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Information Systems: A House Divided?

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Abstract:

Is the IS discipline a single discipline that focuses on both behavioral (BIS) and technical (TIS) topics, or is it two disciplines split between these orientations? Current opinion emphasizes BIS and reinforces the notion that researchers practice research in disconnected silos as opposed to a relatively continuous web. Such silos do disservice to the diversity of scholarly interests, skew productivity expectations in favor of small subsets of journals that often exclude technical- and decision science-oriented journals, and run the risk of creating self-perpetuating journal groupings. Silos disadvantage IS researchers by making the discipline narrower in comparison to other business disciplines and contradict the nature of IS pedagogy that equally reflects technology and management. We applied social network and cross-citation analyses to a sample of 98 IS journals to examine the cohesiveness of IS and to understand the extent to which boundary-spanning journals maintain scholarly connections between the approaches. Distinguishing between weak and strong ties among journals, we found that a discipline that comprises both BIS and TIS journals is highly cohesive in terms of weaker ties and that many boundary-spanning journals are quite balanced in their citations to and from each orientation. However, we did not find that IS is uniformly cohesive. Even so, our findings imply that IS scholars with different interests can parse out distinct subsets of journals that are central to their interests. We demonstrate as much by examining the most central journals for three examples of IS scholars: those with a strongly behavioral approach, with sociotechnical interests, and with specialized interests, such as medical informatics. The most central journals for these three interests are distinct subsets of the IS discipline.

Keywords: Technical, Behavioral, Disciplines, Cohesion, Cross-citations, Social Network Analysis, Journals.

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1 Introduction

Researchers have debated the boundaries and mandate of the information systems (IS) discipline over the past three decades; in particular, they have raised questions about its distinct identity (Benbasat & Zmud, 2003), its relevance to practitioners faced with rapid change in technology (Benamati, Serva, Galletta, Harris, & Niderman, 2006), and its reliance on reference disciplines (Baskerville & Meyers, 2002). Most of these evaluations tend to distinguish between those IS journals based on research about "organizational, social and management issues" (a mandate of the *Journal of Information Technology*) and those based on technical scientific and engineering methods. We refer to the former as behavioral IS (BIS) and the latter as technical IS (TIS). These latter typically include journals that examine technology itself or embrace highly technical analysis including mathematical modeling and formalization.

Most current research and prevalent opinions emphasize the behavioral and management orientation of IS and, unfortunately, reinforces the notion that researchers practice research in disconnected silos as opposed to a relatively continuous web. Historically, these beliefs contradict the inherent nature of IS, which is inextricably linked with development of IS technology (Hirschheim & Klein, 2012). A narrow view of IS harms the diversity of scholarly interests because it skews productivity expectations in favor of small subsets of journals that often exclude technical-, decision science-, and knowledge/data management-oriented journals. A limited viewpoint also risks creating self-perpetuating journal groupings, such as the Senior Scholars' basket of eight, and disadvantages IS researchers by narrowing the discipline in comparison to other business disciplines. Furthermore, does this management orientation truly reflect IS pedagogy that trains students equally for both management and technical IS roles? Clearly, decisions about these boundary delineations have implications for the organization and competitive position of university departments (Abbott, 2001).

These concerns motivate the question that we examine in this study:

> **RQ**: Is the IS discipline a single discipline that focuses on both behavioral (BIS) and technical (TIS) topics, or is it two disciplines split between these orientations?

IS no longer has a monopoly on the study of information and computer technologies (Walsham, 2012) but engages in "competition for settlement" with related disciplines (Bernroider, Pilkington, & Córdoba, 2013, p. 84). These questions are timely as the Senior Scholars are engaged in active dialog with the IS community to explore the possibility of expanding the scope of its basket of eight journals. They are also timely as the IS community continues to explore its identity and core properties (Benbasaat & Zmud, 2003). We specify and examine this topic through six research questions that we elaborate on in Section 2. Through these questions, we explore the cohesiveness of IS journals, presence of boundary-spanning journals, strength of cross-journal ties, and implications for top journals such as those in the basket of eight.

The IS discipline certainly has no dearth of studies that evaluate its journals, particularly those that develop and reconcile rankings. These studies use a wide range of criteria for identifying journals to evaluate and methods to generate rankings. In most cases, studies use subjective definitions and may, for instance, specifically select management/behaviorally oriented IS journals (e.g., Lowry et al., 2013) or those that do not distinguish between a management- and technical orientation (e.g., Pratt, Hauser, & Sugimoto, 2012). These studies also range on the approaches they use to rank selected journals. Our study differs in two ways: first, we take an empirical approach to identify and include journals using the Web of Science's Journal Citation Reports (JCR). Second, we use cross-citation and social network analysis to explore IS journal orientations, cohesion around these orientations, and boundary-spanning journals that can make bridge distinct orientations and make innovative research contributions. To the best of our knowledge, only one study, Polities and Watson (2008), has followed a similar approach, but their study emphasized journal ties as opposed to disciplinary orientations.

2 Background and Research Questions

2.1 Why IS Might be Cohesive

Before we explore whether the IS discipline demonstrates "cohesion", we explain how we interpret the term. "'Cohesion' in our ordinary [English language] usage", as Chan, To, and Chan (2006, p. 289) point out, "refers to a state in which components 'stick' to together to form an effective or meaningful whole". Its opposite, then, is fragmentation. This interpretation seem simple enough. However, a diverse and extensive literature presents a welter of definitions for cohesion: some focus on subjective and individual properties, and others focus on objective and collective properties (Friedkin, 2004; Mizruchi, 1990). We focus on the latter. As Moody and White (2003, p. 106) note, it is “the social relations of its members [that] hold [a cohesive collectivity] together”. Further, just as multiple definitions for cohesion exist, so too do the methods one can use to measure cohesion. For example, the “cohesion” module in the UCINET software package for social network analysis includes 18 routines. Measures typically involve the extent to which connections among members are dense or sparse, many or few, and mutual or unilateral (Freeman, 2011). We explore whether these sorts of measures provide evidence that one can better regard the IS discipline as a “meaningful whole” or as fragmented across its more technical and more behavioral publications.

Existing literature gives several reasons to believe that IS may be a relatively connected web of journals that comprises both behavioral and technical concerns. Some journals, such as *Information Systems Frontiers*, cover a broad range of “research domains, [specifically,] environment, organization and technology” (Bang, 2015, p. 217). Therefore, some IS scholars treat both BIS and TIS approaches as part of a unified discipline. For example, Pratt et al. (2012) indistinguishably treat IS as comprising behaviorally oriented journals (e.g., *MIS Quarterly*) and the more technical ones (e.g., *Journal of the ACM*). Moreover, IS research widely adopts the notion that information systems are sociotechnical systems (STS) (Bernroider et al., 2013; Walsham, 2012). A central theme in STS thinking is that technology affects social systems and vice versa; simply put, understanding organizations of any sort requires paying attention to both “the people and the equipment” (Trist, 1981, p. 10). As such, in IS in particular, one needs to pay attention to “technology [and] the importance of the IT artifact” (Arnott & Pervan, 2005, p. 82). A recurring theme throughout the development of IS has been the need to accommodate both the technical dimensions through so-called “hard” methods and the social dimensions through “soft” methods (Mingers, 2004). Moreover, technology profoundly affects both management and organizations (Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007).

If one accepts that IS incorporates the study of both social and technical concerns, it follows that the IS discipline is inherently multifaceted and includes both technical and social science disciplines (Walsham, 2012). Particular IS topics, such as software engineering and services computing (Zhao, Tanniru, & Zhang, 2007), require paying attention to both behavioral and engineering or technical expertise. Publications in IS frequently refer to its “interdisciplinary” character (e.g., Bang, 2015; Leitner & Rinderle-Ma, 2014). Bernroider et al. (2013, p. 84) demonstrate that a variety of disciplines form “highly inter-connected fields” that connect with IS. Similarly, Raasch, Lee, Spaeth, and Herstatt (2013, p. 1115) present evidence of a cluster of “computer science and information systems” scholars who co-author paper together. Also, Cronin and Meho (2008) show that “information studies” tend to cross-cite across technical and social orientations.

2.2 Why IS Might be Fragmented

The above studies suggest but do not definitely establish cohesiveness. The interdisciplinary nature of IS could encourage fragmentation among its constituent subdisciplines. Prior research has not clarified this possibility because it has not examined the extent of fragmentation or cohesiveness across the technical and social orientations. For example, Lim, Saldanha, Malladi, and Melville (2013) examined the “cohesiveness” of IS knowledge but with regard to only two of the basket journals (*MIS Quarterly* and *Information Systems Research*). Similarly, Oh, Choi, and Kim (2005, p. 274) studied the cohesiveness of subdisciplinary networks with a sample of only four IS journals “in the domain of management”.

These competing views of IS influence decisions about which journals are recognized as prestigious IS outlets. As an indication of this orientation, in surveying IS journals, Lowry et al. (2013) excluded journals regarded as belonging to computer science, operations research, decision science, or other more technically oriented disciplines. The basket of eight journals, widely regarded as top IS journals and as behaviorally oriented (Association for Information Systems, 2016), represent a similar approach to IS as a predominantly behavioral discipline. Although the basket has not met with universal acceptance (e.g., Chen, 2011), it has found explicit support in widely cited journals (Chan, Guness, & Kim, 2015; Lowry et al., 2013). For example, Bernroider et al. (2013, p. 79) treat it as “reflecting…the IS field…as a whole”. Many studies in the literature have also examined it: we found 240 citations in Google Scholar for the joint terms “information systems” and “basket of eight” and 126 to “information systems” and “basket of six” (as of 11 November, 2016). Support for the basket may be an argument that one could reasonably limit the discipline to behaviorally oriented journals.

The orientation of a discipline might also reflect and influence researchers' behaviors. In the case of IS, it may be that scholars with a management orientation publish with little influence from TIS scholarship and vice versa. More generally, one might characterize the landscape of research disciplines as sets of "disconnected silos" (Jacobs & Frickel, 2009, p. 48). Indeed, Donald Campbell (2005, p. 4) first observed as much in noting "a redundant piling up of highly similar specialties, leaving interdisciplinary gaps" (his paper originally appeared in 1965). It also fits Raasch et al.'s (2013, p. 1147) findings for the discipline of open source innovation whose "scholars study a set of closely related issues, but increasingly do so within and for their own disciplines". In IS, Ellis, Allen, and Wilson (1999, p. 1095) found information science and information systems to be "conjunct subjects [that publish as] disjunct disciplines" with little cross-fertilization. Researchers have also found other examples of fragmentation in related scholarly disciplines in accounting and management approaches to control (Euske, Hesford, & Malina, 2011), consumer behavior (MacInnis & Folkes, 2010), "heterodox" economics (Cronin, 2008), political science (Garand, 2005), and supply chain management (Giannakis, 2012). As such, we ask:

RQ1: How cohesive is IS across its more behavioral and technical orientations?

With this question, we determine whether research in these two orientations shows extensive cross-fertilization as reflected in citations across them. We explore whether the IS discipline is fragmented into distinct, largely isolated journal sets—one behavioral and the other technical.

2.3 Boundary-spanning Journals

Although one can readily find disconnects between topically similar disciplines in the literature, boundary-spanning journals, collections, and conferences might link the various specialties in loosely organized disciplines. Jacobs and Frickel (2009, p. 48) argue that, at some "level[s] of aggregation…and…substantive distance between fields", the image of "a web" better fits research practice than the image of disconnected silos. The image of a web concurs with Pierce's (1999, p. 271) finding that "boundary-crossing authors can be identified in many disciplinary literatures". The web metaphor is more promising for advancing knowledge because researchers across specialties need to collaborate to solve important but ambiguous problems, particularly those that require both technical and social science expertise (Fischer, Tobi, & Ronteltap, 2011; Melero & Palomeras, 2015). As many writers have observed, such boundary spanning across specialties can generate unusually innovative research outcomes (e.g., Leahey & Reikowsky, 2008; Rafols, Leydesdorff, O'Hare, Nightingale, & Stirling, 2012).

Cohesiveness in this study refers to measures of the extent of cross-citations between journals that represent one or another scholarly discipline, specialty or orientation, such as cohesion between information science and communication (Borgman & Rice, 1992) or between information science and information systems (Ellis et al., 1999). Because specialization is a necessary quality to advance knowledge (Leahey & Reikowsky, 2008), we expect that some journals will focus strongly on BIS or on TIS. However, to the extent that the leading IS journals are cohesive across the BIS and TIS orientations, at least some of these journals must play a boundary-spanning role (Rafols et al., 2012). As such, we ask:

RQ2: How balanced between BIS and TIS cross-citations are IS journals?

With this question, we determine whether a substantial percentage of IS journals have a relatively balanced number of citations to and from BIS andTIS journals. These journals would play a role of boundary-spanning across the orientations and, thus, suggest that a cohesive behavioral and technical IS discipline exists. In addressing this question, we also identify the number of journals that play a boundary-spanning role.

RQ3: If indeed relatively balanced IS journals exist, which subset of IS journals, if any, is cohesive across the behavioral-technical distinction?

We examine types of journals that are relatively likely or unlikely to cross-pollinate across this boundary and determine if there are particular types of journals that play a boundary-spanning role.

2.4 Measuring the Strength of Cross-journal Ties

One can measure cohesiveness with both weaker and stronger ties of cross-citations. First, we treat cross-citations in terms of dyads of journals with no requirement that they are reciprocal or that they exceed a cut-off of more than one citation. This weaker measurement of cohesiveness is useful because it captures the full extent of cross-pollination (if any). However, it can be useful to know if a deeper structure of cross-pollination exists such that the ties between different types of journals are more robust. For this purpose, we follow Borgman and Rice (1992, p. 401) who explored the number of “triangular”—not merely dyadic—ties among journals. These ties, called Simmelian ties, occur when the entities involved are “reciprocally and strongly tied to each other and are both reciprocally and strongly tied to at least one common third party in common” and, thus, form a type of “clique” that does not necessarily have strong ties (Krackhardt, 1998, p. 24). Simmel (1950), who originally proposed these ties, suggested that relations embedded in a triad are stronger, more durable, and can “produce agreement between actors that relations not so embedded” (Krackhardt & Kilduff, 2002, p 281). Borgman and Rice (1992) is the only example we found that examines Simmelian ties in the context of cross-citations. They focused on the “openness” of citation patterns compared with dominance by sets of cross-citing journals. Our interest lies in strong ties across the BIS-TIS boundary, which indicates that elite journals are open to alternative approaches. As such, we ask:

RQ4: Can we identify journals with strong boundary-spanning Simmelian ties and, thereby, demonstrate that the IS journal network has more robust overall cohesion?

To this point, we have proposed examining cross-citations at the journal-to-journal level. One can aggregate these citations to the level of clusters of types of journals. Thus, we also examine the pattern of cross-citations at the cluster level.

RQ5: Do some clusters play a boundary-spanning role between other clusters? For example, do BIS journals bridge between different types of TIS journals? Do some types of TIS journals play a bridging role?

2.5 Implications for “Top” Journal Lists

Virtually all “top” journal rankings, such as the one that Chan et al. (2015, p. 239) present, have an “interest in identifying a set [singular] of information system journals”; that is, to present a singular, definitive set. Ironically, many published lists of “top” journals—in both IS other disciplines—propose a singular set of journals with clearly demarcated boundaries yet differ widely in their approaches (Lowry et al., 2013) and findings. This irony also applies to journal lists that university departments create: they are definitive but inconsistent compared with one another (Athey & Plotnick, 2000; Watson & Montabon, 2014). Findings may differ in statistical significance, but “the unexplained variance of more than 50% shows that these rankings do not succeed in arriving at a consistent…ranking” (Eisend, 2011, p. 250). Similar findings are also reported in Mingers and Harzing (2007). With the “great variety of IS journals” available (Cabanac, 2012, p. 977), institutional and national diversity (Vitari, Humbert, & Rennard, 2012), and the diversity of approaches IS research adopts (Gallivan & Benbunan-Fich, 2007), IS scholars in research universities unsurprisingly publish in a wide array of journals (Dean, Lowry, & Humpherys, 2011). The AIS Senior Scholars recognized this diversity in their explanation of their favored list of top journals (the basket of eight) and note that the “behavioral, business-oriented IS” journals of the basket are “not a universal model” and that some departments prefer publications in more “technical” or more “multidisciplinary” journals (Association for Information Systems, 2016). As such, we ask:

RQ6: Can we identify multiple subsets of IS journals that are appropriate for disseminating research from varying perspectives or might there be a universal and definitive list of top IS journals?

