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A Historical Observation of the Intellectual and Institutional Structures of the Field

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Abstract:

In this paper, we examine the evolution of the institutional and intellectual structures of the IS field. We argue that, though the field's institutional structures—academic programs, journals, conferences, and professional associations—have developed admirably, the state of the field's intellectual structure is less clear. We employ a co-citation lens to analyze the development and evolution of subfields across three periods. We rely on Culnan's (1987) second co-citation study as a point of departure for our analysis. We then extend her work through two additional studies that individually assess the state of subfield development at distinct periods during the field's history. Over the three periods, we note that the field has experienced change in subfield diversity and cohesion. Culnan's study exhibits low levels of cohesion and diversity among topics. Our first study shows continued isolation but growth in subfield diversity. This period is indicative of a fragmented adhocracy. Our second study suggests increasing levels of integration despite only a slight reduction in subfield diversity. While we largely only describe the field's evolution, any assessment of whether this evolution represents a positive or negative trajectory for the field will be subject to interpretation and debate.

Keywords: History, Author Co-citation, Field Change, IS Field, IS Research.

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"If you don't know where you've come from, you don't know where you are." –James Burke[1]

1 Introduction

Speaking at the inaugural International Conference on Information Systems (ICIS) in 1980, Peter Keen encouraged those in attendance to take an introspective look at the information systems (IS) field (Keen, 1980). He posed six questions that, if unanswered, could hinder the field's future development: 1) "what are the field's reference fields?", 2) "what is the dependent variable?", 3) "how do we build cumulative tradition?", 4) "what is the relationship of IS research to computer technology?", 5) "what is its relationship to practice?", and 6) "where should we try to publish?". Broadly understood, these questions fall into one of two areas of concern. The first addresses the field's *intellectual structures* by emphasizing the need for a consistent approach toward integrating reference fields, a shared understanding of the field's focal phenomenon, and the establishment of a rigorous research tradition among the field's members. The second broad area of concern focuses on the field's *institutional structures* that would support the publication of field-specific research and the development of cumulative, reciprocal relationships among IS researchers.

In the ensuing 34 years, many academics have heeded Keen's call and turned their attention to the field's intellectual and institutional development. Early efforts to develop the field's boundaries led to various attempts at organizing and classifying IS research. For example, Culnan (1985, 1987) developed a classification scheme for the field's reference fields, which establishes three broad classifications (fundamental theory, underlying fields, related applied fields) in which IS reference fields may reside. Other researchers have turned away from the field's boundaries and toward the center to identify the phenomena that constitute the core of IS (DeLone & McLean, 1992; Lim, Rong, & Grover, 2007). Though these and other developments have provided a platform for IS's growth and maturity as an applied management field, the dynamic nature of the field's growth has led to vigorous debate among IS academics as they search for the proper balance between basic and applied research and as scholars continue to negotiate the field's intellectual structure (Benbasat & Zmud, 2003; Robey, 2003).

Many of these debates play out across a variety of institutional outlets. In its infancy, the field was dependent on reference field journals and conferences for support to establish its identity as an independent field. As the field grew, its leaders responded to the paucity of resources by forming a variety of field-specific journals and conferences to meet the needs of a growing and diverse field. Further improvement in the institutional structures and support of the field can be seen in the increase in quality and number of IS journals (Straub & Anderson, 2010), the ever-swelling attendance of IS-specific regional and international conferences, and the establishment and subsequent growth of the Association of Information Systems—the field's professional society. However, the development of these structures is not without controversy because academics continue to question whether the building of these support structures is creating a platform for or a barrier to increased discourse between academics and professionals.

Though many scholars have participated in and contributed to these ongoing debates, we neither enter into nor settle the debate. Instead, we step back from the debate and consider IS's evolution. Clearly, the field is neither where it once was nor where it will ultimately be, and, because we consider the field's present state, we should do so in light of its patterns of intellectual and institutional growth. We take stock of the field's institutional structures and argue that they have evolved handsomely. We then spend the bulk of the paper identifying the field's intellectual structures and find that there are indeed some observable patterns that could provide insight into the field's development. In observing these patterns, we shed light, albeit descriptively, on the patterns of evolution in our intellectual structures. Whether one can view these patterns positively, commensurate with the maturing of institutional structures, is subject to interpretation and debate.

