evaluating interpretive field studies in information systems
22	DAVIS FD	1989	MANAGE SCI	V35	P982	User acceptance of computer technology: a comparison of two theoretical models
22	BENBASAT I	1987	MIS QUART	V11	P369	The case research strategy in studies of information systems
21	WALSHAM G	1993	INTERPRETING INFORMA	VBOOK	P0	Interpreting Information Systems in Organizations
21	CHECKLAND P	1981	SYSTEMS THINKING SYS	VBOOK	P0	Systems Theory/Systems Theory, Systems Practice

Table 2: Top ten references cited by EJIS authors

B. Turning point articles (based on co-citations by EJIS authors)

Citespace identifies potentially important articles in a co-citation network through landmark nodes (a node with extraordinary attributes), hub nodes (widely co-cited article) and pivot nodes (common nodes that are shared between two co-citation network or gateway nodes that are interconnected by inter-network links), and by enhancing the visual features of such nodes it makes it easier to detect them through visual inspection (Chen, 2004). It is important to note that turning point articles that are identified by Citespace are not necessarily those that have high citations. This analysis is very different to the previous analysis, which only considers the number of citations as the key indicator. The pitfall of gauging the importance of an article solely on the basis of the number of citations has been discussed earlier (see "Introduction").

Figure 2 shows a screenshot of articles (purple coloured nodes) that may be considered as turning point articles. Table 3 lists the papers representing the landmark, the hub and the pivot nodes and are based on ISI Web of Knowledge data specific to EJIS. The articles are sorted by Citespace in descending order in accordance to their potential significance (a concept referred to as "centrality" in Citespace). However, the centrality measure should only be considered as indicative. The reader will note that the citation frequency (first column) is mostly irrelevant in this analysis. For example, as can be seen in Table 3, the potential significance of the article written by *Mata FJ* is much more than an article written by *Markus ML*, although the latter has 23 citations against 8 citations of the former. The identification of turning point papers is only possible because Citespace does a time-sliced co-citation analysis, as against a simplistic citation analysis. In this scheme of things, an article that has been co-cited many times within one time slice (say 1995-1997) may be considered less important than a paper that has been co-cited less number of times but across different time slices (say 1995-1997, 2001-2003 and 2004-2006).