If the IS discipline is not cohesive across its behavioral and technical approaches but instead comprises isolated “silos” of scholarship that each has its own unique set of relevant journals, IS scholars face a choice about which silo they should join. In contrast, if a substantial and cohesive set of IS journals represent a diversity of approaches and topics, IS scholars face many choices as to the subsets that best represent their scholarly interests and concerns. A consequence of cohesiveness across diverse approaches to IS would be that no singular, unique set of “top” journals exists for every one of them.

3 Research Method

3.1 Method Overview

We used journal-journal cross-citation analysis with data from ISI Web of Science and social network method routines from UCINET (Borgatti, Everett, & Freeman, 2002) to answer the research questions. Our analysis required the following steps: 1) creating a sample of IS journals with both BIS and TIS orientations, 2) generating a cross-citation matrix based on this sample, 3) clustering the matrix so as to differentiate between BIS and TIS journals, 4) assessing the cohesiveness of the overall sample and of the BIS and TIS clusters by examining the number and robustness of components and 5) by evaluating the extent to which journals play boundary-spanning roles across the two orientations, and 6) determining which ties are robust by finding the Simmelian ties (reciprocal, triadic, and strong) that form specialized samples of IS and IS-related journals (behavioral, sociotechnical or boundary-spanning and medical informatics) and determining the rank orders of degree centrality in those samples. Table 1 below summarizes the key measurements used in our study.

Table 1. Measures Used in Study with Related Descriptions

Measurement	Description
Cross-citation matrix	**Isolates and near isolates**: nodes (journals) with one or fewer cross-citations in either direction. **Indegree**: citations received. **Outdegree**: citations sent. **Degree centrality**: sum of direct ties (citations), which can be based on indegree, outdegree, or both.
Clustering by optimization	Tabu search of correlation matrix that optimizes high correlations within and low correlations without. Tabu search is an adaptive, heuristic method for solving combinatorial optimization problems. It uses other methods such as linear programming and specialized heuristics to overcome limitations of local optimality (Glover, 1989).
Cohesiveness (extent of connectedness)	Here, based on the minimum number of removed nodes to fragment a strong component. **Strong component**: network with paths between all nodes in both directions. If one direction, it is a weak component.
Simmelian ties	Very strong ties that meet a threshold for each tie (a minimal number of citations) in each direction (thus mutual) and triadic (thus forming a clique). Theoretically, triad members are constrained by shared norms (e.g., for reviewing standards.

3.2 Sample

For both cohesion and topical analyses, we needed to determine what IS journals to include in our sample for analysis. To that end, we first had to decide whether to include a large, broadly defined set as in Cabanac (2012) or a smaller, more focused set as in Lowry et al. (2013) and Chan et al. (2015) that emphasized more behaviorally oriented journals. For instance, Lowry et al. began with a sample of 140 journals but eventually analyzed only 21 due to their disqualifying journals for a variety of reasons, such as for being one of a set of journals (e.g., IEEE journals) or a magazine rather than a scholarly journal. They excluded 55 journals based on their editorial scope: they excluded 28 for having a “primarily CS” scope, seven for having a “primarily OR/OM” scope, and one for having a “primarily decision science” scope (Lowry et al., 2013: Table B1). In short, they excluded several journals because of their technical orientation.

Chan et al. (2015) used an even more focused sample that centered on the basket of eight and “obtain[ed] an expanded sample of IS journals…that show high citation behavior within the set and low citations of individual journals outside the set” (Chan et al., 2015, p. 240). Their resulting sample comprised only 13 journals. Despite this severely restricted range, they claimed to have “identif[ied] the set of IS journals” (p. 244). Similarly, Bernroider et al. (2013, p. 79) included journals in “operations research and management science” but not those oriented towards computer science or engineering. They presented the basket “as reflecting the core body of knowledge within the IS field…as a whole”.

Whereas the above authors used some subjective definitions of the boundaries of IS, we took an empirical approach to explore if the discipline should include both the orientations. To do so, we followed Cabanac (2012) and began with journals from the Web of Science’s Journal Citation Reports (JCR) category “computer science/information systems”. Only this category on the Web of Science includes the term “information systems” (see Leydesdorff, 2007, for the way that the Web of Science determines subject classification). While we were interested in the more influential journals and those that are more likely to be cited, we also wanted a large enough sample to reflect the diversity of IS journals. Therefore, we started from the journals in that subject category with the highest two-year journal impact factors (JIFs)[1]

[1] *ACM Transactions on Intelligent Systems and Technology* and *IEEE Communications Surveys and Tutorials* for 2014.

down to JIFs of 0.750. Because citations are subject to some year-to-year fluctuations that special issues and other idiosyncrasies cause, we created a sample using the two most recent years with published JIFs: 2014 (citing papers from 2012 and 2013).

This approach netted 90 journals. However, the JCR category omitted three highly cited journals, two of them in the basket of eight: *Information Systems Journal*, *Information Systems Research*, and *Information and Organization* (categorized under “information science and library science”). We added these three to the sample. We also wanted to explore whether some of the journals excluded by prior studies as non-IS (typically for being in technical disciplines such as computer science and decision sciences) might be closely connected with behaviorally oriented journals. For instance, in their survey, Mylonopoulos and Theoharakis (2001) identify 23 of the journals that Lowry et al (2015) reject as belonging in the top tier of IS journals. For instance, Mylonopoulos and Theoharakis report that 88 percent of their respondents reported *Management Science* as a top ten IS journal, 72 percent reported *Organization Science*, and 68 percent reported *Decision Sciences*. Further, Karuga, Lowry, and Richardson (2007) regard *Management Science* as one of the three core IS journals.

Therefore, we added these journals plus *Computer-Supported Cooperative Work*, *Computers & Operations Research*, *Computers in Human Behavior*, *European Journal of Operational Research*, *Expert Systems with Applications*, *International Journal of Information Management*, *Journal of Systems and Software*, *Knowledge-Based Systems*, and *Omega*. We chose these journals based on the extent to which they cover IS topics as found in Web of Science, ProQuest, and Google Scholar searches and, in our decision to include *Omega* but not the *Academy of Management Journal*, the topics the journal itself says it covers. *Omega* notes “business analytics”—“the intersection of operations management with…information and knowledge management”—as part of its mandate. At this stage, prior to removing isolates and near-isolates, the sample comprised 105 journals.

3.2.1 Isolates and Near-isolates

Cross-citation matrices make it possible to identify and exclude isolates and near-isolates to yield a more robust sample. Based on our data, we removed journals that had at most one other sampled journal that that it cited or that cited it. Seven journals met this criterion: *Distributed and Parallel Databases*, *Human-Computer Interaction*, *IEEE Transactions on Information Technology in Biomedicine*, *International Journal of Web and Grid Services*, *Journal of Chemical Information and Modeling*, *Journal of Cheminformatics*, and *Journal of the ACM*. As with Lowry et al. (2013), we also excluded from the initial sample a self-described “magazine”, *IT Professional*. Thus, the remaining sample comprised 98 journals, somewhat larger than the 77 culled by Cabanac (2012) from the same JCR categories, due largely to our additions.

3.2.2 Three Other Samples for Specialized IS Interests

In addition to the sample described above, we created three additional samples: a behaviorally oriented sample, a boundary-spanning sample, and medical informatics as an example of a technology specialty. The behaviorally oriented sample comprised the 45 journals that cited the basket of eight. Because of their importance in the IS discipline, we included the basket of eight journals in the other two specialized samples as well. The sociotechnical or boundary-spanning sample comprised 61 journals that cross-cited *Decision Support Systems*, which we found to be a particularly important boundary-spanning journal; eight of these 61 journals come from outside the sample of 98. The medical informatics sample comprised 49 journals based on topical relevance and relatively high citation scores in the Journal Citation Reports. We do not propose these three specialized samples as definitive in terms of inclusiveness. They doubtless miss some journals that we would have included had we used a wider time frame. However, their ranking based on indegrees (citations received) and outdegrees (citations sent) indicates which journals do not seem as relevant for the specialized approach in question.

3.3 Cross-citation Matrix

Examining cross-citations requires one to make a decision about the time periods for the citing and the cited works. Mingers and Leydesdorff (2015) used one year for citing and all the prior years for the cited periods. However, we followed the two-year JIF with a one-year citing window and a two-year cited window because selecting all prior years would not necessarily represent the current status of the journals and state of the discipline. We derived data from the cited reference search facility in Web of Science (WoS). WoS citation searches apply only to citations received; that is, “indegrees” in social network terminology. However, our purposes also required the citations sent; that is, “outdegrees”. With finite samples, such as the 95 journals in the sample of this study, one can also find outdegrees from searching citations received. When one includes all the indegrees, one also includes their sources. Hence, we recorded all the outdegrees (citations sent) with respect to the sample (though not with respect to the universe of citations).

3.3.1 Normalizing Cross-citations for Different Numbers of Journals and Papers

One can count cross-citations at the paper-to-paper level and the journal-to-journal level. We used the latter approach, which simplifies the ties, when calculating cluster-to-cluster connections. Because the clusters had different sizes, we report both raw connections and connections adjusted for cluster size. Most of our results employ paper-to-paper measures. Raw results, unadjusted for the number of papers per journal, are the most meaningful because authors do not cite at random but do so based on content such that they are more likely to cite journals with more papers. This rationale may hold between journals with similar content. Authors might cite one behavioral journal more than another, one technical journal more than another, or one type of technical journal more than another if it has more papers to cite. However, we cannot imagine an author's citing a technical journal rather than a behavioral journal (for example) because the former has more papers. In other words, all else equal, an author might be more likely to cite *Knowledge-Based Systems* with its 544 in-period papers rather than *Knowledge and Information Systems* with its 201 but be less likely citing *IEEE Transactions on Information Theory* with its 1,061. Therefore, we employed paper-based normalization only for the summary figures in Table 4 (see Section 4.6). In making the adjustment, we adapted a recommendation by Rafols et al. (2012). When normalizing the outdegree, the rows are weighted; to normalize indegree, the columns are weighted. Using raw or normalized data affects boundary-spanning measures but not the other measures of cohesion, which are indifferent to the strength of a tie, which is the only difference between raw and normalized data.

3.4 Identifying Clusters

When clustering a matrix, tone can force the result into any number of clusters (from one to 98 in our sample). Given that we sought to identify whether one should best interpret IS as a single discipline or two based on a social science or "technical/computer science" orientation, we used the hierarchical clustering of UCINET to gain an initial derivation of two non-overlapping clusters of BIS and TIS journals. We then used the optimization (Tabu Search) routine, which generates fit statistics, to determine the number of clusters with stable BIS clusters and diminishing returns of fit for larger cluster numbers. Following conventional practice, with each type of clustering, we performed the routine on a correlation matrix, not the raw data (Wasserman & Faust, 1994).

3.5 Cohesiveness as Determined by Multiple Measures

Most cohesiveness measures, such as those in the "cohesion" set of routines of UCINET (Borgatti et al., 2002), apply to matrixes as wholes without regard to the connectedness or disconnectedness between subsets of theoretical interest, such as BIS and TIS journals. Because we focus on this latter concern in this study, we focus on two types of measures that directly apply to it. The first approach is based on the components—the maximal subsets in a network in which each node (e.g., journal) can reach every other node (e.g., by paths of cross-citations)—in each sample. We used the default in UCINET, which is to search for "strong" components such that each node can reach every other node, taking into account the direction of ties (Borgatti et al., 2013, p. 23). This first approach, based on components, has two steps. First, one determines the number of components per sample. Next, one determines the minimum number of journals that one needs to delete in order to split the sample into more components. The second approach is based on the extent of boundary spanning by sample journals across the orientations and involves two steps: calculating the extent of boundary-spanning for each journal and determining how many journals have high levels of boundary spanning based on cross-orientation citations.

3.6 The Number of Components

If the sample matrixes prove to comprise more than one component, particularly if one can interpret them as representing BIS and TIS orientations, we would have compelling evidence of fragmentation in the IS discipline. If the sample matrixes prove to comprise only one component, we would have evidence of cohesiveness. However, this approach would not measure the robustness of cohesiveness. Therefore, we followed the recommendation of Moody (2004, p. 217) who argues that "structural cohesive[ness]…can be exactly characterized as the extent to which a network will remain connected when nodes are removed from the original" (see also Moody and White, 2003). In this approach, one seeks the minimum number that must be removed because the greater the number of removals the greater the robustness. Only the minimum number of removals avoids inflating the measure of robustness. One can only determine this minimum number of nodes to be removed iteratively by successively removing nodes (in our case, journals) that are most likely to hold the networks together. Intuitively, these journals will be the most "central" journals. Moody (2004) used degree centrality and Franceschet (2012) used betweenness centrality as the criterion for node removal. However, this criterion does not generate the true minimum. Strong components in our context have paths between each and every journal in both citing and cited directions. Removing in the order of reciprocated ties, therefore, maximally fragments them.

3.7 Splitting the Sample into BIS and TIS Components

The minimum number of nodes needed to split a component measures the cohesiveness of the sample as a whole but does not measure the robustness of the connection between BIS and TIS orientations. For this purpose, we needed to find the minimum number of journals that had this specific effect, which was simply the number of journals that have boundary-crossing ties. Leaving any one of them would fail to split the sample completely into BIS and TIS components. Therefore, we could explore the cohesiveness across BIS and TIS approaches by determining whether half or more of the journals have such ties or not.

3.8 Cohesiveness Based on Boundary-spanning Journals

Another way that we expressed the cohesiveness of the sample with respect to the BIS-TIS difference was to determine the extent to which IS journals play a boundary-spanning role between the orientations. We did so in as follows. We calculated for each journal the percentage of its dyadic ties (i.e., *ij* and *ji* pairs based on cross-citations) that cut across the BIS and TIS clusters. We expected that some journals would lack any such border crossing dyads. However, if the IS discipline proved to be cohesive across these orientations, we would find many journals that had such ties and several with high percentages. The calculations required dichotomized matrixes (if > 0,1,0) with zeroes on the diagonal. The denominators were the sums of the rows (outdegrees) and the columns (indegrees) and the numerators were the sums to or from the other orientation. We then expressed these calculates as averages for the sample overall and for the BIS and TIS subsamples in order to indicate which if either of these orientations plays a larger role in the cohesiveness of the IS discipline.

3.9 Boundary Spanning as a "Balance" Between BIS and TIS

Recognizing that the clustering of journals is less than exact, we calculated boundary spanning for each journal in such a way that is indifferent to the clustering boundaries. For each journal, we report the relative balance between BIS and TIS indegree and outdegree citations with a value from 0.0 (which indicates no balance with all citations to or from either BIS or TIS) to 1.0 (which indicates equal balance with the same number to or from the same orientation). In other words, the higher the value of these measures, the more one can consider that journal a boundary-spanning journal. We calculated these values separately for both indegree and outdegree citations. We normalized the values for the number of journals in each cluster by means of the percentage of (other) cluster members that are cited or that cite each journal.

3.10 Interpreting the Cohesion Measures

Our cohesion measures are rigorous but lack definitive decision rules. Thus, we had to make judgment calls. Specifically, we determined cohesion across BIS and TIS if:

1) The sampled journals comprised only one component
2) Many journals had to be removed in order to split the one component into BIS and TIS components
3) Balance across BIS and TIS was not zero, and
4) Many journals were quite to very highly balanced across the orientations.

We determined fragmentation across BIS and TIS if:

1) The sampled journals comprised two or more components, one of which was BIS and the other(s) was TIS

2) In the possible case of only one component, few journals had to be removed in order to split it into BIS and TIS components
3) Balance among the journals was bimodal, with almost all journals substantially cross-citing only within one orientation, and
4) Few journals played boundary-spanning roles.

A clear decision rule for determining fragmentation is possible with our measures of boundary-spanning. Specifically, fragmentation between BIS and TIS journals would be reflected in measures, for a value of zero, for both the boundary-spanning balance and dyadic crossing Thus, we calculated the 95 percent confidence intervals to determine whether or not they included zero. We also reported the upper end of confidence intervals, which provided a sense of the extent of cohesion (if any). Because individually the criteria lack established decision rules, an ultimate conclusion depended on whether the preponderance pointed clearly towards cohesion or toward fragmentation.

