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The Development of Social Capital in the Collaboration Network of Information Systems Scholars

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Abstract

This study examines the development of social capital in the collaboration network of information systems (IS) scholars over a 33-year period (from 1980 to 2012). Using the co-authorship data from six premier journals (MIS Quarterly, Information Systems Research, Journal of MIS, Journal of the AIS, European Journal of Information Systems, and Information Systems Journal), we analyze the historical trajectory of five aspects of the field's structural social capital: network ties, network configuration, structural holes, growth, and structural cohesion. Our results show that, as a scientific field, the IS community has made significant progress in accumulating social capital. The current IS collaboration network is also comparable in several aspects with networks found in other business disciplines (e.g., management, finance, and marketing). Our study has several important implications for the focus-versus-diversity debate in the IS field. Based on our findings, we offer some recommendations as to how the IS community can increase the field's social capital, and thereby facilitate knowledge creation and innovation.

***Keywords**: IS Field, IS Discipline, Social Capital, Collaboration Network, Co-Authorship Analysis.*

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The Development of Social Capital in the Collaboration Network of Information Systems Scholars

1. Introduction

Creating knowledge is one of the key roles scientific fields play (Crane, 1972; Whitley, 1975, 1984). In a field, scholars engage in scientific practices and produce new knowledge in the form of theories, methodologies, techniques, and artifacts pertaining to a specific set of subjects. Their effort contributes to the intellectual development of their field and the growth of the body of knowledge (Crane, 1972). Since its beginnings in the late 1960s, the information systems (IS) field has undergone recurrent assessment and self-assessment of its intellectual development that has aimed to clarify its identity as a scientific field (Banville & Landry, 1989; Benbasat & Zmud, 2003; Farhoomand, 1987; Robey, 2003; Vessey, Ramesh, & Glass, 2002). Along this line of concern, Banville and Landry (1989) called the IS field a "fragmented adhocracy" and heated up the debate about its identity. A long-lasting point in this debate has been one concerning the focus or diversity in IS research (Benbasat & Weber, 1996; Robey, 1996; Taylor, Dillon, & van Wingen, 2010; Vessey et al., 2002). Benbasat and Zmud (2003), for example, advocate focus and call for the articulation of the intellectual core through studying "the IT artifact and its immediate nomological net" (p. 186). Other scholars, in contrast, believe that the diversity of research topics and approaches is the IS field's defining feature that strengthens rather than weakens it (Galliers, 2003; Ives, Parks, Porra, & Silva, 2004; Lyytinen & King, 2004; Robey, 2003).

In response to this debate, several recent empirical studies have reexamined the IS field's intellectual development. Sidorova, Evangelopoulos, Valacich, and Ramakrishnan (2008) analyze the abstracts of research papers published in three top IS journals and identify five core areas in IS research (IT and organizations, IS development, IT and individuals, IT and markets, and IT and groups). They note substantial focus at the research area level, and observe great diversity at the research theme and topic level. Taylor et al. (2010) employ a longitudinal, author co-citation analysis and show that the IS field has shifted from a fragmented adhocracy to a polycentric state with a higher level of mutual dependence[1] among IS scholars.

Although these studies demonstrate to a certain degree the IS field's "cognitive legitimacy" (Benbasat & Zmud, 2003), they overlook the social aspect of scientific practice and the knowledge-production process (DeSanctis, 2003, p. 363), which Whitley (1984) and Banville and Landry (1989) explicitly emphasize. Crane (1972) points out that the process of conducting research is inherently social. In a scholarly community, members interact with each other, share common research interests, use similar methods and techniques, pick up each other's ideas, and influence each other's work (Culnan, 1986, 1987; Moody, 2004). These social interactions weave scholars into a complex social network in which knowledge is generated, exchanged, and updated. Social capital, which influences and is influenced by the development of intellectual capital of a social unit (e.g., the scholarly community), is deeply embedded in this social network (Nahapiet & Ghoshal, 1998).

This paper examines social capital development in the IS community from 1980 to 2012. We treat the IS community as a knowledge production system (Whitley, 1975) and assess how much social capital the IS community has accumulated in the past 33 years. Through this study, we address a few key questions: has the IS community made progress in developing social capital? Is the IS community connected or largely fragmented? Do the social ties between IS scholars accommodate effective and efficient access to diverse knowledge? Have the sub-communities in the IS field become more (or less) cohesive and focused? We address these questions mostly from a historical perspective by tracking the temporal changes and progress (or lack of it) in various aspects of social capital. In addition, we compare our findings with those of three other business fields to better contextualize our results.

The social network we study in this paper is the collaboration network among IS scholars based on co-authored papers in six top IS journals between 1980 and 2012. While there are many forms of

[1] According to Whitley (1984), mutual dependence has two aspects: strategic dependence and functional dependence. Banville and Landry (1989, p. 54) define strategic dependence as "a measure of the political dependence of the members within a field", and functional dependence as "a measure of the technical and procedural coherence within a field".

collaboration (e.g., conference organization, journal editing, and paper reviewing), co-authorship is the most formal manifestation of intellectual collaboration (Acedo, Barroso, Casanueva, & Galan, 2006). Certainly, using co-authorship as the surrogate for collaborative relationships among scholars has methodological risks. For example, two scholars may work together on one project but choose to publish their work separately. Also, directors of research laboratories or other "rainmakers" may be listed as co-authors on multiple papers but may not have participated directly in these efforts (Borgman & Furner, 2002). Nevertheless, a co-authorship network provides us with a window on the social capital development in the IS community.

Compared with two prior studies that examine co-authorship dynamics among a set of 316 key IS authors (Oh, Choi, & Kim, 2006) and among authors of papers in the *Proceedings of the International Conference on Information Systems* (Xu & Chau, 2006), our study offers a more-comprehensive assessment of the social capital embedded in the IS collaboration network at a much larger scale. Together with the recent studies on the intellectual development of the IS field (Sidorova et al., 2008; Taylor et al., 2010), which reflect its cognitive legitimacy, this study provides a complementary report on the IS field's progress. In addition, we identify ways in which we can further facilitate knowledge production in the IS field.

The remainder of this paper is organized as follows. In Section 2, we review the concept of social capital and identify the five key aspects of structural capital, based on which we present questions regarding how the social capital of the IS community has changed in the past 33 years. In Section 3, we provide details on the methods and data we used for this study. In Section 4, we report our findings and compare our results with those of three other business fields; we also explain our findings in this section. In Section 5 we points out the limitations to our results' generalizability. In Section 6, we discuss the implications of our findings and make recommendations for the future development of social capital in the IS field. Finally, in Section 7, we conclude the paper.

2. Social Capital

The social capital concept has been widely used in social sciences to describe and explain many phenomena related to knowledge production and innovation (Ahuja, 2000; Brown & Duguid, 1991; Burt, 1997; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998). Various definitions focusing on different aspects of social capital have been proposed in the literature. We adopt a definition that summarizes and synthesizes prior proposals by broadly defining social capital as "the sum of actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" (Nahapiet & Ghoshal, 1998, p. 243). This definition emphasizes that social capital is a type of asset possessed by an individual or a social unit (e.g., an organization) and that social capital is an integral part of the very structure of the social network in which the individual or the social unit resides (Adler & Kwon, 2002; Nahapiet & Ghoshal, 1998; Putnam, 1995). In this sense, the IS community can be considered a social unit that produces knowledge by leveraging its social capital.

Several theories have been proposed to explain the impact of social capital on the outcome of knowledge creation and innovation by individuals and organizations (Burt, 1997; Inkpen & Tsang, 2005; Nahapiet & Ghoshal 1998). Nahapiet and Ghoshal (1998), for example, posit that social capital facilitates the development of intellectual capital and contributes to the competitive advantage of an organization by providing the opportunity, anticipation, motivation, and capability of knowledge combination and exchange, which are the two primary processes of knowledge creation and innovation. This applies to the IS community. The more its social capital, the better the IS community is able to produce knowledge and innovate.

Social capital has three dimensions (Nahapiet & Ghoshal, 1998): the structural dimension, the relationship dimension, and the cognitive dimension. The structural dimension concerns the overall pattern of social ties between members in a social network. The relationship dimension refers to personal relationships (e.g., trust, obligations, and identification) that members in a social network have developed through their history of social interactions. The cognitive dimension represents resources such as codes, languages, and narratives (e.g., stories of success or failure) that are shared among members in a social network. The three dimensions are not independent of each other. The increase in one dimension can strengthen and reinforce other dimensions. For example, the strengthening of social ties (the structural dimension) may facilitate repeated interactions between members of a social network, and thereby increase trust and friendship (the relational dimension) and build shared language and narratives (the cognitive dimension).