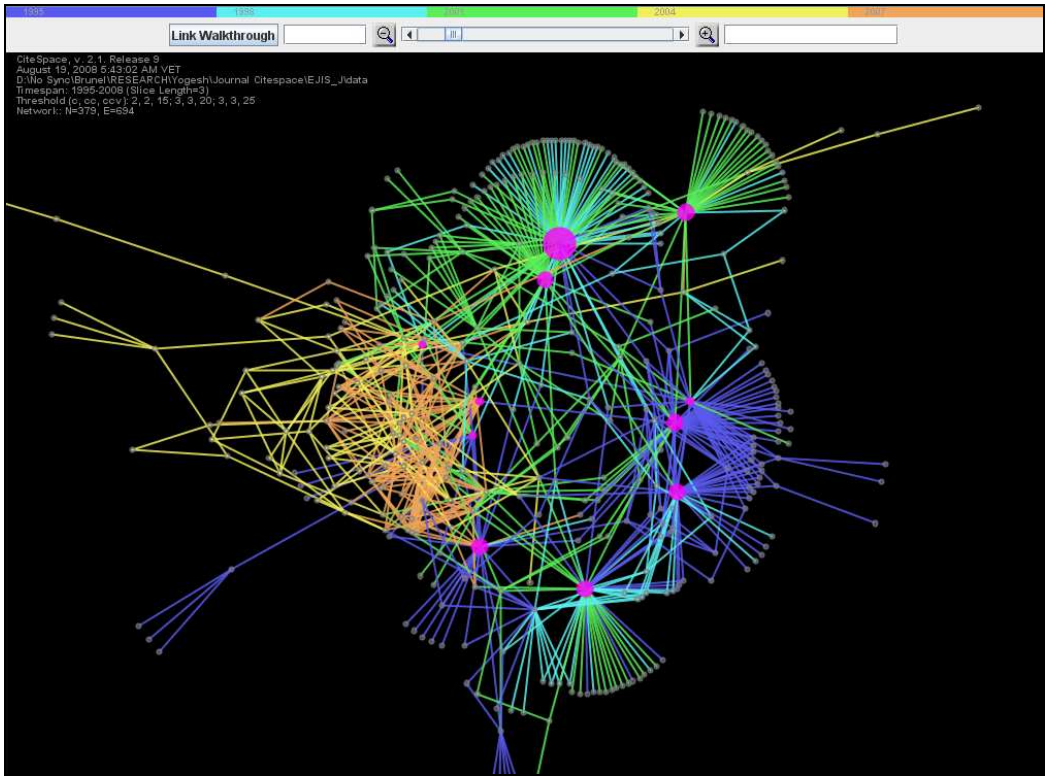

Figure 2: Citespace identifying turning point articles in EJIS

Freq	Author	Year	Source	Paper title
21	WALSHAM G	1993	INTERPRETING INFORMA	Interpreting Information Systems in Organizations
23	DELONE WH	1992	INFORMATION SYSTEMS	Information Systems Success: The Quest for the Dependent Variable
12	WILLIAMSON OE	1975	MARKETS HIERARCHIES	Markets and hierarchies, analysis and antitrust implications: a study in the economics of internal
31	EISENHARDT KM	1989	ACAD MANAGE REV	Building Theories from Case Study Research
8	MATA FJ	1995	MIS QUART	Information technology and sustained competitive advantage: A resource-based analysis
23	MARKUS ML	1983	COMMUN ACM	Power, politics, and MIS implementation
21	CHECKLAND P	1981	SYSTEMS THINKING SYS	Systems Theory/Systems Theory, Systems Practice
19	NUNNALLY JC	1978	PSYCHOMETRIC THEORY	Psychometric theory
15	LYYTINEN K	1987	OXFORD SURVEYS INFOR	Oxford Surveys in Information Technology
14	ORLIKOWSKI WJ	1993	MIS QUART	CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development

15	COOPER RB	1990	MANAGE SCI	Information technology implementation research: a technological diffusion approach

Table 3: Turning point articles based on EJIS citation data

C. Highly cited authors (based on co-citations by EJIS authors)

For this analysis Node Type "cited authors" has been selected in Citespace. A list of top 25 highly cited authors (based on co-citations by EJIS authors) is presented inTable 4. The frequency represents the total number of citations for papers written by a particular author. Each author is represented as a node in the author co-citation network, the diameter of author citation ring represents the total number of citations, the colour of the individual rings (that together make up the author citation ring) depict the year and its thickness is proportional to the citation per time slice (compared to the total number of citations). In visualisation terms, the Knowledge Domain Visualisation (KDVis) of cited authors will be similar to the KDVis of highly cited articles (see Figure 1). However, it is also possible to determine other characteristics from the author co-citation network, for example, a group of co-citing authors (see Figure 3, centre). Each node represents an author and the links between the nodes are the co-citations. Please note that Figure 3 presents the EJIS co-citation network for only one time slice, namely 2001-2003.

Figure 3 also shows certain pivot nodes (in this analysis it means important authors, irrespective of the citation count) and the authors they represent. These are considered important authors because they are being referenced by different nodes in dissimilar spatial space and from different co-citation networks, unlike the case of author co-citation concentration (highlighted with a black circle in Figure 3) in which a group of authors appear to co-cite each other frequently in 2001-2003 time slice.

The four authors (citation count in the brackets) cited by EJIS publications that are considered significant are *Benbasat, I.* (49), *Porter, M.E.* (32), *Earl, M.J.* (32) and *Brynjolfsson, E.* (20). Again, as was the case with the identification of turning point articles in the last section, the reader should note that these authors are not necessarily the ones that have the highest number of citations. The first three authors are represented with a grey background in Table 4. *Brynjolfsson, E.* is not present in the EJIS-specific columns of the table since the author does not have enough citations to make it to the top-25 EJIS list (Table 4).