3.11 Determining Robust Ties

We adopted the SNA construct of Simmelian ties, or triadic cliques, in which ties are reciprocal, strong (in our context, strong means each dyad has at least two cross-citations in each direction) and triadic (Krackhardt, 1999; Tortoriello & Krackhardt, 2010)[2]. We recognize that researchers have scarcely explored Simmelian ties for their effects among journals (Borgman and Rice (1992) have conducted the only analogous study). However, based on studies of Simmelian ties in organizational contexts, we have reason to believe that the presence of a third shared tie has two important consequences *when they also cross social boundaries*. First, they have a constraining effect partly because, when boundaries span triadic ties, the spanner must conform to the norms of both sides of the boundary (Krackhardt, 1999). In the present case, they would require journals to conform to norms of both technical and behavioral journals, which we assume to be somewhat distinct[3]. Second, in these cases, the spanner develops shared understandings with (in our case) both BIS and TIS approaches (Tortoriello & Krackhardt, 2010). Because only one citation might be made for a myriad of idiosyncratic reasons, we consider a tie Simmelian if it is reciprocal, triadic, and made up of at least two citations in each direction.

We explore increasingly strong Simmelian ties with at least three, at least four, and at least five reciprocal triadic cross-citations in each direction. Because these cross-citations are reciprocal, the number or ties in the triads of journals for the three levels of strength is ≥ 12, ≥ 18, ≥ 24, and ≥ 30, respectively[4]. The increasing robustness of the Simmelian ties is meant to capture the robustness with which BIS and TIS are cohesive. We expect that cohesion in BIS journals will exceed that of cohesion between BIS and TIS journals and vice versa. By increasing the stringency of our Simmelian measures, we seek the deeper structure of cohesion in IS.

4 Results

4.1 Visual Representations

One can express cross-citation data in matrix form, but they become more intuitively understandable when represented visually. As Zhu and Watts (2010, p. 327) argue: “visual representations enable better comprehension of [network] information than when it is represented using text” or tables. Therefore, we created visual images using NetDraw (Borgatti, 2002) and its “spring embedding” facility. The first image (see Figure 1) shows the cross-citation matrix[5]. In the figure, squares indicate BIS journals, and crosses in these squares indicate a basket of eight journal. Triangles indicate TIS journals. The TIS journals most appear on the left and the BIS mostly appear on the right.

[2] Tortoriello and Krackhardt (2010) regard the extension of dyads to triads and tie strength as constitutive of Simmelian ties. UCINET has a routine in the cohesion group for Simmelian ties.
[3] If they were not at least somewhat distinct, we would not expect to see the concern in works such as Lowry et al. (2013) to exclude the more technical journals from comparison with the behavioral journals that they regard as exclusively “IS” journals.
[4] As with all cross-citations in this study, all must occur in 2014 journal papers that cite 2012-2013 journal papers. For this reason, we regard these levels as large enough to represent strong ties.
[5] The graphic results of spring embedding results are similar to those of MDS but are somewhat easier to interpret (Bernroider, et al., 2013; Hanneman & Riddle, 2005).

4.2 Clusters

A four-cluster solution had the best fit with an R^2 of 0.440. Table 2 lists the journals with their clusters. We list the TIS journals alphabetically first and the BIS journals alphabetically second. The four clusters include the BIS journals plus three clusters of technology journals. We need to focus only on the BIS-TIS distinction to answer RQ1. However, distinctions in TIS are relevant for our other questions, so we label them as knowledge and data management (KD), computer networking (CN), and health informatics (HI). We mark BIS journals as behavioral (BEH)[6]. For a recent study of the subdisciplines in the technical IS orientations, see Zhu and Yan (2015).

4.3 Research Question 1: Overall Cohesiveness

Figure 1, which shows the cross-citations among all 98 journals, suggests that the set might be cohesive. Not surprisingly, both the BIS journals and TIS journals tended to cluster together with themselves. However, the entire sets of journals were tightly intertwined: many journals appeared somewhere in the middle of the two IS orientations.

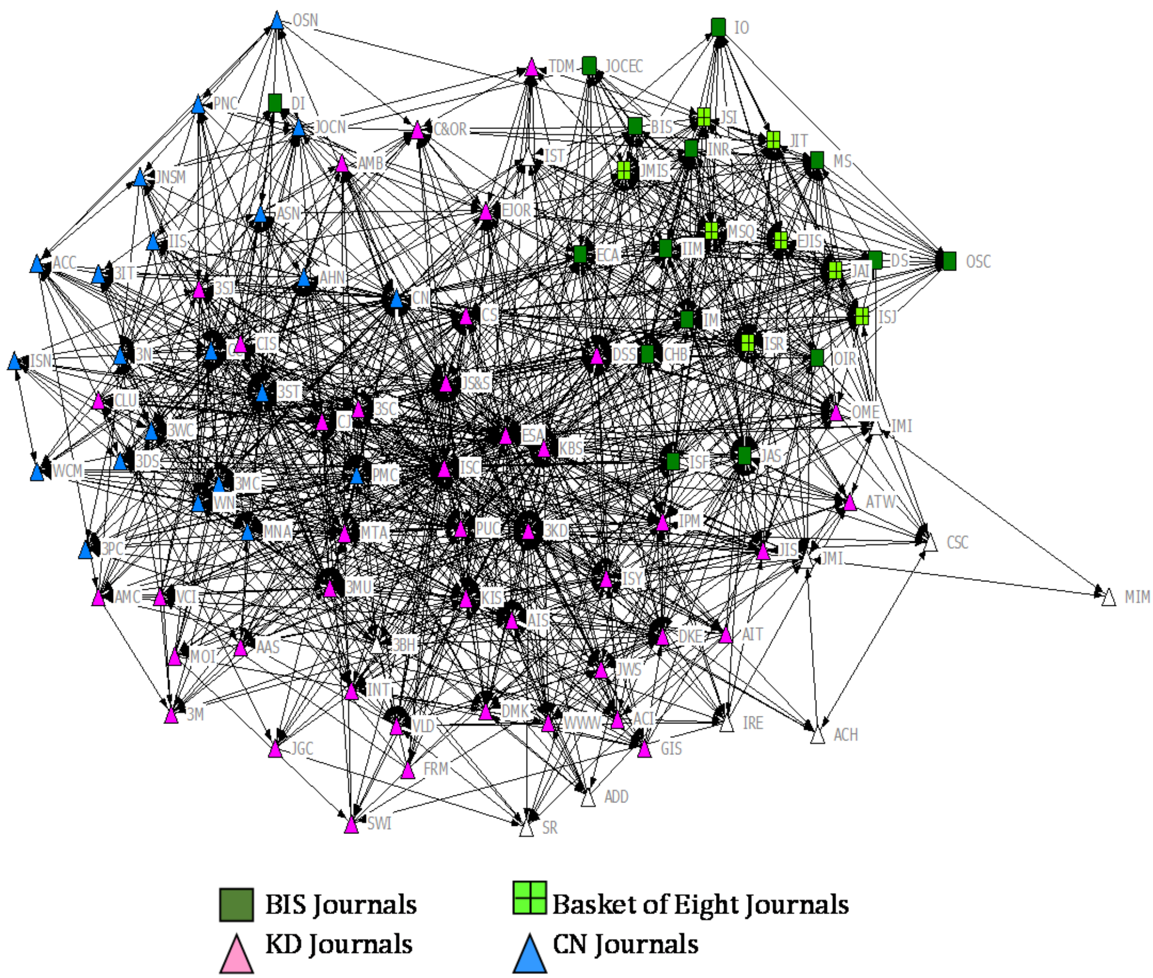

Figure 1. Cross-citations among 98 IS and IS-related Journals, 2014 Citing 2012-2013

Table 3 reports various measures of cohesion. The full set of 98 IS journals, which includes 20 BIS and 78 TIS representatives, comprised only one component. Because the component was strong, every journal had a path through outdegree citations to every other journal and also a path through indegree citations from every other journal. We found that we needed to remove a minimum of 13 journals, which account

[6] An anomalous categorization is *Digital Investigation* as a BEH journal despite its being much more tied to KD journals. Because this was the only clear anomaly, we elected to maintain a consistent use of the Tabu search results.

for a total of 231 reciprocated ties, in order to split the matrix into two strong components (i.e., one weak component).

We report matrix density in two ways. The mean cross-citations among potential ties, at 0.42, refers to the average number of cross-citations between *ij* and *ji*—that is, for any possible citation sent or received. Thus, we derived this measure from the valued matrix. The other measure of density, at 0.15, refers to the actual ties relative to potential ties. We derived it from the matrix dichotomized at if > 0, 1.

This result of 0.15 compares with a density (in the same sense) of 0.03 that Franceschet (2012) found among 6,702 journals. However, Franceschet examined a cited time period that was two-and-a-half times longer. Nonetheless, the difference in these densities seems low considering the huge sample in Franceschet's study. Similarly, the average path distance that Franceschet found was 2.4, which is not much longer than the 2.1 path distance we found. However, Franceschet's study included science journals with spectacular indegrees and outdegrees. For example, over half of the journals in Franseschet's sample cited the journal *Science* (3,697) and *Proceedings of the National Academy of Science* (3,640). Thus, it is difficult to know how to place the density and distance figures in a comparative context. However, with the findings so far we can report that we do not find evidence of fragmentation and that we do find an extensive set of inter-connections which provide evidence that the overall IS discipline might be cohesive.

Table 2. BIS-TIS Balance Among 98 IS and IS-related Journals

Journal	Abbrev.	Clust	Out bal	In bal	Av bal	DyOut	DyIn
Business & Information Systems Engineering	*BISE*	BEH	0.545	0.533	0.539	7	2
Computers in Human Behavior	*CHB*	BEH	0.573	0.509	0.541	20	8
Decision Sciences	*DS*	BEH	0.714	0.667	0.690	4	5
*Digital Investigation**	*DI*	BEH	0.000	0.222	0.111	3	7
Electronic Commerce Research and Applications	*ECRA*	BEH	0.897	0.560	0.728	8	7
European Journal of Information Systems	*EJIS*	BEH	0.226	0.182	0.204	5	4
Information & Management	*I&M*	BEH	0.468	0.490	0.479	8	9
Information and Organization	*I&O*	BEH	0.000	0.154	0.077	0	1
Information Systems Frontiers	*ISF*	BEH	0.818	0.462	0.640	12	9
Information Systems Journal	*ISJ*	BEH	0.000	0.400	0.200	0	5
Information Systems Research	*ISR*	BEH	0.200	0.436	0.318	3	12
International Journal of Information Management	*IIM*	BEH	0.633	0.529	0.581	9	5
Internet Research	*INR*	BEH	0.467	0.333	0.400	5	2
Journal of Information Technology	*JIT*	BEH	0.103	0.205	0.154	2	3
Journal of Management Information Systems	*JMIS*	BEH	0.233	0.390	0.312	4	3
Journal of Organizational Computing and Electronic Commerce	*JOCEC*	BEH	0.923	0.000	0.462	5	0
Journal of Strategic Information Systems	*JSIS*	BEH	0.114	0.381	0.248	1	3
Journal of the American Society for Information Science and Technology	*JASIST*	BEH	0.538	0.791	0.665	17	12
Journal of the Association for Information Systems	*JAIS*	BEH	0.320	0.098	0.209	7	2
Management Science	*MS*	BEH	0.364	0.820	0.592	4	6
MIS Quarterly	*MISQ*	BEH	0.188	0.215	0.201	3	7
Online Information Review	*OIR*	BEH	0.667	0.000	0.333	9	0
Organization Science	*OSC*	BEH	0.000	0.095	0.048	0	2
ACM SIGCOMM Computer Communication Review	*ACCR*	CN	0.000	0.000	0.000	0	0
ACM Transactions on Sensor Networks	*ATOSN*	CN	0.000	0.105	0.053	0	1
Ad Hoc Networks	*AHN*	CN	0.038	0.000	0.019	1	0
Computer Communications	*CC*	CN	0.000	0.000	0.000	0	0

Table 2. BIS-TIS Balance Among 98 IS and IS-related Journals

Computer Networks	*CN*	CN	0.170	0.022	0.096	9	1
IEEE Communications Surveys and Tutorials	*I3ST*	CN	0.000	0.027	0.014	0	1
IEEE Network	*I3N*	CN	0.000	0.000	0.000	0	0
IEEE Pervasive Computing	*I3PC*	CN	0.000	0.000	0.000	0	0
IEEE Transactions on Dependable and Secure Computing	*I3TDSC*	CN	0.000	0.000	0.000	0	0
IEEE Transactions on Information Theory	*I3IT*	CN	0.000	0.000	0.000	0	0
IEEE Transactions on Mobile Computing	*I3MC*	CN	0.000	0.000	0.000	0	0
IEEE Wireless Communications	*I3WC*	CN	0.000	0.028	0.014	0	1
International Journal of Information Security	*IJIS*	CN	0.200	0.250	0.225	1	1
International Journal of Sensor Networks	*IJSN*	CN	0.000	0.000	0.000	0	0
Journal of Network and Systems Management	*JNSM*	CN	0.000	0.333	0.167	0	1
Journal of Optical Communications and Networking	*JOCN*	CN	0.087	0.000	0.043	2	0
Mobile Networks and Applications	*MSA*	CN	0.000	0.056	0.028	0	1
Optical Switching and Networking	*OSN*	CN	0.141	0.000	0.070	1	0
Pervasive and Mobile Computing	*PMC*	CN	0.000	0.250	0.125	0	4
Photonic Network Communications	*PNC*	CN	0.045	0.000	0.023	1	0
Wireless Communications & Mobile Computing	*WCMC*	CN	0.000	0.087	0.043	0	1
Wireless Networks	*WN*	CN	0.000	0.000	0.000	0	0
ACM Transactions on Computer-Human Interaction	*ATOCHI*	HI	0.000	0.000	0.000	0	0
ACM Transactions on Knowledge Discovery from Data	*ATKDD*	HI	0.000	0.286	0.143	0	1
Computer Supported Cooperative Work	*CSCW*	HI	0.667	0.750	0.708	1	5
IEEE Journal of Biomedical Health and Informatics	*I3BHI*	HI	0.000	0.333	0.167	0	1
Information and Software Technology	*I&ST*	HI	0.462	0.353	0.407	5	3
Information Retrieval	*IRE*	HI	0.286	0.400	0.343	1	1
International Journal of Medical Informatics	*IMI*	HI	0.368	0.625	0.497	6	7
Journal of the American Medical Informatics Association	*JAMIA*	HI	0.222	0.213	0.217	3	5
Methods of Information in Medicine	*MIM*	HI	0.000	0.000	0.000	0	0
SIGMOD RECORD	*SIGMODREC*	HI	0.000	0.500	0.250	0	1
ACM Transactions on Autonomous and Adaptive Systems	*ATOIS*	KD	0.000	0.400	0.200	0	1
ACM Transactions on Information Systems	*ACI*	KD	0.111	0.000	0.056	1	0
ACM Transactions on Intelligent Systems and Technology	*AIS*	KD	0.182	0.129	0.155	1	2
ACM Transactions on Internet Technology	*AIT*	KD	0.400	0.000	0.200	2	0
ACM Transactions on Multimedia Computing, Communications and Applications	*ATOMM*	KD	0.000	0.000	0.000	0	0
ACM Transactions on the Web	*ATW*	KD	0.667	0.533	0.600	2	3
Cluster Computing	*CC*	KD	0.080	0.000	0.040	1	0
Computer Journal	*CJ*	KD	0.000	0.069	0.034	0	1
Computers and Operations Research	*C&OR*	KD	0.000	0.027	0.014	0	2
Computers & Security	*C&S*	KD	0.541	0.727	0.634	7	7
Data & Knowledge Engineering	*DKE*	KD	0.000	0.267	0.133	0	3
Data Mining and Knowledge Discovery	*DMKD*	KD	0.000	0.105	0.053	0	1

Table 2. BIS-TIS Balance Among 98 IS and IS-related Journals

Decision Support Systems	*DSS*	KD	0.905	0.759	0.832	17	15
European Journal of Operational Research	*EJOR*	KD	0.246	0.091	0.168	4	5
Expert Systems with Applications	*ESA*	KD	0.098	0.222	0.160	9	6
IEEE Multimedia	*I3MM*	KD	0.000	0.000	0.000	0	0
IEEE Systems Journal	*I3SJ*	KD	0.000	0.000	0.000	0	0
IEEE Transactions on Knowledge and Data Engineering	*I3KD*	KD	0.036	0.132	0.084	1	6
IEEE Transactions on Multimedia	*I3TOM*	KD	0.000	0.019	0.010	0	1
IEEE Transactions on Services Computing	*I3SC*	KD	0.211	0.143	0.177	2	3
Informatica	*INF*	KD	0.000	0.000	0.000	0	0
Information Processing & Management	*IPM*	KD	0.364	0.483	0.423	4	5
Information Sciences	*ISC*	KD	0.053	0.067	0.060	7	4
Information Systems	*ISY*	KD	0.261	0.194	0.227	2	2
International Journal of Geographical Information Science		KD	0.167	0.000	0.083	1	0
International Journal of Information Technology & Decision Making	*TDM*	KD	0.000	0.200	0.100	0	2
International Journal on Semantic Web and Information Systems	*IJSWIS*	KD	0.000	0.000	0.000	0	0
Journal of Ambient Intelligence and Smart Environments	*JAISE*	KD	0.000	0.000	0.000	0	0
Journal of Grid Computing	*JGC*	KD	0.286	0.000	0.143	1	0
Journal of Information Science	*JIS*	KD	0.703	0.941	0.822	3	5
Journal of Intelligent Information Systems	*INT*	KD	0.000	0.000	0.000	0	0
Journal of Systems and Software	*JS&S*	KD	0.182	0.105	0.144	3	4
Journal of Visual Communication and Image Representation	*JVCIR*	KD	0.059	0.000	0.029	1	0
Journal of Web Semantics	*JOWS*	KD	0.000	0.316	0.158	0	2
Knowledge and Information Systems	*KIS*	KD	0.000	0.107	0.054	0	1
Knowledge-Based Systems	*KBS*	KD	0.086	0.115	0.100	7	8
Mobile Information Systems	*MOIS*	KD	0.000	0.000	0.000	0	0
Multimedia Tools and Applications	*MTA*	KD	0.000	0.041	0.020	0	1
Omega - International Journal of Management Science	*OMEG*	KD	0.145	0.092	0.119	3	4
Personal and Ubiquitous Computing	*PUC*	KD	0.080	0.340	0.210	2	5
Science China - Information Sciences	*SCIS*	KD	0.038	0.000	0.019	1	0
VLDB Journal	*VLDB*	KD	0.000	0.000	0.000	0	0
World Wide Web-Internet and Web Information Systems	*WWW*	KD	0.143	0.200	0.171	1	1
					Sum	250	250

Legend: BEH: behavioral, CN: computer networking, HI: health informatics, and KD: knowledge discovery.