In this study, we focus on the structural dimension of social capital, which can be quantitatively assessed using social network measures. Structural social capital can be assessed at different levels (Adler & Kwon 2002; Nahapiet & Ghoshal, 1998), such as individual (e.g., an IS scholar), group (e.g., an IS sub-community), and network (e.g., the IS community). The structural social capital of an individual is embedded in the individual's ego network, which comprises the individual and their direct contacts. The structural social capital of a group is based on both the internal ties between its members and its external relationships with other groups. The structural social capital of the network is reflected in its structural characteristics. In this study, we assess the development of structural social capital for individual IS scholars, five IS sub-communities, and the IS community.

Various measures have been proposed for assessing structural social capital. Based on a literature review, we have identified several measures for five key aspects of structural social capital (Burt, 1992; Coleman, 1990; Inkpen & Tsang, 2005; Nahapiet & Ghoshal, 1998)[2]: network ties, network configuration, structural holes, network growth, and structural cohesion (of sub-communities). In this study, we use these measures to characterize the collaboration network of IS scholars to assess and examine at different levels (i.e., individual, group, and network) the structural social capital that has accumulated in the IS community over more than three decades.

2.1. Network Ties

Network ties (also called links in network studies) are a type of fundamental structural asset that can serve as a channel through which resources are shared and exchanged between network members. Information is a resource that is particularly important to the process of knowledge creation and innovation. Specifically, network ties bring three forms of informational benefits (Burt, 1992): network members can gain access to information from their social contacts that would otherwise be unavailable; network members can gain from timing through accessing the information sooner than they can do otherwise; and network members can gain from referral through reaching via a shorter path to other important network members who possess better reputation, higher status, and more knowledge. In the IS community, co-authorship links among scholars provide them with timely access to information and referral opportunities.

An individual's network ties have been shown to positively impact their knowledge production. Ahuja, Galletta, & Carley (2003) found that the number of network ties an individual has is positively associated with their performance in R&D projects. Similarly, a firm's external ties contribute to its innovative output by allowing it to leverage complementary skills, expertise, and techniques from its partners, which allows it to accomplish larger tasks and projects and achieve scale economies (Ahuja 2000). Further, network ties between members of an open source project group have also been found to help increase the group's knowledge-creation rate (Singh et al., 2011). Based on these findings, we anticipate that, as IS scholars build and maintain more co-authorships with others, they are likely to create more knowledge, which makes the IS community better at knowledge creation and innovation.

A community's network ties are the aggregate of network ties of individuals within the community. More network ties give rise to more opportunities for social interactions between members, which thereby increases information sharing and knowledge exchange. Members with a large number of network ties often are deemed "central members" or "information hubs" (Freeman, 1979). In scientific fields, central scholars may play an important role in the diffusion of ideas (Crane, 1972; Moody,

[2] These five aspects of structural social capital are by no means exhaustive. These five aspects have been examined because these are very relevant to knowledge creation and exchange.

2004; Newman, 2001). In this paper, we address two questions concerning the network ties of the IS community at the network and individual levels:

> **Q1a:** Has the IS community accumulated more network ties over time?
>
> **Q1b:** Who has been the central members in the IS community at different times?

2.2. Network Configuration

Besides network ties, network configuration (the pattern of network ties) is an important element of structural social capital. Network configuration can be characterized using network connectivity metrics (Nahapiet & Ghoshal, 1998), which indicate if members in a community can reach others through direct ties or paths of indirect ties. A fragmented network is a "caveman graph", which consists of many small isolated clusters or "caves" (Watts, 1999). A network with good connectivity has a "critical core" that comprises the majority of the members in the network (Albert & Barabási, 2002; DeSanctis, 2003). A critical core provides the conditions and opportunities for information sharing and knowledge exchange among network members. The absence of a critical core in a scientific community yields a fragmented network with no connections between groups of scholars.

Moreover, network configuration can affect the efficiency of knowledge exchange and creation (Burt, 1992). Researchers have shown that information can be shared and diffused faster in a network in which the "social distance" between members is short (Watts & Strogatz, 1998), a condition known as structural efficiency. A network in which members are close to one another, despite the network's large size, is often called a "small world" (Watts & Strogatz, 1998)[3]. In this paper, we address two questions about the network configuration of the IS community pertaining to connectivity and structural efficiency:

> **Q2a:** Has the IS community become more connected or fragmented over time?
>
> **Q2b:** Has the IS community become more structurally efficient over time?

2.3. Structural Holes

There has been debate in the literature about the roles of closure and structural holes in knowledge exchange and creation. Researchers advocating network closure maintain that dense network ties between members provide easy access to information and reduce the chances of opportunistic behavior (Bourdieu, 1986; Coleman, 1990; Putnam, 1995). A dense network fosters trust, identification, norms, shared language, and narratives between members and enriches social capital in the relational and cognitive dimensions (Coleman, 1990; Ibarra, 1992). A high level of network closure reinforces the boundary of a community by separating members from non-members (Boland & Tenkasi, 1995). A closed scientific field can more effectively maintain a focused set of research problems (Whitley, 1975). This rationale underlies the call for focus in IS research in order to build an intellectual core (Benbasat & Zmud, 2003).

In contrast, Burt (1992) believes that structural holes, which are gaps between non-redundant contacts, can provide more informational benefits to network members. A high level of closure may cause information redundancy, tighten the community boundary, reduce the community's openness, and result in a form of "collective blindness" (Nahapiet & Ghoshal, 1998) that prevents the community from getting new ideas and seeing new ways of doing things. Whitley (1975) points out that a highly closed scientific field with a clearly articulated boundary implies a high degree of resistance to innovations. As a result, sparse networks, in which members can leverage their weak ties (Granovetter, 1973) and structural holes in their social contacts, may be preferred over dense networks (Burt, 1992).

[3] The small-world phenomenon is well known because of the famous sociological experiment that found "six degrees of separation" between any two people in the population (Milgram, 1967).

Empirical research has yielded evidence in support of the structural hole proposition. For example, Burt (1997) found that managers benefitted substantially from their non-redundant social contacts in their ego networks. Similarly, other researchers have shown that academic scholars' research performance is positively associated with their structural hole resources (Oh et al., 2006). This line of argument underlies the call for diversity in IS research because accommodating a diversity of research topics and approaches is believed to strengthen rather than weaken the IS field (Galliers, 2003; Ives et al., 2004; Lyytinen & King, 2004; Robey, 2003). Because the debate in the literature on structural holes has useful implications for the focus versus diversity debate in the IS community, we examine the IS community in terms of an increase or a decrease in structural holes:

Q3: Has the IS community accumulated more structural holes over time?

2.4. Network Growth

A community is never static but evolves over time. In a scientific field, new research themes emerge and new means of data collection and processing become available over time. Members of the community may become more or less active over time for various reasons. In a healthy community, there must be a self-renewal process whereby new members (e.g., doctoral students) can regularly become a part of the community. These new members form new collaborative relationships with other members, which add to the network ties and change the network configuration (Barabási & Albert, 1999). Moreover, other kinds of new members (e.g., researchers from other fields with different backgrounds and expertise) may introduce fresh ideas and innovative ways of doing things through increased structural holes. Therefore, the assimilation of new members affects the health and sustainability of a community in the long term. In this study, we examine the network growth in the IS community:

Q4: Has the IS community been able to assimilate new members over time?

2.5. Structural Cohesion

In a scientific field, there often exist sub-communities of members or "invisible colleges" (Crane, 1972). Members in a sub-community may share similar research interests and strive to address a common area of scientific concern (Whitley, 1975). In the IS field, research area based sub-communities are particularly important because they serve to maintain our intellectual core, and, at the same time, accommodate diversity in topics, methodologies, and contexts in response to a fast-changing technological environment (Sidorova et al., 2008; Taylor et al., 2010).