Authors highly cited by EJIS publications	
Freq	**Author**
71	WALSHAM G
71	MARKUS ML
70	ORLIKOWSKI WJ
52	YIN RK
49	BENBASAT I
46	DAVIS FD
42	DAVENPORT TH
41	DELONE WH
40	EISENHARDT KM
40	LYYTINEN K
37	CHECKLAND P

35	ROBEY D
34	GALLIERS RD
33	JARVENPAA SL
32	EARL MJ
32	PORTER ME
31	ROGERS EM
31	WILLCOCKS L
30	HIRSCHHEIM R
30	VENKATRAMAN N
29	VENKATESH V
28	MINTZBERG H
28	LATOUR B
28	IVES B
28	BASKERVILLE R

Table 4: Top 25 highly cited authors based on EJIS citation data

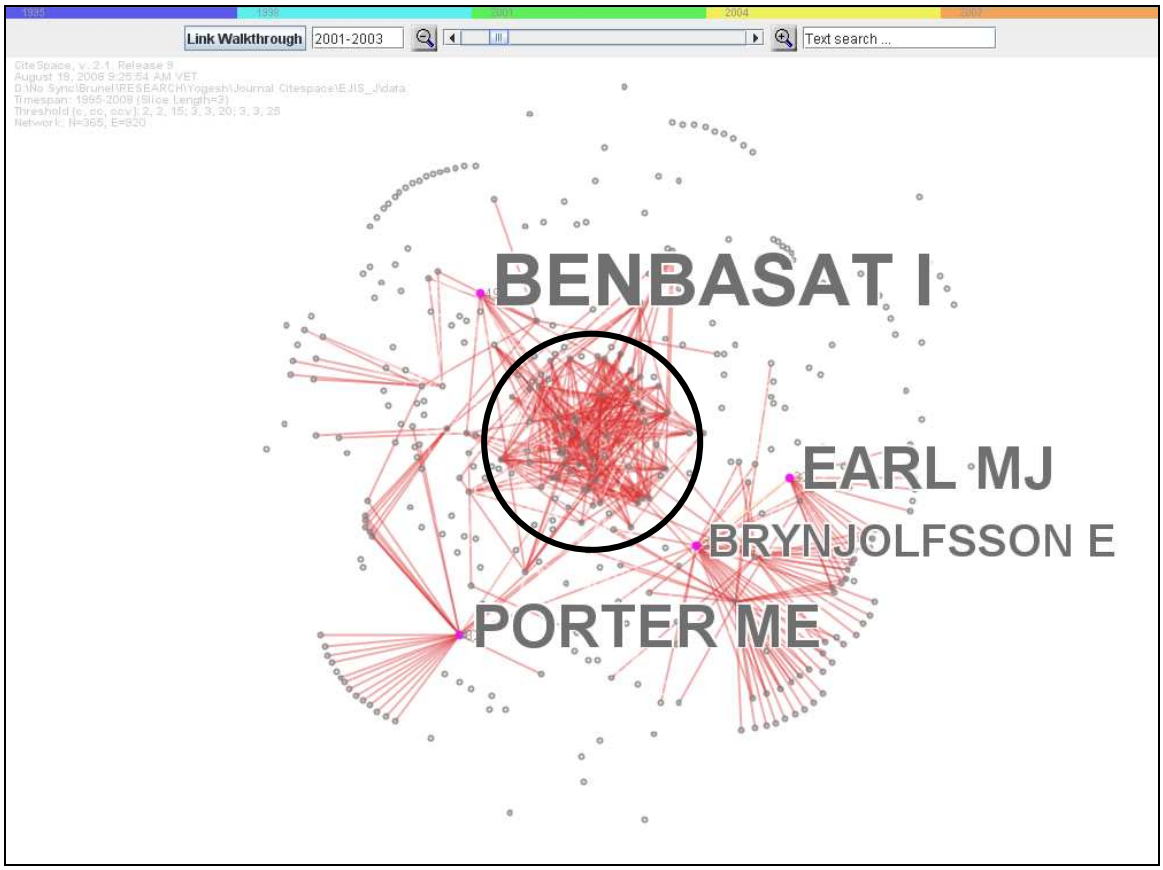

Figure 3: Author co-citation network for 2001-2003 (EJIS) showing high-occurrences of co-citation among authors (marked in black circle)

D. Journals that have been highly cited by EJIS authors

The top 20 journals that have been highly cited by the EJIS authors are presented in Table 5. It is interesting to note that all of the top ten cited journals are either American or European journals.