Thus, for RQ1, we found that the sample of 98 IS and IS-related journals reflects a heterogeneous but nonetheless cohesive discipline. It comprises three main clusters—behavioral (BEH), computer networking (CN), and knowledge and data management (KD)—plus a small cluster of health informatics (HI). Although one can differentiate these clusters, several measures support the sample's cohesiveness, which results from extensive cross-citations across the BIS and TIS orientations.

Table 3. Measures of Cohesion for 98 IS and IS-related Journals

Number of strong components	1
Minimum journals to remove to split the component	13
Reciprocated ties thereby also removed	231
Density (actual/potential ties)	0.15
Density (mean cross-citations among potential ties)	0.42
Average distance (path length) between journals	2.11
Journals with BIS-TIS cross-citations	55

Note: reciprocated ties removed are those associated with the 13 journals. These ties are the minimum one needs to remove to split the strong component into a weak component.
Density measured by actual over potential ties is based on the matrix dichotomized at if ij>0, then 1.
Density measured by the valued matrix is the average entry among the 9,506 (98^2 -98) cells. As with all other measures, density refers to one year of citations that cite the prior two years. With a longer time-period, these numbers would naturally be higher.
BIS-TIS cross-citations may be one-directional.

4.4 Research Question 2: Boundary-spanning Journals and the Balance between BIS and TIS Orientations

Table 2 (above) reports the balance between BIS and TIS cross-citations for each journal. The table lists the journals alphabetically in clusters. We gave them a score of 1 for equal cross-citations of each type and zero for complete dominance by either BIS or TIS. For example, imagine a BIS journal with 12 sent citations, nine to other BIS journals and three to TIS journals. We would have scored this journal 0.5 because three is half of the number six that would have made these citations equally balanced between BIS and TIS. As an intuitive indicator of balance, the table also reports for each journal the number of dyadic ties that cross the BIS-TIS border. The bottom rows of the table report the average score and the 95 percent confidence intervals for the four clusters and for the sample as a whole.

In Table 4, we report the means and 95 percent confidence intervals for the data in Table 2 and add parallel results for the balance results calculated on a journal-to-journal basis (Table 3 calculations are on a paper-to-paper basis). The confidence intervals permit some inferences about cohesion. The paper basis is more conservative. With the unadjusted citations, the minimum of the interval for the 98 journal confidence intervals was never zero: the lowest was 0.131. There was only one negative minimum among the cluster figures for the outdegree boundary-spanning dyads for computer networking journals.

The confidence intervals, which are based on small *n*s, were, hence, quite wide. For example, the CN minimum would always be non-negative if it had an *n* of 31 rather than 22. The confidence intervals were considerably wider for the adjusted paper results. The table shows the greater variance with these data. As we note above, we regard the rationale for the adjusted data to be weak. Nonetheless, we cannot reject the possibility of widespread fragmentation if we regard the adjusted data as indicative.

The 98 journals had 250 boundary-crossing dyads. More than half (55) of the journals had at least one boundary-crossing tie, which suggests that boundary spanning between TIS and BIS journals is far reaching though not uniform. Figure 2 depicts these connections. This figure also foreshadows results noted below regarding which individual journals and which types of journals were particularly important in connecting BIS and TIS orientations. For example, we see only six of the 23 CN journals had boundary-crossing ties. In summary, for RQ2, we found that, although boundary spanning between behavioral and technical journals appears to be widespread in the IS discipline, it is not uniform. Rather, overall cohesiveness is based on a bridging role that certain journals play.

4.5 Research Question 3: Which Types of Journals are Most Balanced?

Table 5 reports the percentage of journals exceeding three (arbitrary) thresholds of 0.20, 0.33, and 0.5 for the four clusters, TIS journals (made up of three clusters), and the sample as a whole. This table shows that, for the whole sample and for the KD cluster, over half of the sample reached the modest balance level of 0.2 and over 1/5 the level of 0.33. The HI cluster was highly balanced regarding indegrees, although we should recall its small *n*. As we saw with Table 4, the BEH cluster was the most balanced in that over 4/5 exceeded 0.2, over half exceeded 0.33, and over 1/3 exceeded 0.5[7]. The CN cluster was scarcely at all balanced in this sense of citations to or from BIS journals and other TIS journals.

We infer that, in terms of cross-citations across the BIS-TIS boundary, the IS discipline is not fragmented. Of course, it is also not fully cohesive. Such a result would mean that BIS journals were just as likely to cite and be cited by TIS journals as by BIS journals and vice versa. The upper limits of the confidence intervals give an overall sense of the extent of cohesion.

When we compare the minimum of the 95 percent confidence interval for the BEH journals with the maximum of the confidence intervals of the CN and KD clusters, we see that the latter fall short of the former in all measures. Therefore, we conclude that the BEH cluster is significantly more balanced than the two larger TIS clusters and is as likely to cite TIS journals as BIS journals. The small TIS cluster, HI, fell short of the BEH balance in that only its outward boundary crossed dyads[8]. For RQ 3, we conclude that the BEH journals are significantly more balanced regarding the BIS-TIS distinction than the other journals.

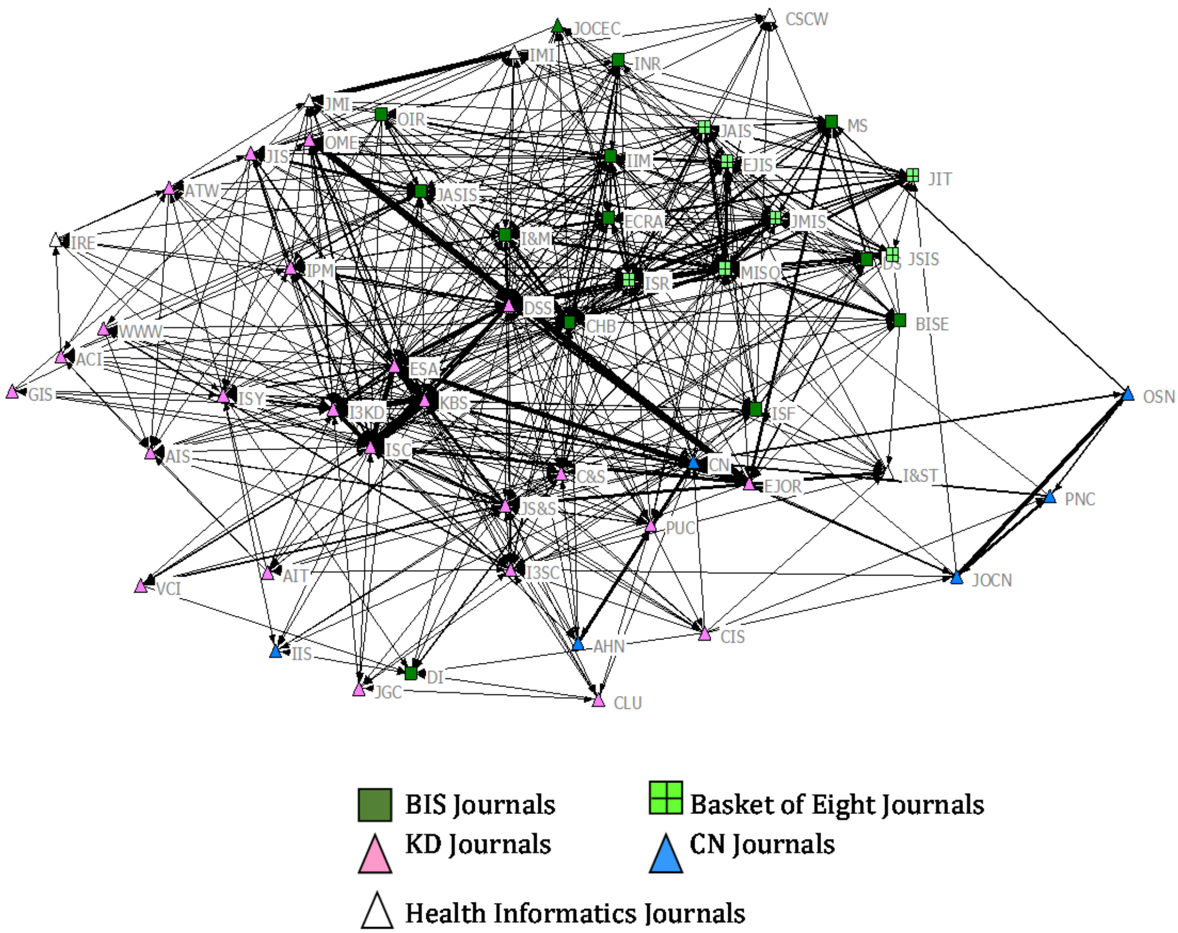

Figure 2. Cross-citations among 55 Boundary-crossing IS and IS-related Journals, 2014 Citing 2012-2013

4.6 Research Question 4: Increasing Level of Tie Strength

Figures 3, 4, 5, and 6 show Simmelian ties—triadic and reciprocal—with strength measured by increasing levels of ties with a range of ≥ 12 to ≥ 30 ties. The triple requirements of triadic ties, reciprocity, and

[7] A post hoc explanation for the greater tendency of BIS journals to cite TIS journals than the reverse is that depictions of rationale and method in technology studies require less explanation or justification (and, therefore, fewer citations) than social science writings (Lariviere, Archambault, Gingras, & Vignola-Gagne, 2006). Thus, they can focus on more narrow topics with an assurance that readers would understand their place in advancing knowledge.

[8] Bearing in mind the *n* of only 10 for the HI journals, it may be that it would be significantly less balanced with a larger sample.

strength, separately and in combination, indicate greater robustness in connections than those in the results we report above. The above results may be based on dyadic, one-directional, single citation ties. We explore increasingly stringent requirements for tie strength to see whether BIS and TIS journals start to separate at deeper levels of cohesion. We also see which journals, if any, account for overall cohesion by virtue of playing boundary-spanning roles.

Table 6 shows all of the Simmelian boundary-crossing ties at the first level (≥ 12) of strength. By definition, these ties are symmetrical between journals. Few journals had many such ties. *Decision Support Systems* had the most with 15 boundary-crossing Simmelian ties out of 40 total Simmelian ties (regardless of boundary crossing) followed by *Computers in Human Behavior* with seven out of 22 total. *Expert Systems with Applications*, *Journal of Management Information Systems*, and *MIS Quarterly* had three apiece out of 16, 16, and 32, respectively. *Information & Management*, *Information Systems Research*, and *Journal of the American Society for Information Science and Technology* had one each.

Other journals with at least ten Simmelian ties (non-boundary crossing) included *Knowledge-Based Systems* (28), *Omega* (26), *Information Sciences* (24), *IEEE Communications Surveys and Tutorials* (18), *European Journal of Information Systems* (14), *European Journal of Operational Research* (14), *Computer Networks* (12), *Journal of Information Technology* (12), *Computers and Operations Research* (10), *IEEE Transactions on Mobile Computing* (10), and *Journal of the Association for Information Systems* (10). The mean number of Simmelian ties (boundary crossing or not) among the 98 journals was 1.95.

Table 4. Summary of BIS-TIS Balance among 98 IS and IS-related Journals

	Out bal	In bal	Av bal	DyOut	DyIn
Unadjusted paper (valued) basis					
Average all 98 journals	0.181	0.203	0.192	2.551	2.551
Behavioral average	0.391	0.368	0.380	5.913	4.957
Computer networks average	0.031	0.053	0.042	0.682	0.545
Health informatics average	0.200	0.346	0.273	1.600	2.400
Knowledge and data management average	0.140	0.159	0.150	1.930	2.326
Confidence intervals					
All 98 journals, low	0.131	0.156	0.148	1.771	1.934
All 98 journals, high	0.230	0.250	0.236	3.331	3.168
Behavioral, low	0.269	0.274	0.293	3.829	3.533
Behavioral, high	0.513	0.463	0.467	7.997	6.380
Computer networks, low	0.005	0.012	0.016	-0.127	0.164
Computer networks, high	0.057	0.093	0.067	1.491	0.926
Health informatics, low	0.051	0.196	0.136	0.193	0.876
Health informatics, high	0.350	0.496	0.411	3.007	3.924
Knowledge and data management, low	0.076	0.091	0.088	0.958	1.427
Knowledge and data management, high	0.205	0.227	0.212	2.903	3.224
Journal (dichotomized) basis					
Average all 98 journals	0.266	0.283	0.275	Same as paper basis	
Behavioral average	0.556	0.529	0.543		
Computer networks average	0.068	0.078	0.073		
Health informatics average	0.343	0.411	0.377		
Knowledge and data management average	0.186	0.224	0.205		
Confidence intervals					
All 98 journals, low	0.202	0.225	0.219		

Table 4. Summary of BIS-TIS Balance among 98 IS and IS-related Journals

All 98 journals, high	0.331	0.340	0.330		
Behavioral, low	0.410	0.409	0.435		
Behavioral, high	0.701	0.650	0.650		
Computer networks, low	0.014	0.027	0.036		
Computer networks, high	0.123	0.128	0.110		
Health informatics, low	0.093	0.229	0.168		
Health informatics, high	0.593	0.593	0.586		
Knowledge and data management, low	0.118	0.151	0.139		
Knowledge and data management, high	0.254	0.298	0.271		
Adjusted paper (valued) basis					
Average all 98 journals	0.153	0.203	0.178		
Behavioral average	0.344	0.368	0.356		
Computer networks average	0.026	0.053	0.039		
Health informatics average	0.137	0.346	0.242		
Knowledge and data management average	0.121	0.159	0.140		
Confidence intervals					
All 98 journals, low	-0.076	-0.035	-0.026		
All 98 journals, high	0.383	0.441	0.382		
Behavioral, low	0.055	0.136	0.162		
Behavioral, high	0.632	0.600	0.550		
Computer networks, low	-0.027	-0.045	-0.017		
Computer networks, high	0.079	0.150	0.096		
Health informatics, low	-0.027	0.104	0.062		
Health informatics, high	0.302	0.588	0.421		
Knowledge and data management, low	-0.084	-0.069	-0.055		
Knowledge and data management, high	0.325	0.386	0.335		

Note: the variance was much greater for the adjusted matrix due to the variance in papers per journal, which ranged from 26 to 2,089 (SD 281.58). The standard deviation of the raw valued matrix was 2.15, whereas it was 5.25 for the adjusted matrix, which had the effect of increasing the range of the confidence intervals.