In the social capital literature, sub-communities are defined as cohesive groups (Moody & White, 2003). A structurally cohesive group has dense internal links and sparse external links (Wasserman & Faust, 1994). The densely internal links facilitate efficient knowledge exchange among members in the group (Coleman, 1990). The sparse external connections allow diverse knowledge to be shared across different groups (Burt, 1992). The structural cohesion of a group is influenced by its closure. Holding external links constant, the denser the internal links (i.e., the more closed the group is), the stronger the structural cohesion. Therefore, as sub-communities of the IS field become more structurally cohesive, they are more able to maintain their research focuses. In this study, we examine the structural cohesion of sub-communities in the IS community:

Q5: Have sub-communities in the IS community remained structurally cohesive over time?

3. Data and Method

3.1. Sample

The dataset we use in this study includes all research papers published in six top-tier IS journals from their inception years (in parentheses) to 2012: *MIS Quarterly* (1980)[4], *Journal of MIS* (1984), *Information Systems Research* (1990), *European Journal of Information Systems* (1991), *Information Systems Journal* (1991), and *Journal of the AIS* (2000). We included *MIS Quarterly* (*MISQ*), *Information Systems Research* (*ISR*), and *Journal of MIS* (*JMIS*) because these journals have been consistently regarded as top-tier journals in various journal ranking exercises and citation studies (Grover et al. 2006; Sidorova et al. 2008). We included the *European Journal of Information Systems* (*EJIS*), *Information Systems Journal* (*ISJ*), and the *Journal of the AIS* (*JAIS*) because they are listed in the "Senior Scholars' Basket of Journals" as highly rated IS journals (Dean, Lowry, & Humpherys, 2011). We excluded journals that have departments covering multiple fields (e.g., *Management Science, IEEE Transactions on Engineering Management, and Communications of the ACM*) from this study because the authorship in these journals has a significant proportion of scholars from other fields.

We collected the metadata of all papers published in these six journals from the Business Source Premier Database (http://www.ebscohost.com/titleLists/bu-complete.htm). We employed a computer program written in Visual Basic to parse the metadata and extract relevant information (e.g., title, abstract, keywords, authors, and author affiliations) of each paper into an Excel file. We removed non-research paper (e.g., editorials and book reviews). We then manually verified the completeness of the dataset by checking it against electronic or printed versions of these journals. We added some missing information to the dataset (e.g., missing keywords, missing authors, and missing author affiliations).

We pre-processed the dataset by assigning unique identifiers to papers, authors, and institutions using another program developed in Visual Basic. In conjunction with this pre-processing, we undertook a manual effort to identify and correct errors and inconsistencies in the dataset. For example, some author names had typos or appeared in different forms (e.g., "Whinston, Andrew B." versus "Whinston, A.B."). The outcome of this process yielded a total of 3,821 papers written by 4,174 unique authors from 1,071 institutions.

3.2. Network Construction and Sub-community Identification

We derived co-authorship links from the extracted paper information. We created a link between two scholars if they co-authored at least one paper in a time window (we used two time windows: a year and a decade). We weighted the link between a pair of scholars was based on the number of papers they co-authored in the time window. We then constructed two types of collaboration networks by using the year windows and decade windows, respectively. We constructed the cumulative yearly networks by adding new authors and new links from each year to the previous years' network, which resulted in a total of 33 networks. The 33rd network corresponded to the entire network including all authors and co-authorship links from 1980 to 2012. We name this particular network the "overall network" hereafter. We generated three non-cumulative, decennial networks by dividing the period from 1980 to 2009 into three separate time windows: the 1980s, 1990s, and 2000s. We did not construct the decennial network for the 2010s because only three years worth of data from 2010 to 2012 were available for this time period. Although the IS scholars in our dataset include only those who have published in the six top-tier journals, this section of the IS community are active researchers who have contributed significantly to knowledge creation and innovation.

Following past categorization efforts (Sidorova et al., 2008; Taylor et al., 2010), we identified sub-communities in the IS community based on research areas. We employed a text-classification approach[5] and categorized the paper abstracts into five sub-communities (IS development, IS for

[4] We removed the papers published in *MIS Quarterly* from 1977 to 1979 from the dataset because the collaboration network then was very disconnected with only 48 authors and 44 links, which renders the results for many metrics difficult to interpret.

[5] Our text-classification approach was based on latent semantic analysis. First, we extracted each paper's abstract and tokenized it into words. We removed each word's suffix using Porter's stemming algorithm (Porter, 1980) and matched it against the terms that

individuals, IS for groups, IS for organizations, and IS for markets), each of which covers one of the key research areas identified in previous work (Sidorova et al., 2008; Taylor et al., 2010).

A total of 23.8 percent of IS scholars published papers in more than one research area. To facilitate interpretation of results, we placed an IS scholar in a sub-community only if the majority of their papers were in that particular area[6]. The resulting sub-community sizes were 1,185 for IS development, 464 for IS for individuals, 234 for IS for groups, 1,951 for IS for organizations, and 340 for IS for markets.

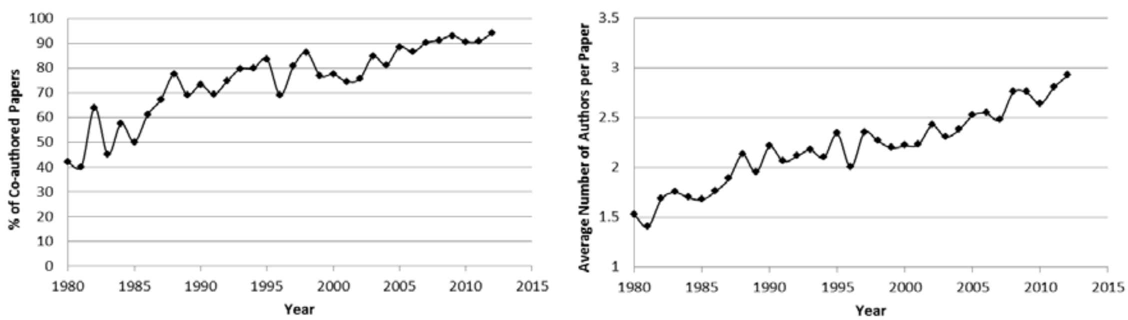
4. Results and Discussion

In this section, we present the results for our research questions. In addition to tracking temporal changes in pertinent measures, we identify baseline benchmarks from the literature for these measures and discuss possible causes for these results.

4.1.Collaboration Trends

We first plotted the collaboration rate and collaboration extent to capture the trends in IS research collaboration in the past 33 years. Collaboration rate is the percentage of co-authored papers out of all papers (Gill & Bhattacherjee, 2009). Collaboration extent is the average number of authors per paper (Laband & Tollison, 2000).

The percentage of co-authored papers has increased from 42.1 percent in 1980 to 94.3 percent in 2012 (see Figure 1a). The average collaboration rate for all years is 81.4 percent. The collaboration extent has increased from 1.5 in 1980 to 2.9 in 2012 (see Figure 1b). The mean collaboration extent for all years is 2.38. In short, there has been an increasing trend for collaborative work.



a. Collaboration rate b. Collaboration extent

Figure 1. Changes in Collaboration Rate and Collaboration Extent Over Time

Table 1 shows a list of metrics regarding collaboration networks in business fields. Compared with these communities, the IS community has the highest collaboration rate and collaboration extent. This growing tendency toward collaboration has also been observed in other scientific fields: mathematics and physics (Newman, 2004), social sciences (Moody, 2004), economics (Hudson, 1996; Laband & Tollison, 2000), and accounting and finance (Beattie & Goodacre, 2004; Fatt, Ujum, & Ratnavelu, 2010).

had a loading above the threshold in the factor analysis results reported in Sidorova et al. (2008). We removed terms without a match. We then multiplied the term frequency and the inverse document frequency of the remaining terms to obtain a vector comprising a set of weights (Salton & Buckley, 1988). Finally, we computed the five factor scores for each paper (corresponding to the five sub-communities) as the inner product of this vector and the factor loadings. We placed each paper under the sub-community that corresponded to its highest factor score.

6 We classified only 112 IS scholars (2.7 percent of all authors) into a sub-community based on less than 50% of their papers. Many of these scholars are among the most prolific authors in the IS field (see the results for Q1b).