Journals highly cited by EJIS publications	
Freq	**Journal Abbreviation**
302	MIS QUART (MIS Q)
198	COMMUN ACM
165	INFORMATION SYSTEMS
157	MANAGE SCI
149	EUR J INFORM SYST
115	INFORM MANAGE
112	ACAD MANAGE REV
110	INFORM SYST RES
106	J MANAGEMENT INFORMA
102	HARVARD BUS REV
100	ORGAN SCI
80	SLOAN MANAGE REV
69	INFORM SYST J
65	INFORMATION TECHNOLO
61	ACAD MANAGE J
61	DECISION SCI
54	J STRATEGIC INF SYST
52	CASE STUDY RES DESIG
51	ADMIN SCI QUART
49	J MANAGE INFORM SYST

Table 5: Top 20 highly cited journals based on EJIS citation data

E. Most frequently used keywords by EJIS authors

Table 6 provides a list of 15 keywords, and their respective frequencies that appear in the EJIS list of top 25 frequently used keywords. As can be seen from the table below, the keywords *technology*, *systems* and *information-technology* are the three most frequently used keywords in our EJIS dataset.

Keywords	EJIS frequency
Technology	63

Systems	60
information-technology	50
information-systems	44
Management	42
Model	38
Design	36
Organizations	33
Implementation	33
Perspective	26
Performance	25
Adoption	25
Innovation	19
User acceptance	14
Strategy	14

Table 6: EJIS and MISQ comparison: Most frequently used keyword

F. Mapping the evolution of IS using EJIS data

In this analysis the time-zone visualisation is chosen and the size of the time slices is set to one. The resultant visualisation for EJIS is shown in Figure 4. The visualisation is based on the noun phrase analysis performed by Citespace. The noun phrases help to identify important single and multi-word terms that have been used by the authors in the paper titles and the abstracts. This analysis is different from keyword analysis (refer to the analysis above) since not all noun phrases are included as keywords, and vice versa. In some ways the noun phrase analysis is akin to grounded research (albeit our time scale and the underlying data set are much smaller). Table 7 shows the top noun phrases associated with EJIS journals for each year along with the its corresponding frequency. This table is sorted according to the year in which a noun phrase appeared in EJIS journal. Through analysis of the noun phrases we expect to depict the evolution of IS domain in general and the changing focus of IS topics published in EJIS in particular.