[1] James Burke's quote sits atop the Association for Information Systems' (AIS) website devoted to the field's history as reminder to all who might be tempted to interpret the events of the present without a historical lens that any such interpretation will be, at best, incomplete.

1.1 Historical Evolution of Institutional Structures

Many of the well-meaning jeremiads against the current adhocracy often fail to acknowledge the state from whence the field has come. During the initial stages of the field's development, none of the leading researchers had training as IS academics. This point is obvious on its face but should be remembered when assessing a field that has formed ex nihilo. The first institutional structures began to take shape the in the late 1960s—approximately 15 years after the introduction of computer systems into an organizational context. The first PhD program designed to train IS researchers was established in 1967 at the University of Minnesota, which was followed by an initial guideline for graduate curriculum for studying IS in 1972. In 1976, the International Federation for Information Processing (IFIP) established a technical committee (TC8—Information Systems) devoted to enhancing dialog between IS academics and practitioners. It added the first TC8 work group (WG8.1) to address the planning and implementation of information systems in organizations, and subsequent work groups have since been added to address the changing landscape of IT research and practice. Due to the sudden rise of information systems as both an organizational and academic concern, the field began as an interdisciplinary endeavor. Early members of the field hailed from a variety of reference fields including computer science and operations research, and each approached the field from a unique perspective yet were drawn by a common organizing phenomenon: information technology. As technology matured and organizational use of technology became more sophisticated, undergraduate programs in the United States and Europe began accepting and training students in IS. These academic structures continue to grow and evolve to meet the changing needs of research and practice.

The early avenues for establishing and disseminating the field's intellectual content were similarly patchwork. Before IS-specific journals formed, researchers relied on the pages of reference journals for publication, validation, and communication (Hirschheim & Klein, 2012). This publishing landscape gave rise to an ad-hoc approach to research because academics tailored their research to the peculiar focus of more established management, economic, and psychology journals. The field's institutional structure shifted dramatically in the late 1970s with the launch of two field-specific journals in 1977: *Management Information Systems Quarterly* (*MISQ*) and *Information and Management* (*I&M*). This marked the beginning of massive growth in IS publishing. The *Journal of Management Information Systems* (*JMIS*) began accepting papers in 1984, followed by the *Journal of Information Technology* (*JIT*) in 1986, *Information Systems Research (ISR)* in 1990, *European Journal of Information Systems* (*EJIS*), *Information Systems Journal (ISJ)*, and *Journal of Strategic Information Systems (JSIS)* in 1991, and the *Journal of the Association of Information Systems* (*JAIS*) in 2000. Together, these journals make up the "basket of eight" journals that many consider to be the field's premiere publishing outlets.

While publishing outlets are necessary for research and academic advancement, they are asynchronous modes of communication and, thus, do not conduce the reciprocal relationships necessary for integrating disparate intellectual silos. Aware of the need for greater knowledge sharing and integration, several leaders in the field organized the International Conference on Information Systems to "provide a direction to IS research as it moved into the 1980s" (Hirschheim & Klein, 2012). While ICIS continued to be the pre-eminent conference, the 1990s broadened this structural resource with many regional conferences: the Australasian Conference on Information Systems (ACIS) began in 1990, the European Conference on Information Systems (ECIS) and Pacific-Asia Conference on Information Systems (PACIS) began in 1993, and the Americas Conference on Information Systems (AMCIS) began in 1995. As the field matured, many of these conferences began hosting pre-conference special interest groups (SIGs) to further encourage discussion and collaboration among academics interested in new and emerging topics.