Table 1. Comparison Between IS Feld and Other Business Fields[7]				
	Management (Acedo et al., 2006)	Marketing (Goldenberg, Libai, Muller, & Stremersch, 2010)	Finance (Fatt et al., 2010)	Information systems
Time period	1980-2002	1964-2008	1980-2009	1980-2012
Data source	10 top journals	35 journals	*Journal of Finance*	6 top journals
Number of authors	10,176	32,381	3,082	4,174
Collaboration rate	N/A	N/A	58%	81%
Collaboration extent	1.88	N/A	1.79	2.38
Average degree centrality	2.86	4.3	3	4.26
Largest connected component	45%	69%	54%	65%
Average network distance[8]	N/A	7.5 (6.9)	8.2 (N/A)	6.0 (5.6)
Density (Closure)	0.02%	0.01%	0.09%	0.02%

These upward collaboration trends may have been driven by factors such as increased specialization and division of labor among scholars in scientific fields, higher requirements for publication quantity and quality, and a growing number of publication outlets (Acedo et al., 2006; Hudson, 1996). Advances in communication technologies may also have made it much easier for scholars to collaborate across institutional and geographical boundaries. Some factors unique to the IS field may have contributed to our increasing collaboration trends. One such factor is the diversity in research topics and methods. IS research is rooted in a variety of contributing fields (Baskerville & Myers, 2002; Keen, 1980; Swanson & Ramiller, 1993; Vessey et al., 2002). Scholars with different backgrounds can examine a problem together fruitfully by bringing to bear their unique expertise. Similarly, scholars with different methodological training can come together to conduct a multi-method study of a phenomenon and thereby yield richer findings (Vessey et al., 2002). Moreover, the rapid growth of IS doctoral programs from the 1990s may have also contributed to this trend through increased collaboration between advisors and their current and former students.

4.2. Network Ties

Q1a: Has the IS community accumulated more network ties over time?

We used the average degree centrality to capture the changes in the quantity of network ties over time. We define degree centrality as the number of network ties a member has (Freeman, 1979). In this study, an IS scholar's degree centrality is the number of other IS scholars with whom the scholar has co-authored papers. The average degree centrality for the network is computed from the mean of individual degree centrality.

As Figure 2 shows, the average degree centrality in the IS community has increased gradually from 2.00 in 1980 to 4.26 in 2012. Two noticeable sharp increases occurred in 1984 and 1990, which correspond to the inception of *JMIS* and *ISR*, respectively. The emergence of these journals provided more opportunities for scholars to publish their collaborative work. Overall, IS scholars have

[7] This comparison provides the context in which we present our results. The metrics are based only on available literature and the networks vary greatly on their sizes, data sources, and time periods. We do not use these findings to make assertions about the identity of any field.

[8] Numbers in the parentheses are the expected values of the average distances (see the explanation in the results for Q2b for details).

accumulated more network ties over time[9]. Compared with other business fields (see Table 1), the IS community has a relatively high average degree centrality (comparable to marketing but ahead of management and finance).

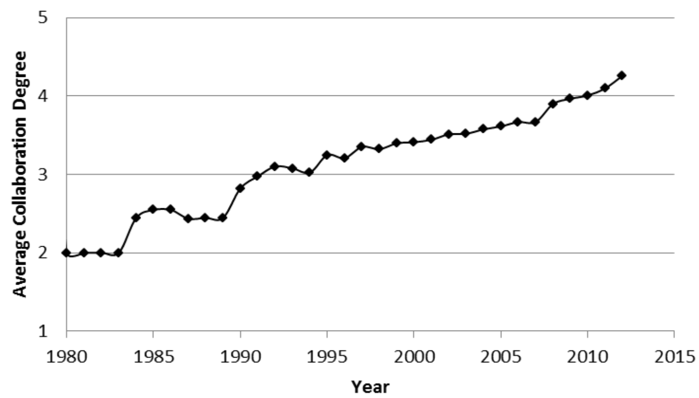


Figure 2. Changes in Average Degree Centrality Over Time (in Yearly Networks)

Q1b: Who have been the central members in the IS community at different times?

Table 2 lists the (top 10) central members in the IS community in the 1980s, the 1990s, and the 2000s based on their degree centrality. Some members (e.g., Jay Nunamaker and Izak Benbasat) have remained central over time. But, in each decade, new central members have emerged. These new central members have brought into the IS community pertinent expertise that corresponds to emerging research themes. For example, in the 1990s, Alan Dennis and Joe Valacich contributed significantly to the stream of research on group support systems. In the 2000s, Robert Kauffman and Andrew Whinston were main movers in research on economics of IS.

Table 2. IS Scholars Ranked by Degree Centrality (in Decennial Networks)

1980s	1990s	2000s
1. Benn R Konsynski (16)	1. Jay F Nunamaker Jr (31)	1. Mark Keil (31)
2. Jay F Nunamaker Jr (15)	2. Alan R Dennis (22)	2. Vallabh Sambamurthy (29)
3. John F Rockart (9)	3. Douglas Vogel (20)	2. Laurie J Kirsch (29)
3. Hugh J Watson (9)	4. Joseph S Valacich (19)	4. Andrew B Whinston (28)
5. Matthias Jarke (7)	5. Gordon B Davis (17)	5. Kalle Lyytinen (27)
5. Daniel Robey (7)	6. Tridas Mukhopadhyay (15)	6. Jay F Nunamaker Jr (26)
5. Izak Benbasat (7)	6. Varun Grover (15)	6. Varun Grover (26)
8. Minder Chen (6)	8. George M Kasper (14)	6. Izak Benbasat (26)
8. Gerardine L DeSanctis (6)	9. Izak Benbasat (14)	6. Robert J Kauffman (26)
8. Gary W Dickson (6)	9. J. Daniel Couger (14)	10. Ilze Zigurs (25)
	9. Richard T. Watson (14)	

In addition to degree centrality, one can use betweenness centrality (Freeman, 1979) to identify central members in the collaboration network. Betweenness centrality is the extent to which a

[9] Most (86.5%) of these ties were “weak ties” (Granovetter, 1973) in the sense that they occurred only once. Around 11.9% of the ties occurred twice or thrice. The rest (1.6%) were stronger, occurring four or more times.

member lies between other members in a network. IS scholars with high betweenness scores may be the “brokers” between different sub-communities of the IS community, serving as important communication links through which knowledge is exchanged. Due to space constraints, we report only the top five IS scholars with the highest betweenness centrality scores in the overall network: Izak Benbasat, Alan Dennis, Jay Nunamaker, Vallabh Sambamurthy, and Andrew Whinston. They are ranked high in both degree centrality and betweenness centrality, indicating their important structural roles in the community. Izak Benbasat, for example, has been collaborating with and bridging scholars from all five sub-communities. Alan Dennis, for example, has been conducting research not only with scholars in his primary sub-community (IS for groups), but also with scholars from other sub-communities (IS for organizations and IS development).

Our findings for Q1a and Q1b suggest that the IS community has made progress in building network ties over the past 33 years. These network ties have resulted from collaboration, which, in turn, leads to knowledge creation and innovation (Nahapiet & Ghoshal, 1998). The Pearson correlation between the degree centrality and productivity (measured by the number of papers published) of IS scholars is 84.3 percent, which shows the relationship between collaboration and knowledge creation.

However, network ties are not evenly distributed among IS scholars. We found that the network’s degree distribution, which is the probability distribution of network ties over the whole network (Albert & Barabási, 2002), follows the power-law ($R^2 = 0.91$). That is, while most IS scholars have few network ties, a small percentage of IS scholars have many network ties. For example, the scholars listed in the 2000s column in Table 2 have, on average, 27.3 co-authors, which is significantly more than the overall average of 3.3. The high degree centrality of some members (e.g., Jay Nunamaker and Andrew Whinston) could be due to their leadership roles of big research centers that have attracted a large number of doctoral students who co-authored papers with them, demonstrating the “preferential attachment” effect (Barabási & Albert, 1999). These central members have played a critical structural role in connecting members in the IS community. However, a healthy scientific field should not depend on a few central members to define the research agenda, which may result in restricted academic freedom and diversity (Robey, 1996).

4.3. Network Configuration

Q2a: Has the IS community become more connected or fragmented over time?

We measured the connectivity of the network by the percentage of total members that were in the largest connected component. In this connected component, each member can reach any other member through direct links or paths of multiple links. Graph theory specifies that a network is well connected if the largest connected component contains the majority (i.e., more than 50%) of members in the network (Bollobás, 1998).