Table 5. Percentages of BIS-TIS Balance Thresholds among the Four Clusters: Paper-to-paper Basis

Percentage of journals with a BIS-TIS balance			
	Indegree	**Outdegree**	**In and out**
At least 0.20			
BEH	73.91%	69.57%	82.61%
CN	13.64%	4.55%	4.55%
HI	80.00%	50.00%	60.00%
KD	27.91%	23.26%	20.93%
TIS (CN, HI, KD)	30.67%	21.33%	21.33%
All 98 Journals	64.29%	48.98%	52.04%
At least 0.33			
BEH	60.87%	52.17%	52.17%
CN	4.55%	0.00%	0.00%

Table 5. Percentages of BIS-TIS Balance Thresholds among the Four Clusters: Paper-to-paper Basis

HI	50.00%	20.00%	30.00%
KD	16.28%	13.95%	21.74%
TIS (CN, HI, KD)	17.33%	10.67%	10.67%
All 98 Journals	27.55%	20.41%	20.41%
At least 0.50			
BEH	30.43%	39.13%	34.78%
CN	0.00%	0.00%	0.00%
HI	20.00%	0.00%	0.00%
KD	9.30%	9.30%	9.30%
TIS (CN, HI, KD)	7.89%	5.33%	5.33%
All 98 journals	13.27%	13.27%	12.24%

At this first level of strength (see Figure 3), we see the crucial boundary-spanning role that *Decision Support Systems* (*DSS*), *Computers in Human Behavior* (*CHB*), and *Expert Systems with Applications* (*ESA*) play. Only these three journals were members of Simmelian triads in which the other two journals were from the opposite side of the BIS-TIS boundary. *DSS* had six Simmelian ties with BEH journals and seven with TIS (KD) journals. *CHB* had two Simmelian ties with TIS (KD) journals and eight with other BEH journals. *ESA* had two Simmelian ties with BEH journals and four with other TIS (KD) journals. Figure 3 also shows the crucial bridging role of *IEEE Transactions on Multimedia* (*I3MU*). This journal was the bridge between the 15 KD journals and the 13 CN journals with Simmelian ties. Because it was the only KD journal with such a bridging role and because it had such ties with only two CN journals, even at this first level of tie strength the cohesion of the whole IS discipline appears less robust than it does when we count any and all cross-citations as connections.

At the next level of tie strength (≥ 18 per triad) (see Figure 4), we see that the connection between CN and KD journals went away. *DSS* played the sole bridging role between BIS and TIS (KD) journals. Further, the KD set split into two: three OR-related journals separated from six knowledge and decision science-related journals. At the next level of tie strength (≥ 24 per triad) (see Figure 5), the only connection between BIS and TIS was the set of three Simmelian ties between *DSS* and BEH journals. At the highest level of tie strength (≥ 30 per triad) (see Figure 6), *DSS* was no longer included, and the discipline fractured into five triads. BEH, like KD, split into two. Only two basket of eight journals remain (the two most highly cited), *MIS Quarterly* and *Information Systems Research*, joined in a triad with a non-basket journal, *Management Science*. This progressive elaboration highlights how uniquely positioned CHB, ESA, and particularly DSS are in supporting cross-disciplinary knowledge exchange and research synergies.

For RQ4, we found the most Simmelian ties across the BIS-TIS border for two journals: *Computers in Human Behavior* (a BEH journal) and *Decision Support Systems* (a KD journal in the main sample but a BEH journal in the medical informatics cluster). When we examined these stronger ties, we found that these two journals, along with *Expert Systems with Applications* (a KD journal), played a unique bridging role in all three of the specialized approaches to IS that we examined: behavioral, sociotechnical, and medical informatics.

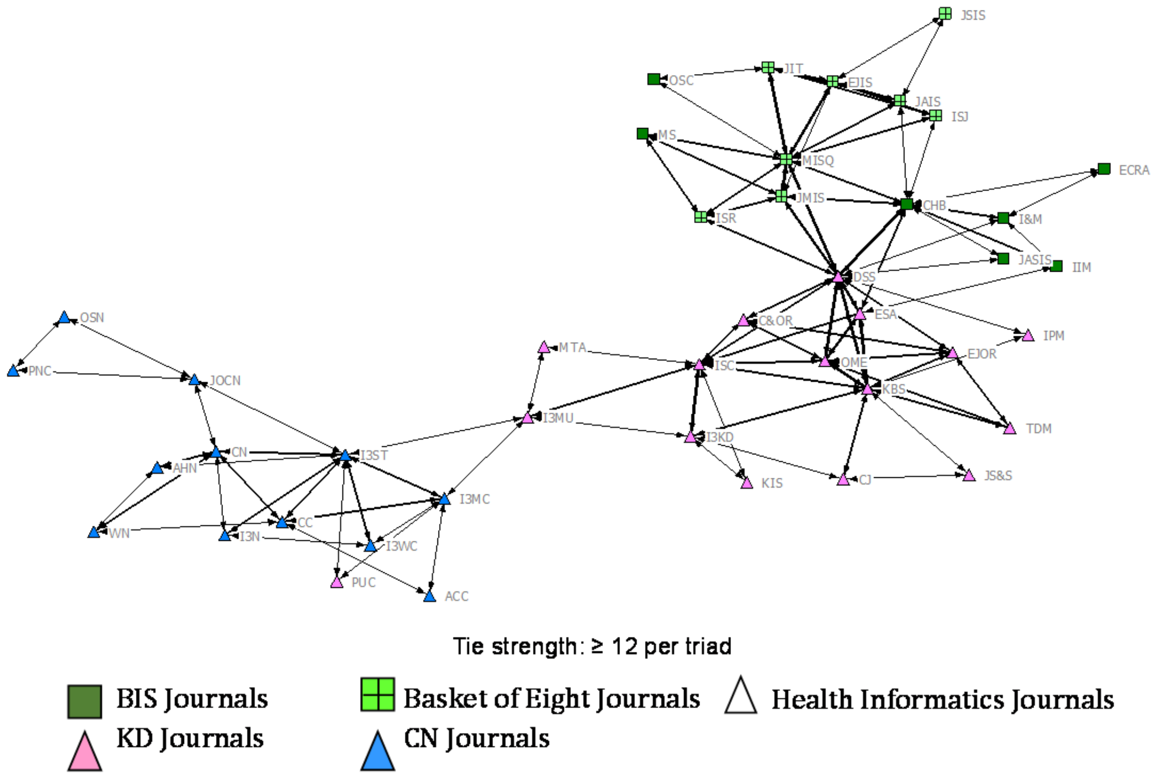

Figure 3. Fairly Strong (Simmelian) Ties Among the 43 of 98 Journals with Such Ties

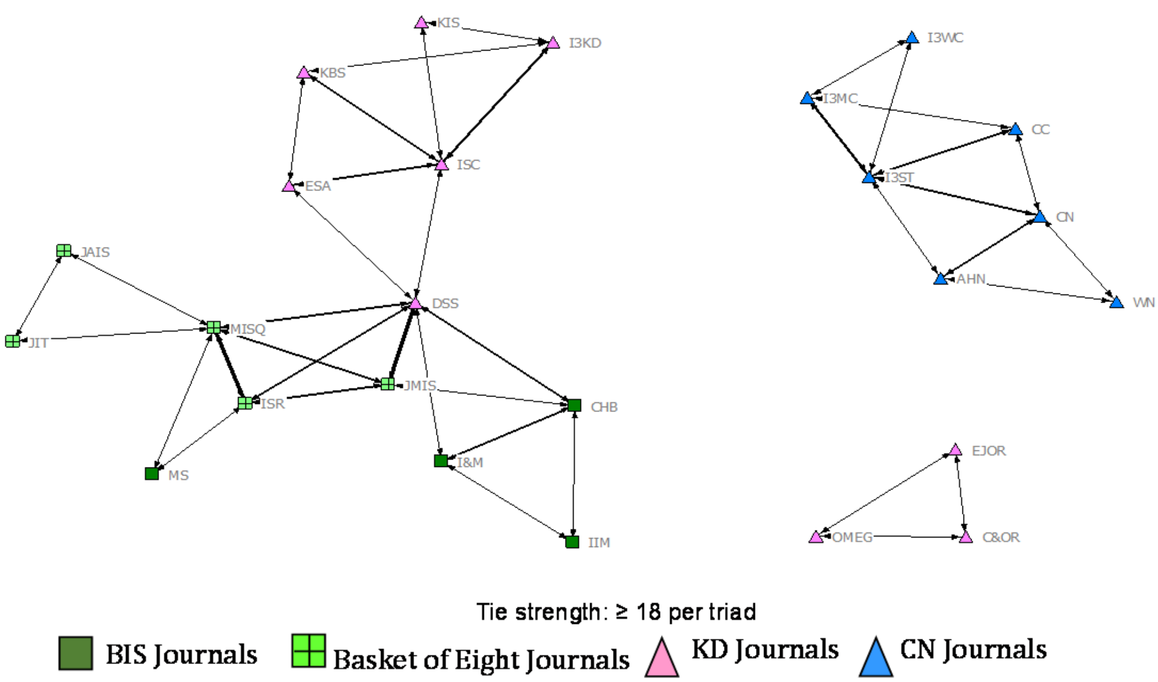

Figure 4. Strong Simmelian Ties Among the 25 Journals with Such Ties

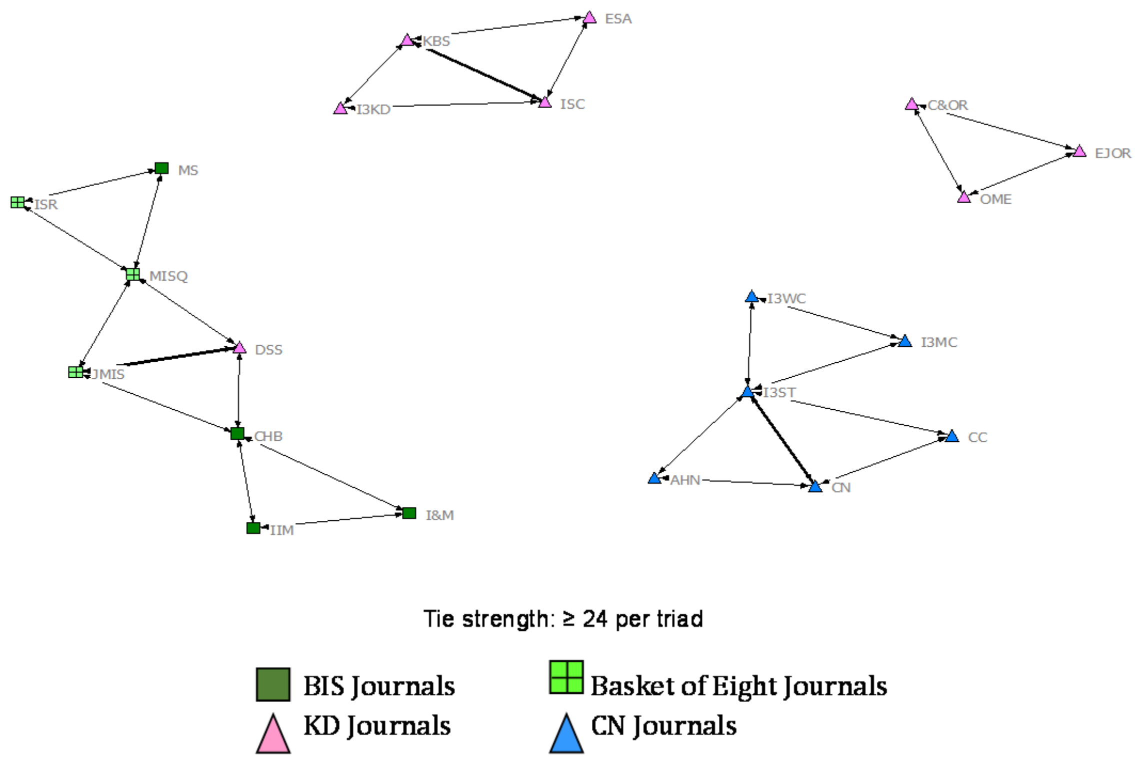

Figure 5. Stronger Simmelian Ties among the 21 Journals with Such Ties

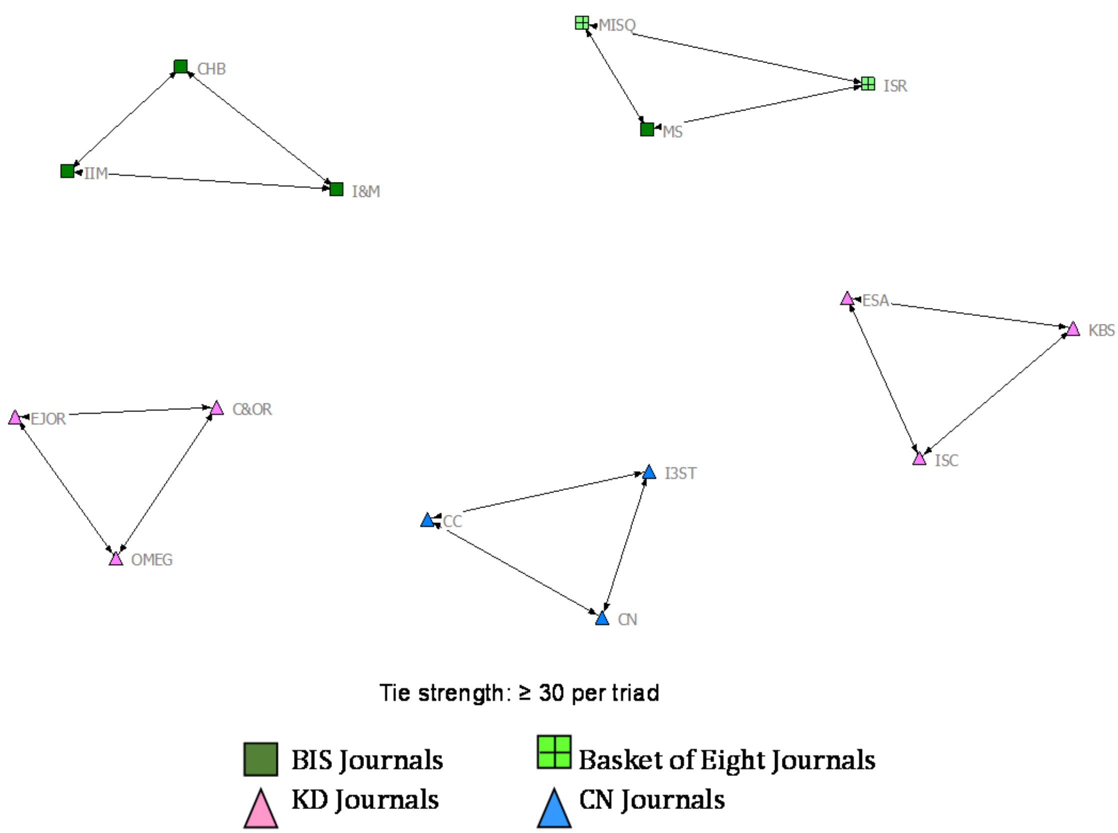

Figure 6. Stronger Simmelian Ties among the 21 Journals with Such Ties

4.7 Research Question 5: Cluster-to-cluster Connections

Table 7 reports cross-citations at the cluster level. Within-cluster numbers are cross-citations to the other journals in a cluster and, thus, do not include journal self-citations. These matrixes follow social network conventions in that the rows represent outdegrees and the columns represent indegrees. For example, one interprets the first matrix of unadjusted papers sent and received as follows: the BEH journals sent and received 1,420 papers to other BEH journals and sent nine to and received 24 from CN journals. The BEH journals sent 65.30 percent of their citations to other BEH journals and received 66.27 percent of their citations from other BEH journals. They sent 2.35 percent of their citations to CN journals and received 4.48 percent of their citations from CN journals.