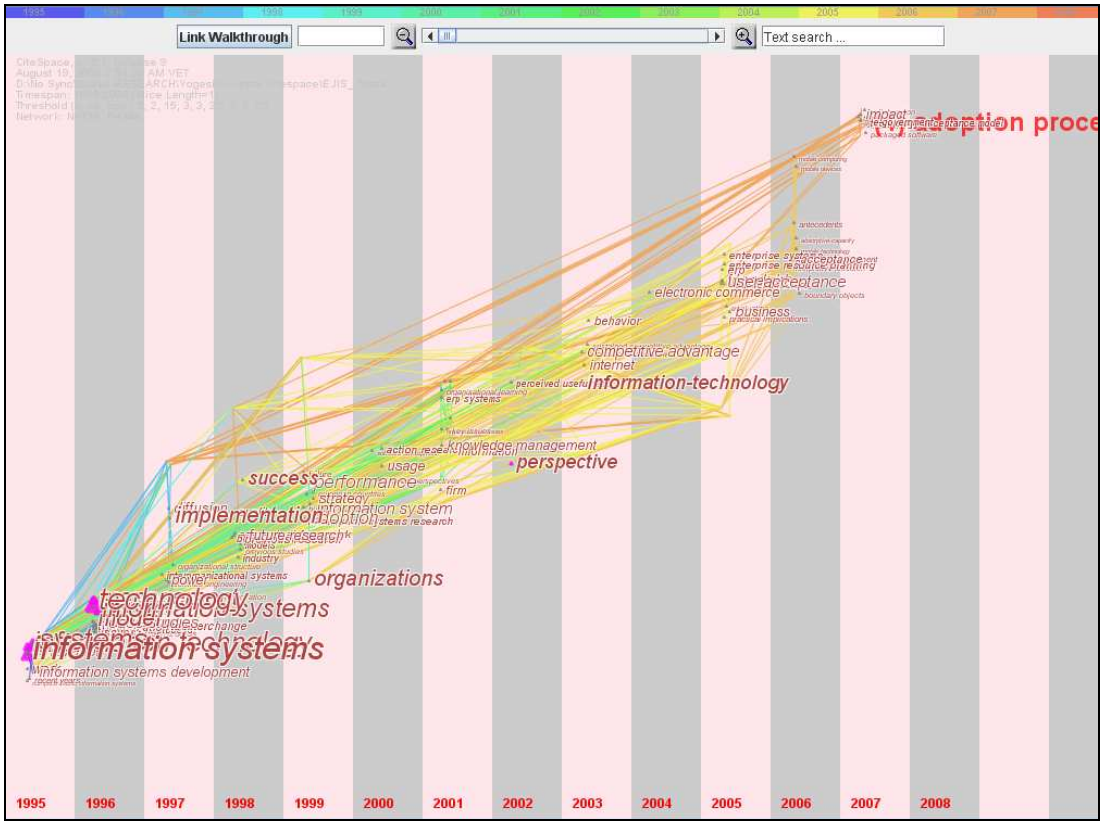

Figure 4: Year-by-year analysis of EJIS publications using noun phrases

Year	EJIS	
	frequency	**noun phrase**
1996	63	technology
	44	information-systems
	42	management
1997	33	implementation
	15	diffusion
	13	power
1998	26	Success
	14	future research
	11	Quality
1999	33	organizations
	25	performance
	25	adoption

2000	14	Usage
	8	action research
	4	different perspectives
2001	13	knowledge management
	11	information
	10	Firm
2002	26	perspective
	7	perceived usefulness
2003	27	information-technology
	16	competitive advantage
	12	Internet
2004	12	electronic commerce
2005	18	user acceptance
	14	framework
	12	business
2006	11	acceptance
	7	case study
	6	antecedents
2007	12	impact
	7	technology acceptance model
	7	e-government

Table 7: EJIS and MISQ comparison: Top three noun phrases in each year

CONCLUSIONS

The contribution of this paper is the literature review methodology that uses co-citation analysis for bibliometric analysis. In the current (and predominant) practice of citation-based analysis, the significance of an article is often measured on the basis of the number of citations it has had. However, findings from this article highlight the fact that this is not always the case and that there are a number of articles that can be considered high-impact even though the number of citations it has received is comparatively less. Our analysis used Citespace in order to demonstrate the significance of co-citation analysis with regard to cited articles (to identifying the turning point papers) and cited authors (to identifying the significant authors). Indeed, the analysis presented in this paper confirmed that the highly cited papers are not necessarily the turning point papers. Therefore, future studies utilising citation counts as means for analysis ought to be more careful in their interpretations and recommendations.

In this study we have only employed citation data pertaining to EJIS. Analysis of only one journal suggests that the findings of this research are limited. However, this also offers potential for future research which could analyse other IS journals and present the readers with a more representative analysis of the IS domain. The use of Citespace in this research has been an encouraging experience, it was quite useful in identifying a new way of ranking journals and authors, and also provided some insights into evolution of IS discipline (based on EJIS data). The authors hope that the literature review methodology, and/or its extension, presented in this paper will be employed by other researchers to conduct similar analysis not only in IS but also in other knowledge domains.

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