Figure 3 shows that the proportion of members in the largest connected component made up only 6.4 percent of all members (6 out of 94 members) in 1980 but this number increased to 65.1 percent (2,718 out of 4,174 members) in 2012. The remaining unconnected members were either isolated authors who only published single-authored papers or formed very small clusters (with few other members). The average size of the 409 clusters outside the largest connected component in the 2012 network was only 3.

The largest connected component reached the 50 percent threshold in 2003 and continued to grow thereafter. An evident rise occurred in the early 1990s, around the time when three journals (*ISR, EJIS,* and *ISJ)* were launched, bringing many new collaboration links into the sample. Compared with other business fields, the IS community is slightly lower in connectivity than marketing but higher in connectivity than management and finance (see Table 1).

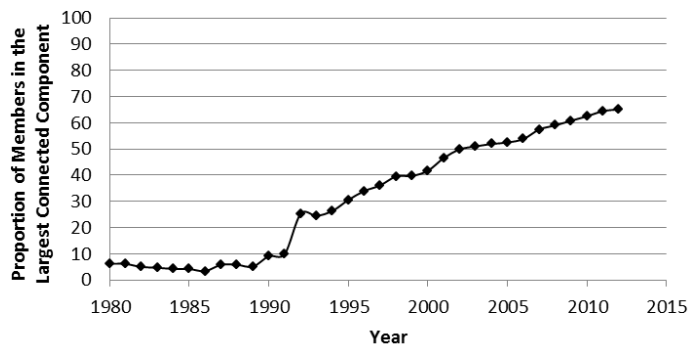


Figure 3. Changes in the Proportion of Members in the Largest Connected Component Over Time (in Cumulative Yearly Networks)

To examine the structure of this “critical core” in the IS community, we constructed a minimum spanning tree for the largest connected component in the overall network. Minimum spanning trees have been used in prior studies to portray the structure of scientific fields (Chen & Morris, 2003; Newman, 2004). The minimum spanning tree connects all members in the critical core using the minimum set of the strongest links. We generated a visual representation of the minimum spanning tree using the NetDraw software (Analytic Technologies, 2009) in Figure 4[10]. On this tree, a node represents an IS scholar and the size of the node is proportional to the number of paper the IS scholar has published.

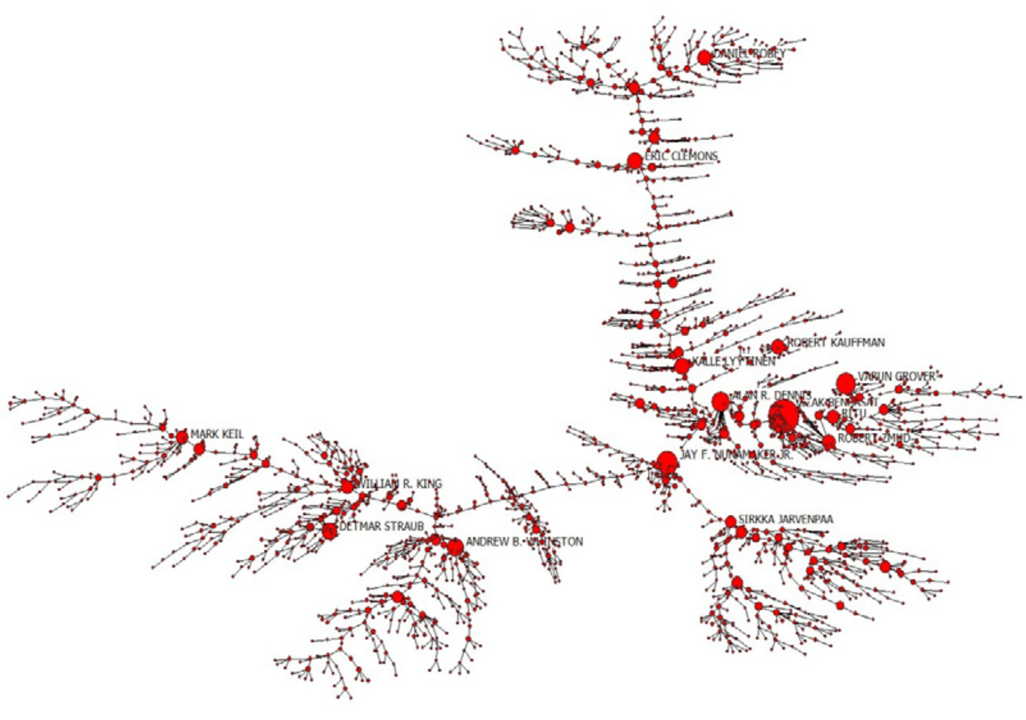


Figure 4. Visual Representation of the Largest Connected Component in the Overall Network

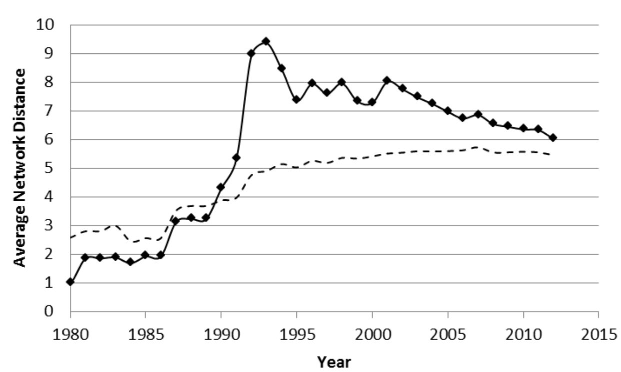
[10] Because the minimum spanning tree contains only the minimum set of links, the absence of a link between two IS scholars does not necessarily mean that they have not co-authored any papers. We displayed the minimum spanning tree rather than all the 5,790 links because the latter would make the visual representation extremely dense and incomprehensible.

Q2b: Has the IS community become more structurally efficient over time?

We used average network distance to measure the network's structural efficiency. The distance between a pair of members is the length of the shortest path between them (Albert & Barabási, 2002). The average distance of the network is computed by averaging the shortest paths between all pairs of members. The shorter the average distance, the closer the IS scholars, and the easier it is for them to reach others[11]. Because network distance is meaningful only for connected graphs (Bollobás, 1985), we calculated this metric for the largest connected components in the yearly networks (see Figure 5).

The average network distance increased from 1.0 in 1980 to 9.37 in 1993, then dropped to 6.02 in 2012. The drastic rise in average network distance in the early 1990s was due to the large number of IS scholars joining the network. These new members greatly increased the size of the largest connected component but formed connections mainly with themselves rather than with existing members, thereby increasing average network distance and reducing structural efficiency. For example, the size of the largest connected component almost tripled from 76 to 220 members in 1992. Yet, only 18 out of the 123 new links (14.6%) were between new members and existing members. Consequently, the largest connected component became less of a "small world".

Because the average network distance is influenced by the network size, the threshold for structural efficiency can be obtained by calculating the "expected" average network distance using a random network[12] as the baseline (Watts & Strogatz, 1998). A network is structurally efficient if its average network distance is less than or equal to this expected value. The dashed line in Figure 5 plots the expected average distances in the random networks from 1980 to 2009. Each random network has the same size and average degree as in the largest connected component of the corresponding yearly network. We can see that, since 1992, the average distances have been gradually returning to their expected values. However, as the current average distance is still slightly greater than its expected value, we cannot deem the network of IS scholars to be structurally efficient. Table 1 shows the average network distances for other business fields. The numbers in the parentheses are the expected network distances. It appears that the networks for other business fields may not be structurally efficient either.



Note: The dashed line represents the expected average distances in the random networks.

Figure 5. Changes in Average Network Distance Over Time (in Yearly Networks).

[11] IS scholars do not rely solely on co-authorship links to share knowledge. Communication technologies facilitate interactions and knowledge exchange among IS scholars. Knowledge exchange also occurs when IS scholars read published work. However, because it is impossible for IS scholars to be connected with all others in the IS community, average network distance provides a measure of the difficulty for exchanging knowledge (including unpublished knowledge) when direct connections do not exist.

[12] A random network is a graph in which the probability of a node connecting with any other node is a fixed constant (Bollobás, 1998). The average distance of a random network can be calculated by ln(n)/ln(k), where n is the network size, and k is the average degree centrality (Watts & Strogatz, 1998).