No clusters had zero cross-citations to any other cluster. However, some of the cluster-to-cluster linkages were sparse. Figure 7, which shows adjusted journal-to-journal sent linkages on a percentage basis, represents the general structure of connections between the clusters. The HI cluster was moderately connected to both the BEH and the KD clusters. The more telling implication of this figure is that the KD cluster was the bridge between the BEH and the CN clusters. The BEH and CN clusters were sparsely connected. However, each was well connected with the KD cluster. Figure 8 represents the many cross-citations between the two main TIS clusters, CN and KD. This finding of the KD cluster's bridging role between BEH and CN clusters is consistent with the finding at the journal level in Figure 3, which shows the first level of Simmelian ties. In summary, findings with reference to RQ5 suggest that the KD cluster was well connected to both the BEH and the CN clusters, which were otherwise poorly connected. One can clearly see the bringing role that KD journals play in the structure of the more robust (Simmelian) ties.

Table 6. Total Cross-citations Between Clusters

Paper cross-citations				
		CN	**HI**	**KD**
BEH	1420	9	29	191
CN	24	1300	4	146
HI	18	11	288	63
KD	162	178	49	3439
Journal-to-journal cross-citations*				
As percentages of citations sent (outdegrees)				
	BEH	**CN**	**HI**	**KD**
BEH	65.30%	2.35%	16.24%	16.11%
CN	6.06%	65.02%	3.72%	25.21%
HI	20.80%	11.70%	41.86%	25.63%
KD	16.10%	22.97%	15.35%	45.58%
As percentages of citations sent (indegrees)				
	BEH	**CN**	**HI**	**KD**
BEH	66.27%	2.71%	31.58%	14.84%
CN	4.48%	54.58%	5.26%	16.91%
HI	4.78%	3.05%	18.42%	5.34%
KD	24.48%	39.66%	44.74%	62.91%
* Adjusted for the number of journals in the cluster				

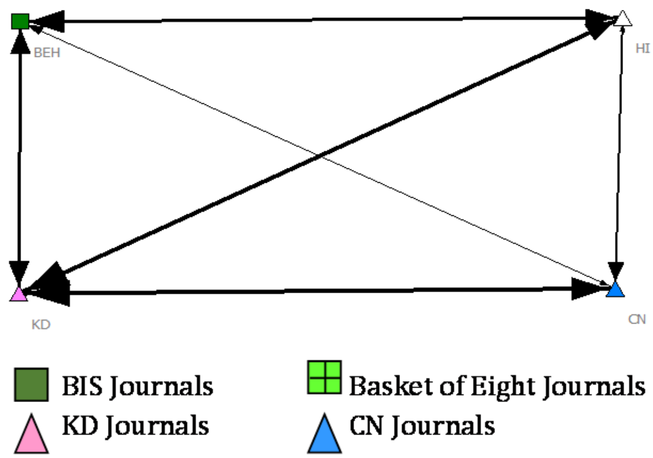

Figure 7. Percentage Journal-to-journal Cross-citations between Clusters

Cluster positions are arbitrary. The relationships are not. We adjusted the journal-to-journal cluster citations by expressing them as as percentages of the number of journals in the cluster and as the percentage of outdegrees from each journal.

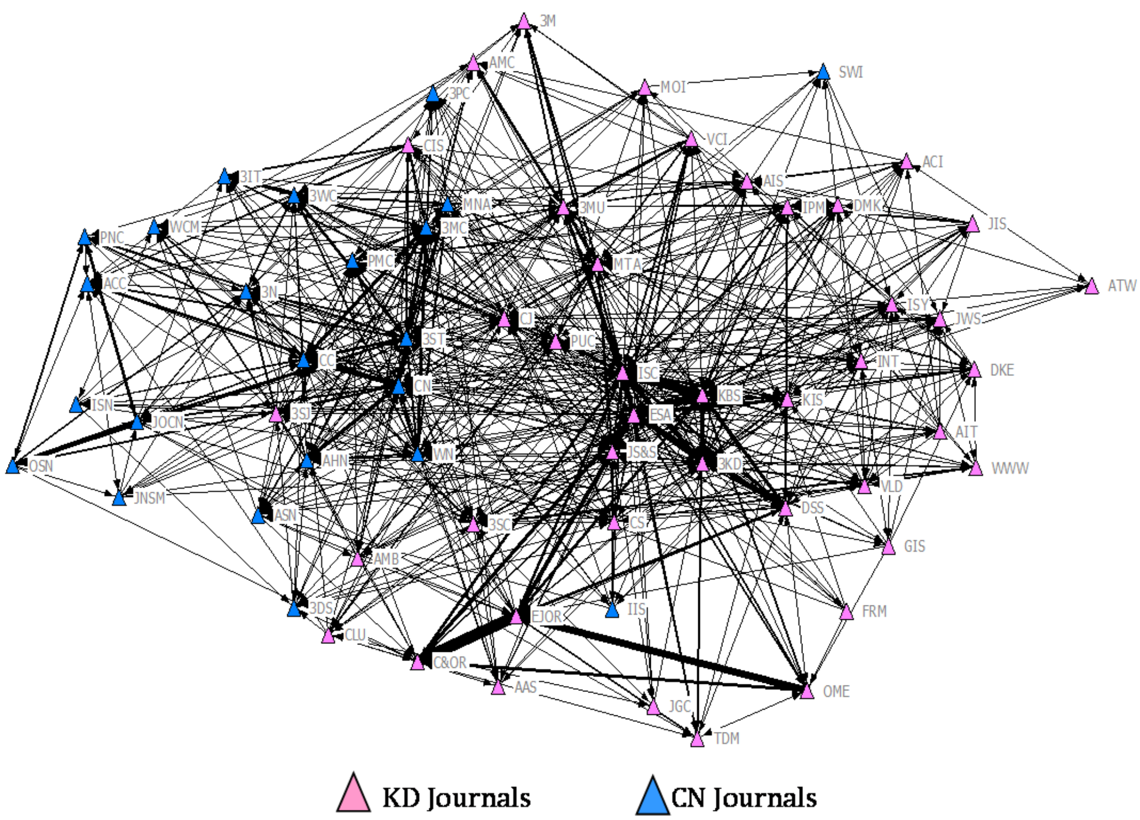

Figure 8. Cross-citations among 23 Computer Networking (CN) and 42 Knowledge and Data Management (KD) Journals

4.8 Research Question 6: Journal Lists Depending on Research Interests

Can we identify multiple subsets of IS journals appropriate for disseminating research from varying perspectives or might there be a universal and definitive list of top IS journals? We can explore this question with only one of the two main methods of determining top journals: expert opinion and citation data. Our study lacks expert opinion data but it does have citation data. Citation data are particularly useful when one can also use them to determine the extent to which journals are central in a sample of journals that is relevant to the discipline or specialty in question. Just as Lowry et al. (2013) could calculate various measures of centrality based on a cross-citation matrix, we could also do so with our data.

We calculated the indegree centrality (the number of citations received) and the outdegree centrality (the number of citations sent) by each journal in the three distinct samples. These samples reflect research interests that are behavioral, sociotechnical (i.e., concerned with the relationships between behavioral and technical phenomena), and (as an example of a technical specialty) medical informatics. Most scholars who contribute to this latter specialty are housed in health related departments. However, some are in IS departments, such as Professors Neill of Carnegie Mellon and Chen of the University of Arizona. Similarly, most IS journals—other than health and medical informatics journals—publish little in this area. However, exceptions include the *European Journal of Information Systems*, *Journal of the American Society for Information Science and Technology* (an IS-related journal), *Journal of the Association for Information Systems*, and *Journal of Information Technology*.

Tables 8-10 present the rank orders and citation counts for these three disciplines. Citations received are an unobtrusive measure of the prominence of a journal in the context of a particular set of journals. More specifically, they indicate the extent to which journals with similar concerns find the focal journal relevant. Citations sent are an unobtrusive measure of the extent to which authors in the citing journal believe that their work is related to that of the other journals. These are measures of affiliation, of belonging, to the set of journals they cite.

Figures 9 through 14 reflect the same data, but we include them to emphasize the skewness in all of the journal lists. Skewness is a well-recognized property of distributions in research (Seglen, 1992). However, skewness is not as prevalent in subdisciplines or specialties (Albarrán, Crespo, Ortuño, & Ruiz-Castillo, 2011). In the research areas of our samples, skewness was sufficiently evident that we need to consider it and not just rank order. It is particularly acute for citations received in the behavioral sample. There, the number one journal (*MISQ*) had seven times as many citations as the number ten journal (*Computers in Human Behavior*) and almost twice as many as the number two journal (*ISR*) (Table 8, Figure 9).

Table 7. Journal Degree Centrality (Directional Cross-citations) with a Focus on Behavioral IS Journals

Received by	Acronym	Citations
MIS Quarterly	*MISQ*	98
Information Systems Research	*ISR*	54
Management Science	*MS*	28
Decision Support Systems	*DSS*	24
Organization Science	*OSC*	23
Journal of the Association for Information Systems	*JAIS*	21
European Journal of Information Systems	*EJIS*	19
Journal of Information Technology	*JIT*	17
Journal of Management Information Systems	*JMIS*	15
Computers in Human Behavior	*CHB*	14
Information Systems Journal	*ISJ*	12
Information & Management	*I&M*	11
Journal of Strategic Information Systems	*JSIS*	11
Information and Organization	*I&O*	9
Business & Information Systems Engineering	*BISE*	5
Journal of the American Society for Information Science and Technology	*JASIS*	5

Table 7. Journal Degree Centrality (Directional Cross-citations) with a Focus on Behavioral IS Journals

Decision Sciences	*DS*	4
International Journal of Medical Informatics	*IMI*	4
Computers & Security	*C&S*	3
Electronic Commerce Research and Applications	*ECRA*	3
International Journal of Information Management	*IIM*	3
Journal of Systems and Software	*JS&S*	3
Computer Supported Cooperative Work	*CSCW*	2
Expert Systems with Applications	*ESA*	2
IEEE Transactions on Knowledge and Data Engineering	*I3KD*	2
International Journal of Information Technology & Decision Making	*ITDM*	2
Internet Research	*INR*	2
Journal of Information Science	*JIS*	2
Journal of Organizational Computing and Electronic Commerce	*JOCEC*	2
Journal of the American Medical Informatics Association	*JMI*	2
Personal and Ubiquitous Computing	*PUC*	2
ACM Transactions on the Web	*ATW*	1
European Journal of Operational Research	*EJOR*	1
Information and Software Technology	*I&ST*	1
Information Processing & Management	*IPM*	1
Omega - International Journal of Management Science	*OMEG*	1
Pervasive and Mobile Computing	*PMC*	1
ACM Transactions on Intelligent Systems and Technology	*AIS*	0
ACM Transactions on Internet Technology	*AIT*	0
Computer Networks	*CN*	0
Information Sciences	*ISC*	0
Information Systems Frontiers	*ISF*	0
Journal of Optical Communications and Networking	*JOCN*	0
Knowledge-Based Systems	*KBS*	0
Online Information Review	*OIR*	0
Sent by		
Computers in Human Behavior	*CHB*	49
European Journal of Information Systems	*EJIS*	38
Information & Management	*I&M*	36
MIS Quarterly	*MISQ*	35
Journal of the Association for Information Systems	*JAIS*	32
Decision Support Systems	*DSS*	31
Journal of Management Information Systems	*JMIS*	30
Information Systems Research	*ISR*	29
Journal of Information Technology	*JIT*	29
Journal of Strategic Information Systems	*JSIS*	28
International Journal of Information Management	*IIM*	26
Business & Information Systems Engineering	*BISE*	22
Information and Organization	*I&O*	16

Table 7. Journal Degree Centrality (Directional Cross-citations) with a Focus on Behavioral IS Journals

Management Science	*MS*	15
Information Systems Journal	*ISJ*	14
Computer Networks	*CN*	9
Information Systems Frontiers	*ISF*	8
Organization Science	*OSC*	7
Internet Research	*INR*	6
Information and Software Technology	*I&ST*	5
Journal of the American Society for Information Science and Technology	*JASIS*	5
Information Sciences	*ISC*	4
International Journal of Medical Informatics	*IMI*	4
Journal of Organizational Computing and Electronic Commerce	*JOCEC*	4
Computers & Security	*C&S*	3
Expert Systems with Applications	*ESA*	3
Online Information Review	*OIR*	3
Decision Sciences	*DS*	2
Electronic Commerce Research and Applications	*ECRA*	2
Information Processing & Management	*IPM*	2
Journal of Systems and Software	*JS&S*	2
ACM Transactions on Intelligent Systems and Technology	*AIS*	1
ACM Transactions on Internet Technology	*AIT*	1
ACM Transactions on the Web	*ATW*	1
Journal of Information Science	*JIS*	1
Journal of Optical Communications and Networking	*JOCN*	1
Journal of the American Medical Informatics Association	*JMI*	1
Knowledge-Based Systems	*KBS*	1
Personal and Ubiquitous Computing	*PUC*	1
Computer Supported Cooperative Work	*CSCW*	0
European Journal of Operational Research	*EJOR*	0
IEEE Transactions on Knowledge and Data Engineering	*I3KD*	0
International Journal of Information Technology & Decision Making	*ITDM*	0
Omega - International Journal of Management Science	*OMEG*	0
Personal and Ubiquitous Computing	*PMC*	0

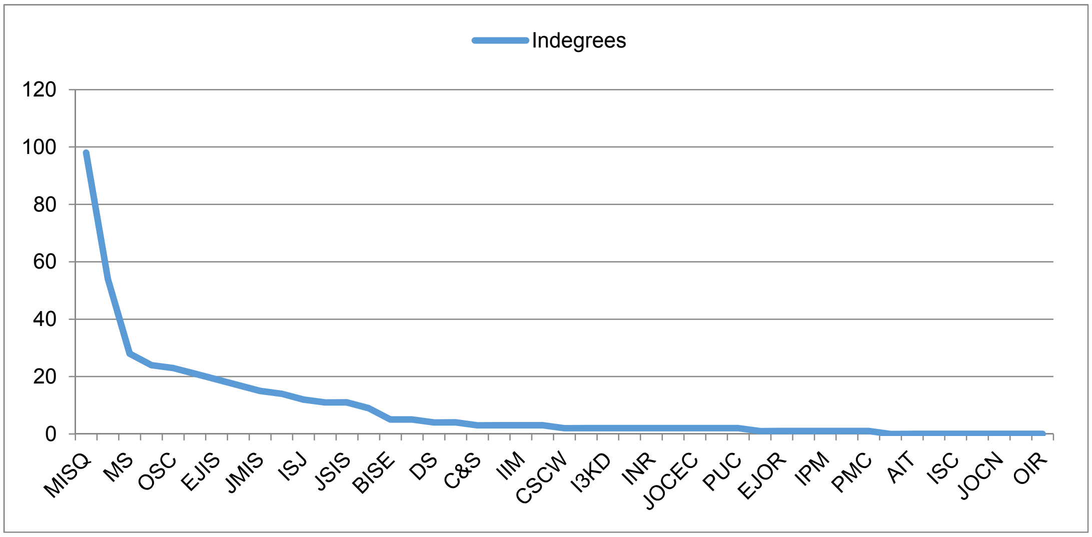

Figure 9. Indegree Centrality (Citations Received) for Behaviorally Oriented IS Journals

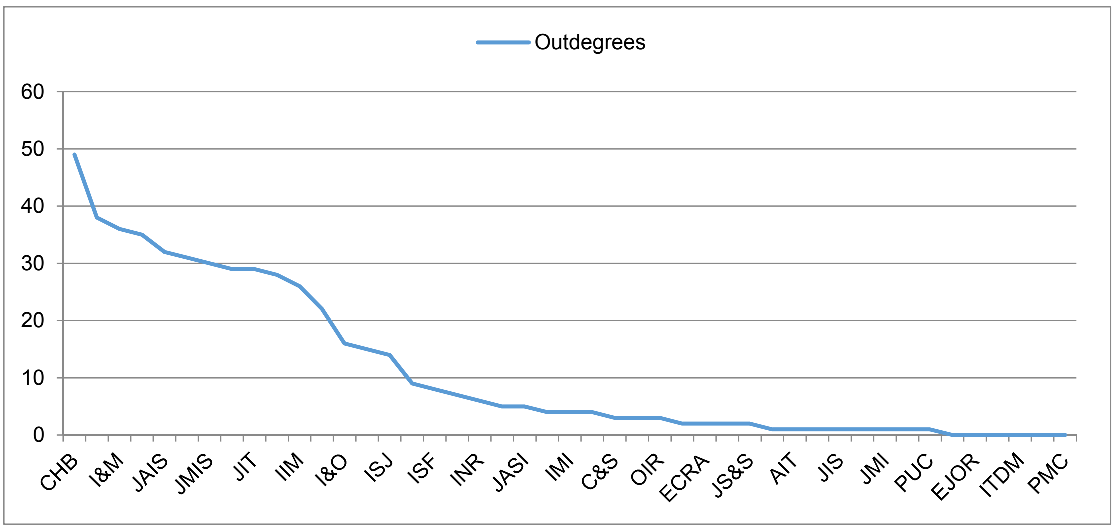

Figure 10. Outdegree Centrality (Citations Sent) for Behaviorally Oriented IS Journals