Field-specific academic programs, journals, and conferences are the institutional structures that provide a necessary foundation for growth in the academy. However, applied fields need additional structures to maintain and strengthen the links between theory and practice. Without appropriate structures, practitioners will continue to think academics "talk funny" (Corley & Gioia, 2011) and the impact of research on practice will remain weak. As a field that was born as an academic response to practitioner problems, IS researchers have enjoyed an enduring relationship with IS professionals. The Society for Information Systems (later the Society for Information Management) was established in the late 1960s to support IS professionals and held an inaugural conference at the University of Minnesota in 1969. In 1974, several leading IS researchers—including Peter Keen—at Massachusetts Institute of Technology (MIT) created the Center for Information Systems Research (CISR) "to conduct research on the effective use of computer-based information systems, and in particular concern itself with helping managers deal with questions of information system effectiveness" (Sloan School of Management Center for Information

Systems Research, 1974, p. 2). As the academic field grew more diverse, leaders in the field identified a need for an academic professional society that would unite diverse communities of researchers: they responded by creating the Association for Information Systems (AIS) in 1994. AIS provides a variety of services to academic members including placement services, journal access, and conference support. Though the professional and academic bodies have matured, the link between the two communities has often lagged. To address the widening divide, some journals developed publications, such as *MISQ Executive* and *Communications of the ACM*, which provided opportunities for academics to specifically target practitioners with shorter, practice-oriented papers.

While any single development is not itself a sign of institutional progress toward establishing a relevant yet rigorous field, these events as a whole should, in accordance with Burke's reminder, provide a richer understanding of the field's institutional evolution by which we may more accurately assess where we are. See Figure 1 for the timeline of significant IS Events.

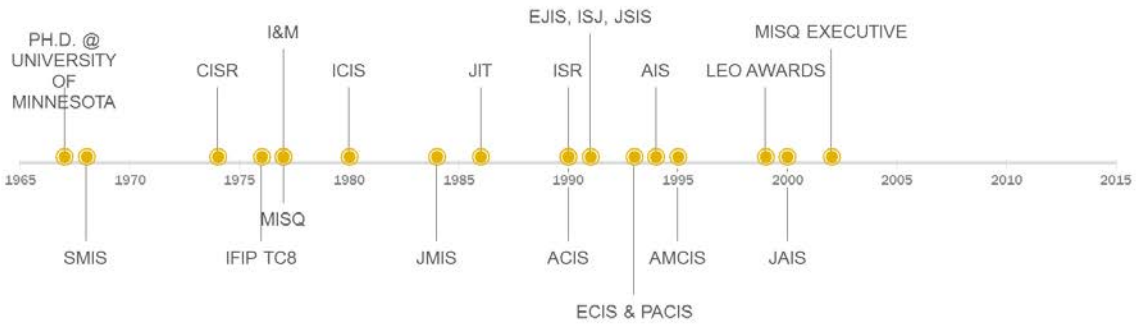

Figure 1. Significant IS Events

1.2 Historical Evolution of Intellectual Structures

In its infancy, IS research primarily focused on the phenomenon that gave rise to the academic field: "the effective design, delivery and use of information systems in organizations" (Keen, 1980, p. 16). The first IS were primarily computation devices installed in organizations to meet a specific organization's needs. These early computer systems were large, complex, and foreign and, thus, academic research focused on installing, adapting, and implementing information systems in organizational settings. Typical of this early perspective is Gorry and Scott Morton's (1971) assertion that "information systems should exist only to support decisions", which suggested an early boundary of the field. Establishing such boundaries gave rise to the Minnesota Experiments, which tended to focus on a narrow set of variables that affected the individual use of information systems in organizations: psychological type of an organizational actor, the type problem the actor needs to solve, the organizational context of the problem, the evidence or information needed to solve the problem, and the methods of presenting the necessary evidence (Mason & Mitroff, 1973).

As technology matured and the price/performance ratio improved, information systems moved out of the back office and on to the desks of managers and support personnel in organizations. A similar shift in research focus accompanied this technological shift. Research streams shifted away from the technical and toward the tactical and strategic as researchers began to consider the strategic importance of information systems (King, 1978). This period also witnessed the emergence of the personal computer (PC) as a management tool and, thus, the end user as an integral component of information system design and implantation (Hirschheim, 1985; Land & Hirschheim, 1983). The increasing diversity of research streams led some researchers to reconsider early conceptualizations of IS research that limited the field's purview to research related to supporting management decisions and to search for a more expansive definition of the field that would accommodate the changing roles of information systems (Hirschheim & Klein, 2012). This introspective search for intellectual identity was accompanied by a growing concern for the field's purpose (DeLone & McLean, 1992) and contribution and the benefits to be reaped from information technology.