Our results for Q2a and Q2b show that, over time, the proportion of IS scholars in the largest connected component has increased. This trend is essential for keeping the IS community from disintegration (DeSanctis, 2003; Wenger, 1998). Because the largest connected component now includes more than 65 percent of all members in the network, the network is no longer fragmented. Although collaboration relationships are by no means equivalent to mutual dependence between IS scholars, we can at least say that the increasing amount of collaborative relationships reflects the tendency of IS scholars to recognize and appreciate each other's specialties, expertise, and capabilities. This finding is consistent with recent evidence about the higher level of mutual dependency in IS research based on an author co-citation analysis (Taylor et al., 2010).

The structural efficiency of the network has been increasing since 1992. Therefore, in the last decade, the IS community is gradually developing into a "small world", which facilitates knowledge exchange between members. Although the IS community cannot be deemed structural efficient based on the expected average network distance, the IS community is clearly making progress over time (see Figure 5) so this should not be a major concern. Indeed, even highly established fields such as finance and physics (Banville & Laudry, 1989; Whitley, 1984) are not structurally efficient based on their respective expected average network distances (Acedo et al., 2006; Newman, 2004).

4.4. Structural Holes

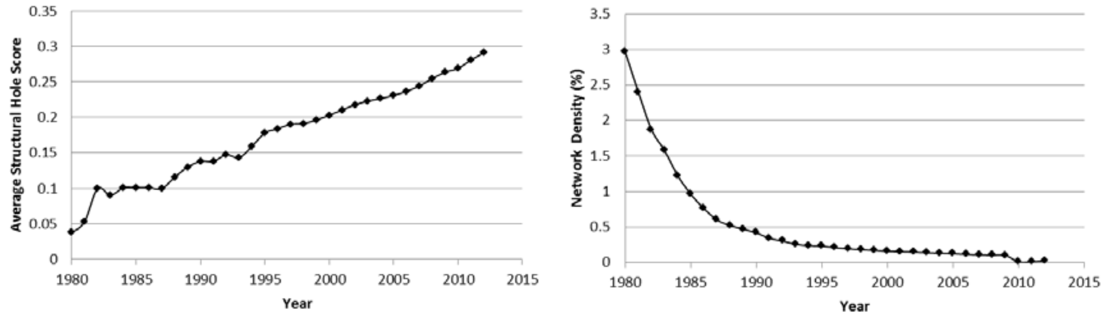
Q3: Has the IS community accumulated more structural holes over time?

At the individual level, the structural hole score for a member is a function of network size, density, and hierarchy (Burt, 1992)[13]. Simply put, the structural hole score is a measure of non-redundancy among a member's ego network of social links, reflecting the potential for the member to access diverse knowledge. Network density, which is often used to measure network closure, is the percentage of actual number of links out of the number of all possible links in a network (Wasserman & Faust, 1994). A network density of 100 percent refers to a situation in which each member is connected with all other members. At the individual level, the less dense an individual's network, the more likely it is that their links possess different knowledge from each other. Consequently, their structural hole score is higher. At the network level, the average structural hole score reflects potential collaboration opportunities in the network.

Figure 6 shows that the average structural hole score of IS scholars increased from 0.04 in 1980 to 0.29 in 2012, and that the network density dropped from 2.96 percent in 1980 to 0.02 percent in 2012. These results suggest that, although the network has grown and IS scholars have become less densely connected, they now have more opportunities to make new connections and thus access diverse knowledge than before.

There is no widely accepted criterion for the "best" structural hole score. Table 1 shows that studies involving other business fields do not report this metric. However, given that the latest structural hole score is only 0.3 (way below the maximum of 1.0), it seems that many opportunities to make new connections still exist. Among other business fields, finance is the most closed community (with the highest density), followed by management, IS, and finally marketing (see Table 1).

[13] Burt (1992) provides the formula for calculating the structural hole score. Because of the space constraint, we did not include that formula in this paper.



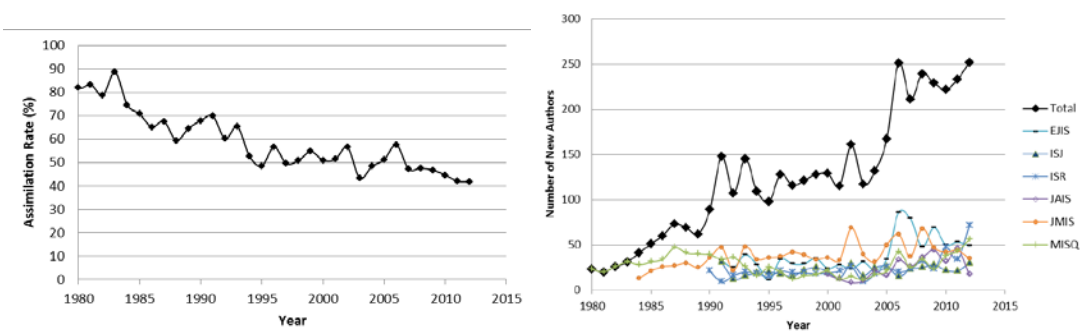
a. Average structural hole score
b. Network density (Closure)

Figure 6. Changes in Average Structural Hole Score and Network Density Over Time (in Yearly Networks)

4.5. Network Growth

Q4: Has the IS community been able to assimilate new members over time?

The assimilation rate is the percentage of new members who joined the network each year. As Figure 7a shows, the assimilation rate was high in the early 1980s because the IS field then was small and growing. New members trained in a variety of related fields joined the IS community during that time (Hirschheim & Klein, 2012). Since 1995, the assimilation rate has been between 40 and 60 percent. Note that the decrease in the assimilation rate only means that the network was growing at a lower speed. In absolute terms, as Figure 7b shows, the total number of new members per year increased from 23 in 1980 to 252 in 2012. Those instances of salient increases may be accounted for by the emergence of new journals or existing journals publishing more paper. With more publication opportunities, more new IS scholars joined the network. For example, the steep rise in 1991 was caused by the inception of two journals (*EJIS* and *ISJ*), which, together, added 64 new IS scholars to the network. The number reached its peak in 2006 when *EJIS* published 22 more paper in that year (from 29 papers in 2005 to 51 paper in 2006), adding 86 new IS scholars to the network. Overall, the total number of IS scholars in the network rose from 94 in 1980 to 4,174 in 2012, an increase of more than 44 fold.



a. Assimilation rate
b. Number of New Authors

Figure 7. Changes in Assimilation Rate and the Number of New Authors Over Time (in Yearly Networks)

The assimilation of new IS scholars into the network was typically accompanied by the emergence of new research topics. This growth in research topics over time has been reported in prior research (Sidorova et al., 2008; Taylor et al., 2010). We found a similar growth pattern. In the 1980s, the dominant research theme was decision support systems. In the 1990s, the dominant research theme was group support systems. In the 2000s, emerging research themes were electronic commerce and economics of IS. Service science and design science have become frequently researched topics from 2010 to 2012. As new research themes became important, IS scholars with relevant expertise joined the network.

4.6. Structural Cohesion

A sub-community comprises IS scholars with common research interests. Before we assessed the structural cohesion of the five sub-communities (IS development, IS for individuals, IS for groups, IS for organizations, and IS for markets), we plotted the changes in group sizes based on the three decennial networks (1980s, 1990s, and 2000s). Figure 8 shows that all five sub-communities grew between 1980 and 2009, but at different rates. Two sub-communities (IS development and IS for organizations) have remained comparatively large over the three decades. Two sub-communities (IS for individuals, and IS for markets) grew relatively quickly from the 1990s onwards. The growth for the IS for markets sub-community has been the strongest (from only three members in the 1980s to more than 200 members in 2000s). Overall, each of the five sub-communities has been able to sustain itself over time, with new members joining from time to time.

The different growth rates of the five sub-communities may reflect the changing relative importance of the research themes of these sub-communities over time (Taylor et al., 2010). While there has been extensive collaboration in the sub-communities, there is also some collaboration across the sub-communities. Indeed, some central members of the IS community have been very active in more than one sub-community, thereby bridging sub-communities (see the discussion for Q1b).