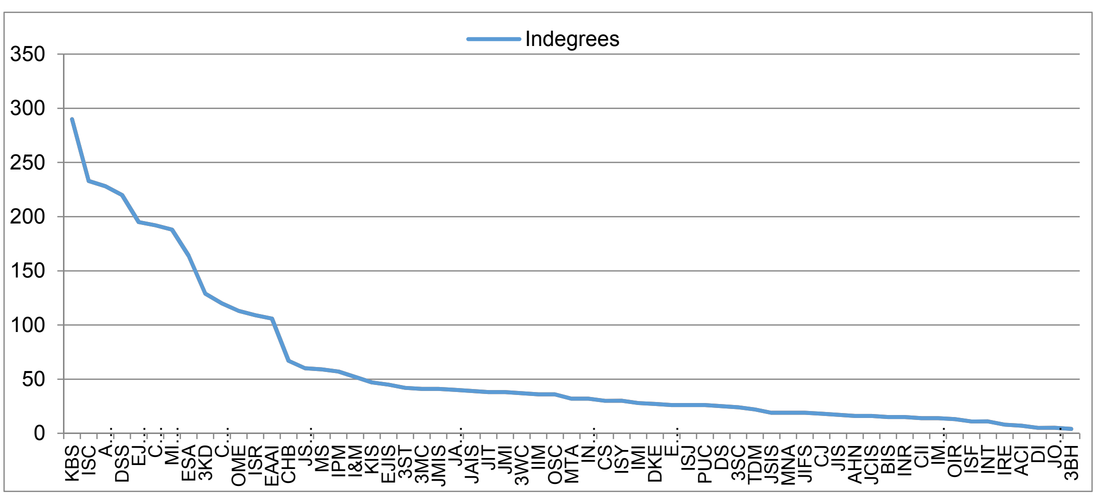

Figure 11. Indegree Centrality (Citations Received) for Boundary-crossing (Sociotechnical) IS Journals

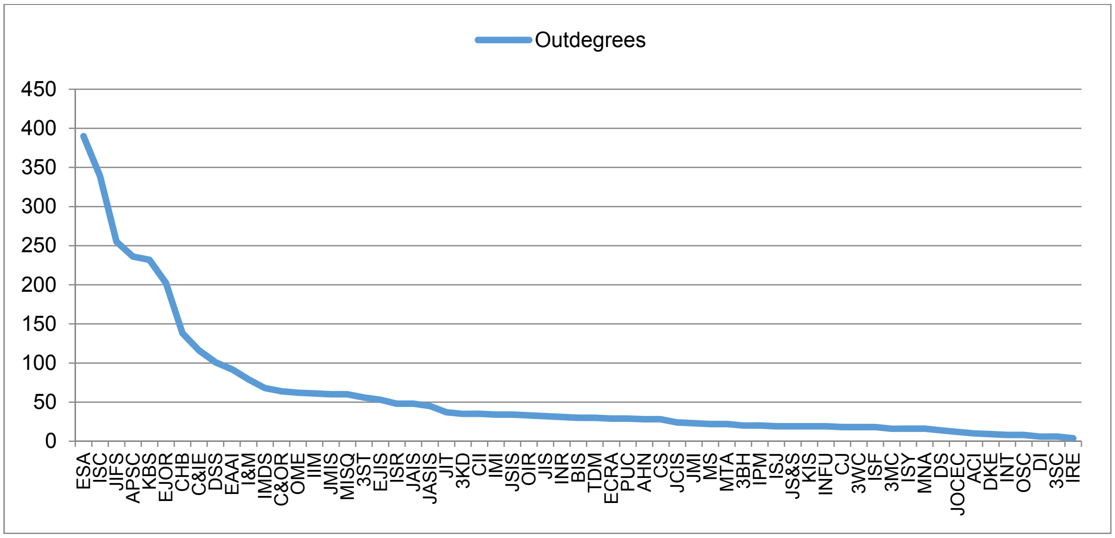

Figure 12. Outdegree Centrality (Citation Sent) for Boundary-crossing (Sociotechnical) IS Journals

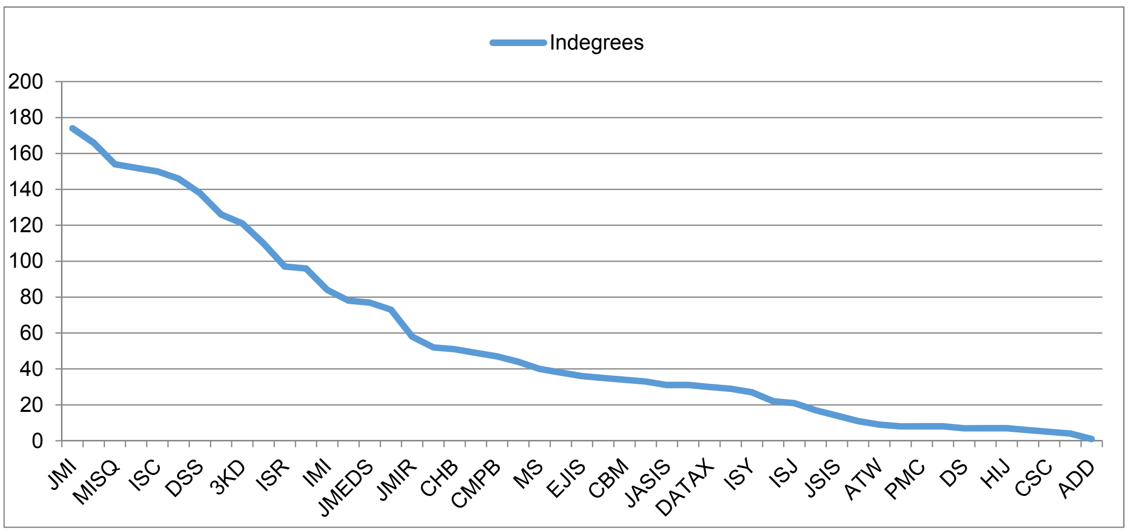

Figure 13. Indegree Centrality (Citations Received) for Medical Informatics and Connected IS Journals

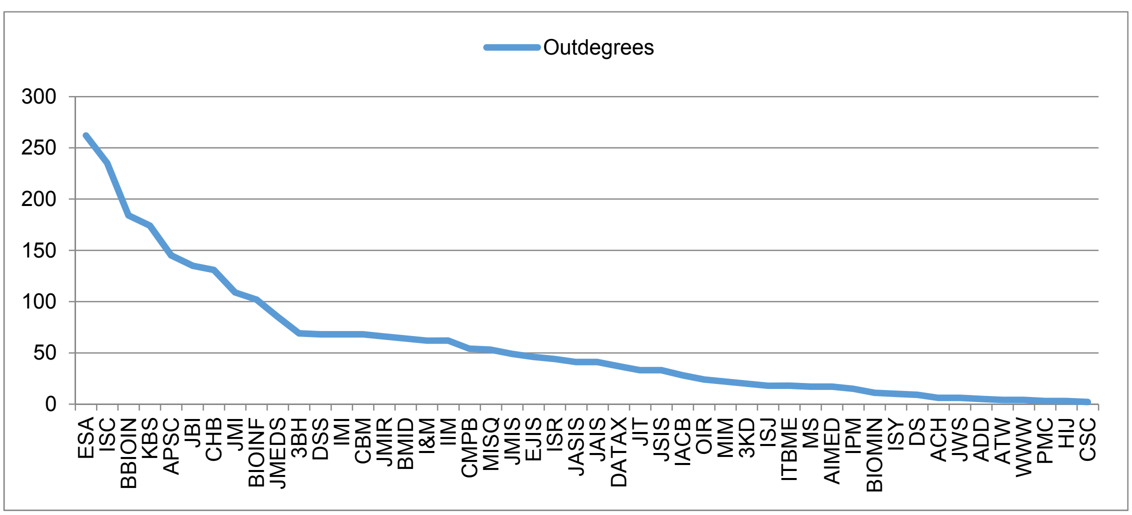

Figure 14. Outdegree Centrality (Citations Sent) for Medical Informatics and Connected IS Journals

With that behavioral sample, which was formed on the basis of citations to the basket, these journals fared unsurprisingly well in both indegree and outdegree measures. Nonetheless, for indegrees, ranks three, four, five, 10, and 12 were not in the basket and all out-ranked the lowest-ranked basket journal. For outdegrees, non-basket journals fared even better with ranks of one, three, six, 11, 12, 13, and 14. Again, these all out-rank the lowest-ranked basket journal. With the sociotechnical sample (Table 9, Figures 11 and 12), the top six journals for indegree centrality were all non-basket journals, and the lowest-ranking basket journal placed 43rd. For outdegree centrality, non-basket journals all held the top 15 ranks: the lowest-ranking basket journal also placed 43rd. With indegrees in the medical informatics sample (Table 10, Figures 13 and 14), *MISQ* ranked third but non-basket journals placed first and second and fourth through tenth. The lowest-ranking basket journal placed 37th. With outdegrees, non-basket journals held ranks one through 19, and the lowest-ranking basket journal placed 33rd. Thus, through exploring RQ6, we found that the most central journals included the basket journals. However, our findings also suggest that these journals by no means comprise a definitive forum for IS scholars—even those with a behavioral orientation. Different sets of journals are the most appropriate for different IS specialties.

Table 8. Journal Degree Centrality (Directional Cross-citations) with a Focus on Boundary-crossing (Sociotechnical) IS Journals

Received by	Acronym	Citations
Knowledge-Based Systems	*KBS*	290
Information Sciences	*ISC*	233
Applied Soft Computing	*APSC*	228
Decision Support Systems	*DSS*	220
European Journal of Operational Research	*EJOR*	195
Computers & Operations Research	*C&OR*	192
MIS Quarterly	*MISQ*	188
Expert Systems with Applications	*ESA*	164
IEEE Transactions on Knowledge and Data Engineering	*I3KD*	129
Computers & Industrial Engineering	*C&IE*	120
Omega - International Journal of Management Science	*OMEG*	113
Information Systems Research	*ISR*	109
Engineering Applications of Artificial Intelligence	*EAAI*	106
Computers in Human Behavior	*CHB*	67
Journal of Systems and Software	*JS&S*	60
Management Science	*MS*	59
Information Processing & Management	*IPM*	57
Information & Management	*I&M*	52
Knowledge and Information Systems	*KIS*	47
European Journal of Information Systems	*EJIS*	45
IEEE Communications Surveys and Tutorials	*I3ST*	42
IEEE Transactions on Mobile Computing	*I3MC*	41
Journal of Management Information Systems	*JMIS*	41
Journal of the American Society for Information Science and Technology	*JASIS*	40
Journal of the Association for Information Systems	*JAIS*	39
Journal of Information Technology	*JIT*	38
Journal of the American Medical Informatics Association	*JMI*	38
IEEE Wireless Communications	*I3WC*	37
International Journal of Information Management	*IIM*	36
Organization Science	*OSC*	36

Table 8. Journal Degree Centrality (Directional Cross-citations) with a Focus on Boundary-crossing (Sociotechnical) IS Journals

Multimedia Tools and Applications	*MTA*	32
Information Fusion	*INFU*	32
Computers & Security	*C&S*	30
Information Systems	*ISY*	30
International Journal of Medical Informatics	*IMI*	28
Data & Knowledge Engineering	*DKE*	27
Electronic Commerce Research and Applications	*ECRA*	26
Information Systems Journal	*ISJ*	26
Personal and Ubiquitous Computing	*PUC*	26
Decision Sciences	*DS*	25
IEEE Transactions on Services Computing	*I3SC*	24
International Journal of Information Technology & Decision Making	*TDM*	22
Journal of Strategic Information Systems	*JSIS*	19
Mobile Networks & Applications	*MNA*	19
Journal of Intelligent & Fuzzy Systems	*JIFS*	19
Computer Journal	*CJ*	18
Journal of Information Science	*JIS*	17
Ad Hoc Networks	*AHN*	16
Journal of Computer Information Systems	*JCIS*	16
Business & Information Systems Engineering	*BISE*	15
Internet Research	*INR*	15
Computers in Industry	*CII*	14
Industrial Management & Data Systems	*IMDS*	14
Online Information Review	*OIR*	13
Information Systems Frontiers	*ISF*	11
Journal of Intelligent Information Systems	*INT*	11
Information Retrieval	*IRE*	8
ACM Transactions on Information Systems	*ACI*	7
Digital Investigation	*DI*	5
Journal of Organizational Computing and Electronic Commerce	*JOCEC*	5
IEEE Journal of Biomedical and Health Informatics	*I3BH*	4
Sent by		
Expert Systems with Applications	*ESA*	390
Information Sciences	*ISC*	339
Journal of Intelligent & Fuzzy Systems	*JIFS*	255
Applied Soft Computing	*APSC*	236
Knowledge-Based Systems	*KBS*	232
European Journal of Operational Research	*EJOR*	202
Computers in Human Behavior	*CHB*	138
Computers & Industrial Engineering	*C&IE*	116
Decision Support Systems	*DSS*	101
Engineering Applications of Artificial Intelligence	*EAAI*	92
Information & Management	*I&M*	79

Table 8. Journal Degree Centrality (Directional Cross-citations) with a Focus on Boundary-crossing (Sociotechnical) IS Journals

Industrial Management & Data Systems	IMDS	68
Computers & Operations Research	C&OR	64
Omega - International Journal of Management Science	OMEG	62
International Journal of Information Management	IIM	61
Journal of Management Information Systems	JMIS	60
MIS Quarterly	MISQ	60
IEEE Communications Surveys and Tutorials	I3ST	56
European Journal of Information Systems	EJIS	53
Information Systems Research	ISR	48
Journal of the Association for Information Systems	JAIS	48
Journal of the American Society for Information Science and Technology	JASIS	45
Journal of Information Technology	JIT	37
IEEE Transactions on Knowledge and Data Engineering	IEKD	35
Computers in Industry	CII	35
International Journal of Medical Informatics	IMI	34
Journal of Strategic Information Systems	JSIS	34
ACM Transactions on Information Systems	ACI	10
Data & Knowledge Engineering	DKE	9
Journal of Intelligent Information Systems	INT	8
Organization Science	OCS	8
Digital Investigation	DI	6
IEEE Transactions on Services Computing	I3SC	6
Information Retrieval	IRE	4

Table 9. Journal Degree Centrality with a Focus on Medical Informatics and Related IS Journals

Received by	Acronym	Citations
Journal of the American Medical Informatics Association	*JMI*	174
Knowledge-Based Systems	*KBS*	166
MIS Quarterly	*MISQ*	154
Applied Soft Computing	*APSC*	152
Information Sciences	*ISC*	150
Bioinformatics	*BIOINF*	146
Decision Support Systems	*DSS*	138
Expert Systems with Applications	*ESA*	126
IEEE Transactions on Knowledge and Data Engineering	*I3KD*	121
Journal of Biomedical Informatics	*JBI*	110
Information Systems Research	*ISR*	97
BMC Bioinformatics	*BBIOIN*	96
International Journal of Medical Informatics	*IMI*	84
IEEE Transactions on Biomedical Engineering	*ITBME*	78
Journal of Medical Systems	*JMEDS*	77
BMC Medical Informatics and Decision Making	*BMID*	73

Table 9. Journal Degree Centrality with a Focus on Medical Informatics and Related IS Journals