The dawn of the "Internet Age" marks the next major transition in the field's identity. A perfect storm of factors—the continued improvement of the price/performance ratio, the commercialization of the Internet, the rise of home computing, and others—converged to again change the field's calculus. While in previous periods information systems served intra-organizational ends, the development of reliable communication networks led to the use of information technology throughout business-to-consumer and business-to-business relationships. As with previous periods, the field's intellectual structure reflected this evolution. Research on the business side of these relationships emerged from a wide variety of topics including globalization, outsourcing, virtual teams, knowledge management, and business intelligence. Consumer-oriented research considered a different set of topics that included: individual technology adoption decisions, the impact of e-commerce, and the use of social networking. In addition to the emergence of new streams and the maturation of established streams, the search for an organizing principle for the field continued. Some authors identified the field's primary research streams, while others sought to identify the field's core (Banker & Kauffman, 2004; Benbasat & Zmud, 2003; Lim et al., 2007). Other researchers questioned the necessity of a core and petitioned instead for the value of the field's dynamism (Lyytinen & King, 2004; Robey, 2003).

Concern for the field's intellectual structure predate Keen's address by at least a decade and continues apace today. Very early in the field's history, researchers sought to establish IS's distinctiveness by identifying conceptualizations and frameworks that describe the field's relationship to and distinguish IS from (Culnan, 1986, 1987; Gorry & Morton, 1971; Mason & Mitroff, 1973) its reference fields. These early attempts at creating a common understanding of the field's core gave way to later, similar attempts (Benbasat & Zmud, 2003; Lyytinen & King, 2004). Despite nearly 40 years of digging to unearth the core of IS, the question of "what IS is" remains. Some researchers warn that the lack of a common body of knowledge ensures that the IS field's research will remain a "fragmented adhocracy" (Banville & Landry, 1989) wherein its subfields exist in silos supported by a subset of authors who are largely disconnected from the remainder of the field. Some might argue that this scenario's perpetuation prevents ideas from cross-pollinating, reduces the field's cohesion, and retards establishing IS as a distinct and consequential field. Therefore, we perform an inductive analysis of the state of IS based on author co-citations to determine whether and to what extent the field's intellectual structure is evolving toward something such as the greater cohesion and integration among its authors and subfields or to a fragmented theme of the larger management field directed by faddish technological trends.

2 Observing the Intellectual Structure over Time

2.1 Co-citation Analysis

Introspective studies are important and essential for addressing many questions related to the IS field's intellectual and institutional structure. With the tremendous possibilities offered by the recent technological explosion, the proliferation of specialized journals, and the diverse viewpoints espoused by key stakeholders on the practice of IS research, our field may be more fragmented today than it has ever been. If so, it is even more important for us to continually assess our intellectual structure in a way that allows us to identify to ourselves, and to others, the key entities (people and topics) and how they are interrelated. Doing so facilitates our ability to provide substantive introspective feedback to the field and observe the foundation on which we are building our field for the new millennium. One mechanism for doing this is an author co-citation analysis (ACA).

Citations document the passage of ideas. Co-citation analysis reinforces the importance of key ideas by noting when a third paper cites two other papers. As such, it can be a particularly useful technique for structuring any field of endeavor by employing analytical and graphical display techniques to produce empirical maps of both people and ideas. Over time, we may infer direction and determine a nucleus of excellence in a particular field. From the depth and breadth of the number of citations, we can construct a picture of those who have gone by and, more importantly perhaps, whether the advance of science was methodic and purposive. Several authors have attempted to develop theoretical boundaries for the IS field (Barki, Rivard, & Talbot, 1988; Barki, Rivard, & Talbot, 1993; King, 1993; Orlikowski & Baroudi, 1991; Robey, 1996). We follow the tradition of these authors who have used empirical methods to outline the IS field's structure (Culnan, 1986; Culnan, O'Reilly, & Chatman, 1990; Culnan & Swanson, 1986; Grover, Segars, & Simon, 1992; Holsapple, Johnson, Manakyan, & Tanner, 1993; Lending & Wetherbe, 1992; Sidorva, Evangelopoulos, Valacich, & Ramakrishnan, 2008; Taylor, Dillon, & Van Wingen, 2010).