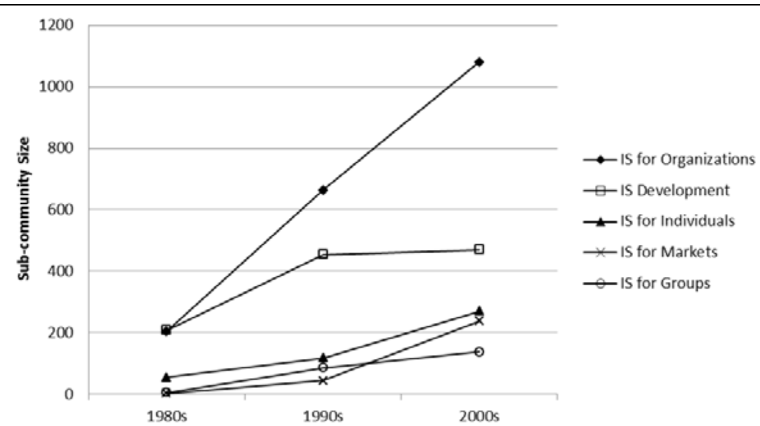


Figure 8. Changes in Sub-Community Sizes Over Time (in Decennial Networks)

Q5: Have the sub-communities in the IS community remained structurally cohesive over time?

Structural cohesion is a group-level metric. The structural cohesion of a sub-community is its internal link density divided by its external link density[14]. A structurally cohesive sub-community maintains relatively dense internal links and relatively sparse external links. A sub-community is considered cohesive if the structural cohesion score is greater than 1.0 (Wasserman & Faust, 1994).

As Figure 9 shows, two sub-communities (IS for groups and IS for markets) have become structurally cohesive since the 1990s (with structural cohesion scores greater than 1.0 since then). The IS for groups sub-community has increased in structural cohesion scores from 0 in the 1980s, 16.8 in the 1990s, to 19.6 in the 2000s. The low structural cohesion score for this sub-community in the 1980s was due to the fact that its size then was rather small (5 members) and these IS scholars did not

[14] Given that a sub-community of size n is connected with g external members through m links, the external link density is m/ng.

collaborate. The structural cohesion scores for the IS for markets sub-community started from 0 in the 1980s, drastically increased to 19.3 in the 1990s, and later dropped to 8.75 in the 2000s. Similarly, the low structural cohesion score for this sub-community in the 1980s was due to its small size (3 members) and the lack of collaboration among these scholars. In the 1990s, IS for markets became a popular area of work and the number of IS scholars in this sub-community increased to 44. However, they tended to only collaborate among themselves, leading to a very high structural cohesion score. Over time, more IS scholars joined this sub-community, increasing its size to 238 in the 2000s. They started collaborating with IS scholars from other sub-communities, thereby reducing the structural cohesion score.

The other three sub-communities (IS development, IS for organizations, and IS for individuals) have maintained their structural cohesion scores at greater than 1.0 over the three decades from the 1980s to the 2000s, but with different trends. The IS development sub-community has increased in structural cohesion score from 3.73 in the 1980s, 4.31 in the 1990s, to 7.19 in the 2000s. The IS for individuals sub-community has decreased in structural cohesion score from 11.17 in the 1980s, 10.48 in the 1990s, to 7.21 in the 2000s. The IS for organizations sub-community has fairly constant structural cohesion score ranging from 3.09 in the 1980s to 3.11 in the 2000s.

Overall, considering that all the five sub-communities have maintained structural cohesion scores at greater than 1.0 since the 1990s, these sub-communities seems to remain structurally cohesive over time. Table 3 provides summarizes these results.

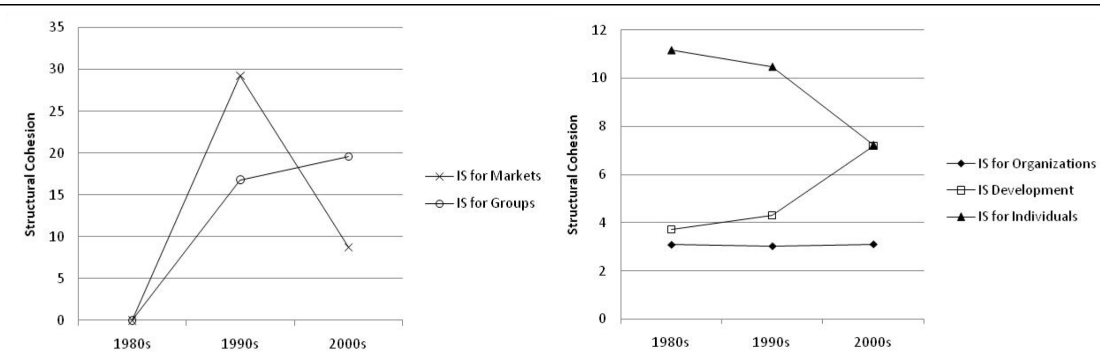


Figure 9. Changes in Structural Cohesion of Sub-Communities Over Time (in Decennial Networks)

Table 3. Summary of Results		
Questions	**Key metrics used**	**Progress made**
Question 1: Network ties		
Q1a: Has the IS community accumulated more network ties over time?	Average degree centrality	Yes
Q1b: Who have been the central members in the IS community at different times?	Degree centrality Betweenness centrality	Not applicable
Question 2: Network configuration		
Q2a: Has the IS community become more connected or fragmented over time?	Proportion of members in the largest connected component	Yes
Q2b: Has the IS community become more structurally efficient over time?	Average network distance	Yes (from 1993 onwards)
Question 3: Structural holes		
Q3: Has the IS community accumulated more structural holes over time?	Average structural hole score Network density	Yes
Question 4: Network growth		
Q4: Has the IS community been able to assimilate new members over time?	Assimilation rate Number of new authors	Yes
Question 5: Structural cohesion		
Q5: Have the sub-communities in the IS community remained structurally cohesive over time?	Structural cohesion of sub-communities	Yes

5. Limitations to Generalization

Our results shed light on the development of social capital in the IS community. Overall, the IS community has made significant progress in accumulating structural social capital in the past three decades (see Table 3). This IS community's progress is comparable to those of other business fields such as management, finance, and marketing (see Table 1). The trends indicated by the metrics on network ties, network configuration, structural holes, network growth, and structural cohesion (of sub-communities) hint that our results may be generalizable to the future of the IS field. Specifically, considering that these trends have moved in the same direction in at least the past two decades, it seems that the IS community is likely to continue on a healthy and sustainable path in the coming years.

Our findings have to be interpreted in the context of their limitations. First, we relied solely on authorships in six top-tier journals to determine the set of IS scholars. Although the six chosen journals are well known in the IS field, the authors of all the papers in these journals do not make up the entire IS community. For example, IS scholars who only publish their work in other journals or in conference proceedings are not included. Moreover, IS scholars from non-English speaking countries who write and publish papers in other languages are not included. Therefore, the collection of IS scholars in our dataset represents only a part of the IS community. Nevertheless, our dataset captures a significant proportion of prominent IS scholars who have contributed much to knowledge creation and innovation in the field. It is important to know how structural social capital has been developing among this group of IS scholars.

Second, our analysis of structural social capital was based only on information on co-authorships. We did not consider other forms of collaboration among IS scholars. For example, besides co-authoring papers, IS scholars can collaborate in research but not publish their work together. They may serve together in journal editorial boards, conference program committees, or professional associations. Nevertheless, the collection of co-authorship links captures formal scientific collaboration (which is the bulk of research collaboration) among IS scholars in research-intensive institutions globally. Such collaboration accounts for a significant portion of knowledge creation and innovation in the IS field.

Third, we focused only on structural social capital. Because we excluded relational social capital and cognitive social capital, our results cannot provide answers about whether the IS field has built up trust, recognition, shared codes, and common languages over the past three decades. Given that these aspects also offer valuable information about the health of communities, future studies could complement this study by similarly examining whether relational social capital and cognitive social capital have been built up in the IS community in the past several decades.

6. Implications and Recommendations

This study has useful implications for the debate on focus versus diversity in the IS field. In addition, we recommend plausible ways that we believe can help enhance the intellectual contribution of the IS field.

6.1. Implications for the IS Field

The results on network growth reveal that the IS field has an assimilation rate of no less than 40 percent, which corresponds to a steady increase in the number of new members yearly. This trend is likely to continue into the foreseeable future. There has been steady growth in three sub-communities (IS development, IS for organizations, and IS for individuals) over the past three decades. While the remaining two sub-communities (IS for groups and IS for markets) have also seen growth, these sub-communities grew significantly in the 1990s. Even with all the growth, the results show that each of these sub-communities has remained structurally cohesive over time. The growth in the various structurally cohesive sub-communities has led to concern that the IS field may be heading in the direction of a fragmented adhocracy (Banville and Landry 1989), in which there would be negligible communication and mutual learning between sub-communities, leading to weakening of the intellectual core and thereby possibly triggering an identity crisis (Benbasat & Weber, 1996; Benbasat & Zmud, 2003).