Journal of Medical Internet Research	*JMIR*	58
IEEE-ACM Transactions on Computational Biology and Bioinformatics	*IACB*	52
Computers in Human Behavior	*CHB*	51
Artificial Intelligence in Medicine	*AIMED*	49
Computer Methods and Programs in Biomedicine	*CMPB*	47
Information & Management	*I&M*	44
Management Science	*MS*	40
Information Processing & Management	*IPM*	38
European Journal of Information Systems	*EJIS*	36
Journal of Management Information Systems	*JMIS*	35
Computers in Biology and Medicine	*CBM*	34
Journal of Information Technology	*JIT*	33
Journal of the American Society for Information Science and Technology	*JASIS*	31
Journal of the Association for Information Systems	*JAIS*	31
Database - The Journal of Biological Databases and Curation	*DATAX*	30
International Journal of Information Management	*IIM*	29
Information Systems	*ISY*	27
Methods of Information in Medicine	*MIM*	22
Information Systems Journal	*ISJ*	21
IEEE Journal of Biomedical and Health Informatics	*I3BH*	17
Journal of Strategic Information Systems	*JSIS*	14
Journal of Web Semantics	*JWS*	11
ACM Transactions on the Web	*ATW*	9
Online Information Review	*OIR*	8
Pervasive and Mobile Computing	*PMC*	8
World Wide Web	*WWW*	8
Decision Sciences	*DS*	7
BioData Mining	*BIOMIN*	7
Health Informatics Journal	*HIJ*	7
ACM Transactions on Computer-Human Interaction	*ACH*	6
Computer Supported Cooperative Work	*CSCW*	6
IEEE Transactions on Dependable and Secure Computing	*I3DS*	4
ACM Transactions on Knowledge Discovery from Data	*ADD*	1
Sent by		
Expert Systems with Applications	*ESA*	262
Information Sciences	*ISC*	235
BMC Bioinformatics	*BBIOIN*	184
Knowledge-Based Systems	*KBS*	174
Applied Soft Computing	*APSC*	145
Journal of Biomedical Informatics	*JBI*	135
Computers in Human Behavior	*CHB*	131
Journal of the American Medical Informatics Association	*JMI*	109
Bioinformatics	*BIOINF*	102

Table 9. Journal Degree Centrality with a Focus on Medical Informatics and Related IS Journals

Journal of Medical Systems	*JMEDS*	85
IEEE Journal of Biomedical and Health Informatics	*I3BH*	69
Decision Support Systems	*DSS*	68
International Journal of Medical Informatics	*IMI*	68
Computers in Biology and Medicine	*CBM*	68
Journal of Medical Internet Research	*JMIR*	66
BMC Medical Informatics and Decision Making	*BMID*	64
Information & Management	*I&M*	62
International Journal of Information Management	*IIM*	62
Computer Methods and Programs in Biomedicine	*CMPB*	54
MIS Quarterly	*MISQ*	53
Journal of Management Information Systems	*JMIS*	49
European Journal of Information Systems	*EJIS*	46
Information Systems Research	*ISR*	44
Journal of the American Society for Information Science and Technology	*JASIS*	41
Journal of the Association for Information Systems	*JAIS*	41
Database - The Journal of Biological Databases and Curation	*DATAX*	37
Journal of Information Technology	*JIT*	33
Journal of Strategic Information Systems	*JSIS*	33
IEEE-ACM Transactions on Computational Biology and Bioinformatics	*IACB*	28
Online Information Review	*OIR*	24
Methods of Information in Medicine	*MIM*	22
IEEE Transactions on Knowledge and Data Engineering	*I3KD*	20
Information Systems Journal	*ISJ*	18
IEEE Transactions on Biomedical Engineering	*ITBME*	18
Management Science	*MS*	17
Artificial Intelligence in Medicine	*AIMED*	17
Information Processing & Management	*IPM*	15
BioData Mining	*BIOMIN*	11
Information Systems	*ISY*	10
Decision Sciences	*DS*	9
ACM Transactions on Human-Computer Interaction	*ACH*	6
Journal of Web Semantics	*JWS*	6
ACM Transactions on Knowledge Discovery from Data	*ADD*	6
ACM Transactions on the Web	*ATW*	4
World Wide Web	*WWW*	4
Pervasive and Mobile Computing	*PMC*	3
Health Informatics Journal	*HIJ*	3
Computer Supported Cooperative Work	*CSCW*	2

4.9 Review of Findings

Table 11 summarizes our key findings according to our six research questions.

Table 10. Summary of Key Findings Organized by Research Questions

Research question	Key findings
RQ1: How cohesive is IS across its BIS and TIS orientations?	The sample of 98 IS and IS-related journals represent a heterogeneous but nonetheless cohesive discipline. It comprises of three main clusters—behavioral (BEH), computer networking (CN), and knowledge and data management (KD)— a small cluster of health informatics (HI).
RQ2: How balanced between BIS and TIS cross-citations are IS journals?	Over half the sample has cross-citations over the BIS-TIS boundary. Overall cohesiveness is based on a bridging role played in certain journals.
RQ3: If indeed relatively balanced IS journals exist, which subset of journals, if any, is cohesive across the behavioral-technical distinction?	Behavioral journals are significantly more balanced regarding the BIS-TIS distinction than the other journals.
RQ4: Can we identify journals with strong boundary spanning ties Simmelian times and, thereby, demonstrate that the IS journal network has more robust overall cohesion?	*Decision Suppport Systems* (a KD journal), *Computers in Human Behavior* (a BEH journal), and *Expert Systems with Applications* (a KD journal) play a unique bridging role in all three of the specialized approaches to IS that we examined in our study: behavioral, sociotechnical, and health informatics.
RQ5: Do some clusters play a boundary spanning role between other clusters? For example, do BIS journals bridge between different types of TIS journals? Do some types of TIS journals play a bridging role?	The KD cluster is well connected to both BEH and CN clusters, which are otherwise poorly connected.
RQ6: Can we identify multiple subsets of IS journals that are most appropriate for disseminating research from varying perspective or might there be a universal and definitive list of top IS journals?	Although the most central journals include the basket journals, the basket of eight does not comprise a definitive forum for IS scholars.

5 Limitations and Opportunities

This study has several limitations. Like many such studies but unlike Borgman and Rice (1992) and Moody (2004), our data represent a snapshot of recent events. We cannot make inferences about trends. In addition, we rely on secondary data from the Web of Science with the advantage of objectivity but at the cost of a restriction to the journals that it covers and that it categorizes as germane for our sample. Regardless of data limitations, our analyses also have two main limitations. First, no singular and definitive test for cohesiveness exists. We can say with some confidence that IS is not fragmented. However, cohesiveness itself exists on a continuum with multiple plausible measures. Second, no common approach to its measurement in other studies exists, which renders it difficult to place our findings in comparative context. These limitations present opportunities for future research.

The nature of our sampling presents further opportunities. All of the journals in our sample are among the most cited IS outlets. However, they differ widely in their number of citations. We did not explore the relationship between their impact and their boundary-spanning behavior. This relationship is worthy of exploration because cohesion across specialty boundaries requires "influential publications" (Fischer et al., 2011, p. 350); otherwise, the resources attendant on publication success will flow largely to the least diverse publication outlets (Rafols et al., 2012). Yegros, D'Este, and Rafols (2013, p. 20) found "that the publications that accrue the most citations are moderately interdisciplinary…[, whereas papers that draw on widely disparate disciplines] are very unlikely to become highly cited". Therefore, an indirect measure of the cohesion of the IS discipline is whether it has highly cited boundary-spanning journals; that is, whether the relationship between boundary spanning and impact is positive or negative.

Our decision rules for sample selection might have left out other journals, aside from *Computers in Human Behavior* and *Decision Support Systems*, which play an important boundary-spanning role. We tested this possibility with a journal that Polites and Watson (2008) describe as a boundary-spanner between technical and behavioral orientations: *Communication of the ACM* (*CACM*). Adding *CACM* to our matrix, we found that it sent five citations to two behavioral journals and received 19 citations from nine such journals. However, it lacked Simmelian ties of any sort let alone such ties across the BIS-TIS boundary. Of course, we may have omitted other journals from our sample that do play a major boundary-spanning role.

6 Discussion

6.1 IS Incorporates both Behavioral and Technical Orientations

Is the IS discipline a single discipline that focuses on both behavioral (BIS) and technical (TIS) topics, or is it two disciplines split between these orientations? The answer depends on the answers to two other questions. First, how strongly connected must a discipline be to be considered cohesive? When we used all cross-citations as the basis for a decision, we found an extensive web of inter-connections that rendered our entire sample cohesive by multiple measures. For example, the entire sample of 98 journals made up one strong component. When we used increasingly stringent measures to measure the strength of the cross-citation ties, we found smaller, uniformly BIS- or TIS-oriented components.

Second, must the BIS journals be well connected to all types of TIS journals? On the face of it, such a situation would be unlikely because some TIS journals focus intensely on technical aspects of hardware among other topics. In fact, we found that the BIS journals were well connected with KD journals and that these latter formed a bridge between the BIS journals and CN journals. Consequently, IS departments or units that wish to maintain connections between BIS and TIS orientations might want to include scholars who represent decision science or other KD approaches to the discipline.

6.2 Journal Lists should be Tailored to Research Specialties

Researchers almost always represent journal lists as singular and definitive despite the empirical reality of heterogeneous research streams often to reduce uncertainty around assessing research contribution for faculty promotion and tenure. These singular lists harm the diversity of scholarly interests (Mingers & Willmott, 2013) and prevent university departments from recognizing original works that authors have published in journals but that are not on their accepted lists. IS scholars may legitimately pursue research questions that are highly skewed to one orientation or the other but may also pursue research at the boundaries of orientations and, in fact, of other disciplines. For example, medical informatics cross-citations the cheminformatics and drug-discovery disciplines, disciplines for which the aforementioned Professor Chen has contributed. However, if the rankings for business school journals favor particular criteria that favor a small set of BIS journals or those that appear on the *Financial Times* list, IS faculty at many institutions that use such lists will not likely meet productivity expectations (Dean et al., 2011). Because IS fares worse than other business disciplines in regards to elite journal outlets (Dennis, Valacich, Fuller, & Schneider, 2006), such rankings can induce faculty members to develop institution-specific human capital and, thereby, limit faculty mobility and career development (Van Fleet, McWilliams, & Siegel, 2002). A formal reflection of the socio-technical nature of the discipline in business school journal rankings can be important for equalizing research recognition for the broader spectrum of IS researchers.

Whereas numerous IS researchers have brought forth the need for research specific journal rankings, in order to address the above concerns, our study is one of the first to identify specific clusters—BEH, KD, CN, and HI—that university departments could embrace as a starting point for expanding their list of acceptable IS journals. Each of our proposed clusters had a subset of high-quality journals that one could use to develop journal tiers within the subclusters. For instance, both the KD and CN cluster included the well-established IEEE and ACM journals that are similar to their underlying disciplines as are the BEH journals in the basket of eight. Alternatively, one could use high-quality journals from each cluster to form a more inclusive set of A-level journals. For instance, institutions that use the basket of eight as their A-level journals could begin expanding this list by including *Decision Support Systems*, a strong boundary-spanning KD journal that can include scholars who research on the boundaries of IS and decision sciences. They could also include select IEEE and ACM journals. Similarly, recognizing the boundary spanning nature of ESA and CHB can elevate the value attributed to these journals that may currently not appear on some lists.

Naturally, some sort of recognition may be warranted for journals that make impactful contributions to the discipline as opposed to a subspecialty. Institutions should determine how they can make such distinctions. For instance, could universities provide additional rewards for publishing in A-level journals that are broadly disciplinary as opposed to niche A-level journals rather than create an institutional norm that may not be relevant to all? Our study raises numerous such questions along with opportunities to innovatively expand the boundaries of the discipline.

6.3 Implications of Focusing on the Basket of Eight

Looking at how journals cite other journals, we found a behavioral/social science cluster and several technology clusters of journals and that they form a cohesive whole (i.e., a strong component that is robust regarding deletions). Additionally, several boundary-spanning journals tie the discipline together. These findings suggest that lists of journals such as the basket of eight, which represent only part of the whole, serve departmental and research interests only if one defines IS from a relatively non-technical perspective. Indeed, narrow definitions of top-tier journals run the risk of creating self-perpetuating journal groupings as top-tier journals tend towards greater self-citation (Palvia, Palvia, & Baqir, 2009). They also run the risk of inadequately representing “all the major forms of research produced by IS academics worldwide” (Lowry, Karuga, & Richardson, 2007, p. 148).

Our findings are timely as the Senior Scholars explore the possibility of expanding the scope of this basket and are engaged in active dialog with IS researchers. Our results show that the IS discipline is broader than the basket of eight. Thus, if the basket came to be widely adopted as the yardstick for hiring, evaluating, and promoting of professors in IS, the discipline would lose the benefit of diverse approaches. Liu and Myers (2011, p. 22) found that “the diversity of the AIS Basket [of six] is not nearly as great as we had anticipated...[in that] all six journals are remarkably similar”. The risk in a constricted domain, as Dogan (1997) has warned, is that “many fields that do not interact outside the discipline tend to stagnate” (p. 437). On a somewhat more positive note, Chen (2011) concludes his critique of the basket by suggesting that it “has appeared to save more jobs than it has destroyed” (p. 10). Nevertheless, if the basket has, as intended, “saved” jobs, they are presumably behaviorally oriented, and, if it has “destroyed” jobs, they are presumably more technically oriented. We doubt that a bias in either direction serves the discipline’s long-term interests.

IS departments can, of course, choose to follow a largely behavioral route and focus narrowly on the basket based on strategic considerations. We suggest four reasons that they might instead include both BIS and TIS journals in evaluating scholarly contributions. First, the history of the IS discipline is inextricably linked with the phases of development of IS technology (Hirschheim & Klein, 2012; Rayward, 2004). Thus, IS scholars face a need, unlike those in most business disciplines, to keep up with technological changes (Benamati & Lederer 2001). Second, like many other disciplines, IS is diverse, fluid, and accepting of a wide variety of cross-disciplinary influences (Bernroider et al., 2013; Taylor, Dillon, & Van Wingen, 2010). Third, BIS scholars cite TIS publications, and they do so much more frequently than other management scholars. Several BIS scholars actively publish in TIS journals as well. For example, Dean et al. (2011, p. 9) found that “IS faculty publish in [CS and engineering journals] in high numbers”. They go on to say: “Of 210 IS scholars who received tenure at research-intensive U.S. business schools, 23% of their tier one publications were in computer science and engineering journals and another 22% were in non-IS business journals” (p. 12). Fourth, including both BIS and TIS journals might move IS closer to a level playing field with other disciplines because many schools advocate the use of A-level journals to reward researchers “without considering that there might be greater opportunities to publish in some disciplines compared to others” (Kozar, Larsen, & Straub, 2006, p. 535). Expanding the scope of IS journal baskets to include more TIS and boundary-spanning journals could improve equity across business school disciplines. Considering these reasons, the call for an “acceptable definition for the ‘IS journal basket’” (Templeton, Lewis, Luo, 2007, Letter 2, p. 1) to support ongoing longitudinal journal assessments is timely, and scientometric studies in IS should include BIS and TIS journals as the norm.

6.4 Implications for the Durability of the IS Discipline

One can argue that it is possible to expand interdisciplinary co-operation or protect it from enroachment. Indeed, some schools of thought suggest that it is better to encroach than be encroached on (Harris & Wise, 1998). For the IS discipline, attempts at encroachment have not been only a speculative possibility (Benbasat & Weber, 1996). As Abbott (2001, p. 137) observes: “bodies of academic work are perpetually being redefined, reshaped, and recast by the activities of disciplines trying to take work from one another or to dominate one another". One needs to strongly justify any attempts to make a discipline smaller. In contrast, if IS researchers proactively seek out other disciplines and identify ways in which IS can add value to them, the discipline can only expand and grow more robust. It may well be that interesting research questions for the entire IS discipline will develop at these boundaries with related disciplines. Boundary-spanning journals will most likely publish this type of research, which requires further exploration.

In addition, the IS discipline has gained some of its academic legitimacy based on its capacity to keep pace with a world of rapid technological change (Lyytinen & King 2004). It has done so in a context that widely criticizes business schools for being out of touch with practice (Pfeffer & Fong, 2002). Finally, as Abbott (2001, pp. 128, 132-139) notes, the institutional basis for disciplinary continuity does not involve fluidly developing research topics but rather the academic department's accrediting students' majors. If it were true that the employers of IS graduates were clamoring for less technical competence in favor of behavioral abilities, restricting IS to the latter would be sensible. According to curricular studies, IS graduates need to be "grounded in the expected requirements of industry [and representing] the views of organizations employing the graduates" (Topi et al., 2010, p. 361). Employers demand not just technology or management but both (Benamati et al., 2006). As Pratt et al. (2012) argue, business school disciplines must be interdisciplinary if they are to maintain relevance for businesses, which requires interdisciplinary knowledge.

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