Co-citation analysis presumes that authors are surrogates for ideas in their paper. Specifically, this analysis is based on two assumptions: 1) that when a third paper cites two other papers together, a cognitive relationship exists between them; and 2) that the strength of this relationship is proportional to the number of papers that cite them (McCain, 1986, 1990; Small, 1973; White & McCain, 1998). One can construct clusters of related papers via factor structures and display the relationships between clusters on a spatial map representing the cohesion among authors. These clusters represent specialties or subfields, and links between them reveal interdisciplinary relationships. For this reason and because co-citation analyses only consider the citations that occur during the period of interest, one can use the ACA methodology to map the structure of research fields, communication between fields, and the development of active research fronts at a given point in time. One can combine these techniques in a longitudinal manner to create a visual map of the historical evolution of a particular research area. Co-citation analysis follows a common sequence of steps as outlined in Appendix A (McCain, 1990, Taylor et al., 2010). It begins with collecting data, which involves selecting a list of authors to search for as cited references in the Social Sciences Citation Index (SSCI) or Web of Science databases. Once one has identified the authors, one can search the SSCI for those papers that cite pairs of authors together. One then tabulates these counts in a raw co-citation matrix. The second phase involves analyzing the raw co-citation matrix. One converts the matrix to a Pearson correlation matrix and subjects the correlation matrix to statistical analysis. In general, one uses three approaches to multivariate analysis to evaluate a co-citation correlation matrix: 1) factor analysis, 2) cluster analysis, or 3) multidimensional scaling (McCain, 1990). We used both principle component analysis (PCA) and multidimensional scaling as complementary methods to understand the relationships between authors. The final step involves interpreting the resulting clusters and maps. Traditionally, author groups or factors undergo a sensemaking process in which one assigns names and descriptions to each cluster. We objectively assign names to each factor by analyzing the titles and keywords of co-citing papers and collecting the self-reported interests of the authors in each factor. One then superimposes these clusters onto the MDS as borders around groups, which creates a visual representation of the subfields in a field of inquiry.

2.1.1 Factor Analysis

One can use factor analysis in co-citation analyses to identify prominent streams of research in a field (Culnan, 1986, 1987; McCain, 1986, 1990). As with scale development and other uses of factor analyses, co-citation studies use this statistical procedure to identify individual *items* that load together to explain a higher-order *factor*. However, interpreting these analyses differs in that the *items* in co-citation studies are authors and the factors represent the topics that emerge from the co-citation patterns. High factor loadings suggest the centrality of an author in a particular research area. An advantage of this method is that, unlike spatial maps that represent authors by a single point, factor analysis allows authors to load on more than one factor and, thus, provides additional insight into an author's breadth of work.

The members of each factor and the overall focus of their research during the period of analysis defines each factor's intellectual structure. This premise demands a sensemaking endeavor that may be somewhat subjective. Therefore, we followed an approach similar to prior studies (Culnan, 1986, 1987; McCain, 1990; Taylor et al., 2010) and analyzed the keywords and titles of co-citing papers. We obtained the frequencies of content-bearing words and used the results to assign names to each of the identified factors. Researchers have previously demonstrated this method to be a reliable technique for bibliometry.

2.1.2 Multidimensional Scaling

Multidimensional scaling (MDS) creates an information rich display (map) of the authors within a field (White & Griffith, 1981). The spatial location of individual authors indicates both their relationship to co-cited authors and to the remainder of the field. Heavily co-cited authors will be proximal to one another. Tightly grouped authors will appear to share space on the map, which suggests a shared interest in a phenomenon or stream of research. Boundary-spanning authors will appear to reside between multiple nuclei of authors and serve to tether groups of authors together. Authors with many links to others tend to be near the center of the map, while authors with weak ties or authors who tend to focus their research on a single topic will be placed on the periphery. MDS maps are further enriched through their using identified factor structures. The structures allow the researcher to superimpose the identified subfields onto a spatial map of the field's authors and, thus, enhance the map's explanatory power. When factors are overlaid, intellectual city-states begin to form. States are positioned based on their similarity/dissimilarity with other states such that states that are nearer to one another share authors and ideas while distal states are separated by their intellectual dissimilarity.