However, the results on network ties demonstrate that average degree centrality for the entire IS community has increased steadily, suggesting that members of the network have become better connected over time. The results on network configuration show that the proportion of members of the network who are part of the largest connected component has increased steadily over time, while average network distance for the entire IS community has been decreasing for the past two decades. These are also indicators that members of the network have become better connected over time. Hence, the results pertaining to network ties and network configuration serve to alleviate the concern about the IS field developing into a fragmented adhocracy.

The fact that the various sub-communities in the field have grown steadily while the entire network became better (rather than worse) connected over time suggests that a proportion of IS scholars must have helped bridge the various sub-communities even as these sub-communities grew. Indeed, a good number of renowned IS scholars listed in Table 2 have played this bridging role. For instance, Kalle Lyytinen has been collaborating with researchers in both the IS for organizations and IS development sub-communities. The value of having IS scholars playing such a bridging role can be seen from the results on structural holes. Over time, the average structural hole score has steadily increased while network density has steadily decreased. These results suggest that members of the IS community have increasingly been able to access more non-redundant knowledge, possibly from other sub-communities of the IS field (or even from other fields).

Some have feared that diversity, which can potentially pull apart the various growing sub-communities, may pose a threat to the intellectual development of the IS field through reducing the chance of developing shared languages and weakening of its intellectual core (Benbasat & Zmud, 2003). These fears have not materialized, possibly due to the growing pool of IS scholars helping bridge the various sub-communities. Instead, as the various sub-communities grow, the IS field makes progress in accumulating structural social capital that facilitates knowledge creation and innovation. And as the various sub-communities advance on research topics, the IS field has grown in its intellectual core by incorporating these new research ideas and by allowing the new research ideas from each sub-community to influence the thinking in other sub-communities.

6.2. Recommendations for IS Scholars

Collaborative work can help IS scholars increase their research productivity, quality, and reputation. However, because collaborative work also incurs costs (e.g., on managing coordination and conflicts), IS scholars need to manage their collaborative relationships strategically. For example, while large-scale collaboration can bring on board many fresh research ideas and perspectives, many institutions may be concerned about publications that have too many co-authors. A survey among department chairs has reported that four or more co-authors in a publication are often considered too many (Nathan, Hermanson, & Hermanson, 1998). In the collaboration bandwidth that IS scholars can manage, they have to achieve a good balance of collaborating in and outside their specific sub-community.

Many IS scholars work primarily within a specific sub-community. Collaborating with other IS scholars from the same sub-community has obvious advantages, such as shared language, common research perspectives, and common theoretical knowledge. For these reasons, IS scholars tend to operate in their specific sub-community. The detriments of doing this would be high knowledge redundancy and less likelihood of innovation. To innovate and do higher impact research work, IS scholars could spend part of their research effort bridging sub-communities to learn and apply new research ideas from other sub-communities for their own research work. Such bridging effort can help reduce the average network distance, thereby increasing the structural efficiency of the entire network (Watts, 1999).

Figure 10 presents the collaboration map for the various sub-communities in the 2000s. The weights of the links between sub-communities are proportional to the number of ties between IS scholars from different sub-communities. Where the links are weak, there exist many opportunities for IS scholars in the pertinent sub-communities to collaborate. For example, IS scholars working in the IS for markets and the IS development sub-communities may work together to analyze Internet commerce behavioral patterns to develop new design principles for IT artifacts. Similarly, IS scholars working in the IS for markets and the IS for groups sub-communities may collaborate to build new IT artifacts to enhance Internet commerce capabilities for the increasingly popular group-buying transactions.

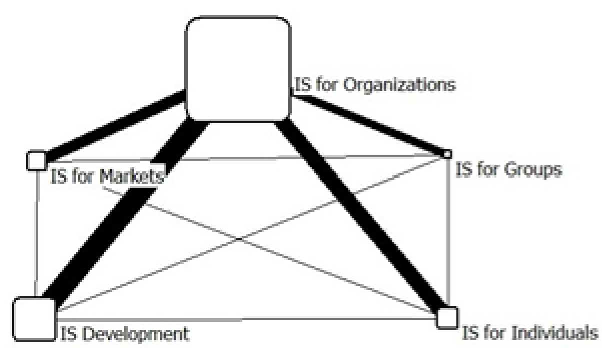


Figure 10. Collaboration Between Different Sub-Communities in the 2000s

The IS field was founded on several reference fields, including computer science, behavioral and social sciences, and organizational science (Keen, 1980). This has contributed to the diversity of research in the IS field (Benbasat & Weber, 1996; Vessey et al., 2002). IS scholars can continue to learn from these contributing fields to expand the intellectual core of the IS community. Such collaborative relationships across fields can also increase the structural social capital of the IS field. For example, IS scholars doing research on "big data" could work with scholars from computer science to process and analyze large datasets (e.g., using efficient algorithms to mine consumer opinions from large volumes of online posts and blogs) and with scholars from information science to discern meaningful patterns in the datasets (e.g., finding out what consumers are really saying about specific products or services over time). This type of inter-disciplinary collaboration has potential to yield interesting research insights.

6.3. Recommendations for IS Publications Outlets

As major outlets publishing fresh research results, academic journals play a crucial role in shaping the intellectual structure of a field. These journals (including the six journals examined in this study) can facilitate the growth and vibrancy of the IS field by publishing research that can potentially accelerate the development of structural social capital (and intellectual core) in the IS community. Such research tends to cut across sub-community (or even disciplinary) boundaries and generate opportunities for the IS community through opening up fresh new research avenues. Journals can facilitate cross-community (or cross disciplinary) research in several ways. First, they can broaden their editorial scope so that such paper do not get filtered out immediately in pre-screening by editors. Second, special issues may even be designed to attract submission of these types of papers. Third, journals can put in more effort to recruit "structural brokers" (i.e., IS scholars who bridge sub-communities or even fields) as associate editors and senior editors[15]. Given the nature of their collaborative research work, "structural brokers" tend to be more able to appreciate papers that transcend the boundaries of sub-communities or even fields. Generally, major IS journals have made much progress in broadening their editorial scope and featuring various boundary-spanning special issues in recent years.

Similarly, major IS conferences can accommodate tracks that publish papers bridging sub-communities or even field. For example, the International Conference on Information Systems has used, in recent years, the "breakthrough ideas" track to publish innovative papers that may not necessarily belong to a specific sub-community. Because these conferences are attended by numerous IS scholars, they help signal new research streams that are to come and offer an excellent forum for IS scholars from the various sub-communities to learn from each other, form collaborative relationships, and embark on exciting research avenues.

7. Conclusion

Using Whitley's framework for classifying scientific fields (Whitley, 1984), Banville and Landry (1989) categorized the IS field as a fragmented adhocracy, in which there was a low level of mutual dependence between scholars. In the years that have since transpired, the IS field has made progress in building a cumulative tradition that has given rise to a body of knowledge unique to the field (Grover, Ayyagari, Gokhale, Lim, & Coffey, 2006; Sidorova et al., 2008; Taylor et al., 2010; Wade, Biehl, & Kim, 2006). In spite of these advances, there is still an ongoing debate about the relative merits of focus versus diversity and a discussion about possible structural disintegration in the IS field (Agarwal & Lucas, 2005; Alter, 2003a, 2003b; Benbasat & Zmud, 2003; Galliers, 2003; Hirschheim & Klein, 2003; Orlikowski & Iacono, 2001).

Against such a backdrop, this study provides empirical evidence to show that the IS field has made significant progress in building structural social capital, maintained five reasonably focused research areas while accommodating diversity, and shifted away from a fragmented adhocracy (and possible structural disintegration) to a more connected community. We believe that IS researchers can continue to engage in cross-area collaboration (in the IS field) and cross-disciplinary collaboration because these types of collaborative activities help build up social capital, facilitate knowledge creation and innovation, and cement the identity of the IS field as a scientific field.

[15] We can supply a list of such names if journal editors are interested.

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