We conducted two studies and merged our findings with Culnan's (1987) second co-citation study to create a longitudinal view of the IS field's intellectual structure. Below, for each study, we describe the author set and the unique aspects of the methodology.

3 Methods

3.1 Culnan 1980-85

In Section 2, we argue that an understanding of our present that is disconnected from a consideration of our past is, at best, incomplete. In keeping with spirit of her co-citation work, we employ Culnan's (1987) co-citation mapping of the field from 1980-1986 as a benchmark for two additional co-citation studies. The results of her study reveal five clusters of research activity: foundations, psychological approaches to MIS design and use, MIS management, organizational approaches to MIS design and use, and curriculum. The analyses of her prior study indicate the emergence of MIS management as a core concern for researchers. According to Culnan, one can see this emergence as evidence of the field's concern for the issues practitioners face. Culnan's studies are important because they each provide a snapshot of field, which, when compared to subsequent snapshots, should help create a narrative for change in the field (Culnan, 1986, 1987). Though we do not draw any specific conclusions from Culnan's original studies, we do acknowledge their value in establishing the context of our and future studies.

3.2 Study 1 (1990-1997)[2]

For study 1, we began by creating an author set. We intended this author set to represent the scholarly perspective being sketched, that is, capture the range of variability in IS specializations and methodologies. For this reason, how one selects authors is a naturally biased procedure: because one extracts a subset of authors from the full population of IS authors, one potentially excludes valuable information from their analysis. In accordance with best practices, we employed both objective and subjective methods to establish a representative, unbiased sample of leading IS researchers. First, we compiled an initial set by systematically counting the number of publications by authors in leading IS publications (*Information Systems Research, MIS Quarterly, Journal of Management Information Systems, Communications of the ACM, Management Science, and Decision Sciences*)[3] appearing between 1991 and 1997 (Gillenson & Stutz, 1991; Hardgrave & Walstrom, 1997). We identified a second set of authors by listing the most frequently cited authors (500 different authors) based on the number of times they were cited in leading IS publications according to the Social Sciences Citation Index (SSCI). We excluded authors with fewer than 70 citations during the period. We then merged these two lists to create a final set of 53 prominent IS researchers. We confidentially mailed this list was to each of these authors to avoid conformist assessments. We asked them to identify additional authors who they felt were influential or major contributors to the IS field. These authors responded with recommendations for four additional authors. Table B1 in Appendix B shows the final list of 57 authors.

We objectively represent authors that had high visibility through publications and citations and complement them with subjective assessments of missing authors. Though this approach limits the impact of selection bias, our methodology suffers from two selection errors that are common to research of this type: the "basket problem" (Chua, Cao, Cousins, & Straub, 2002; Taylor et al., 2010) and a North American bias (Iivari, 2015). The basket problem refers to biasing that arises when researchers identify a subset or "basket" of journals to represent a sample frame that includes all published works in a field. Research has shown journal selection to have a significant biasing effect on the outcome of one's analyses. Similarly, using papers published in a field's top journals as a proxy for the field's entire body of research often excludes international journals and non-English language journals. Research on culture and globalization have shown that phenomena are not evenly distributed across all peoples and places, which suggests that findings based on the analysis of English language journals may not be generalizable to the field. This would be especially true of fields with a vibrant international community. While these problems are real and not insignificant, they are common to bibliometric analyses in general and to other

[2] We conducted this study in 1999 as part of a larger study. We did not publish the co-citation analysis elsewhere.
[3] This list reflects journals that are prominent over the long time periods studied. It is based on two studies: Hardgrave and Walstrom (1997) and Gillenson and Stutz (1991). Both these studies rate these journals as the top six based on large sample surveys of the field

attempts in information systems research to analyze the field's content (Lim et al., 2007; Sidorova, 2008). We discuss these shortcomings and others more in the limitations section.

We then searched the Social Sciences Citation Index (SSCI) index for papers that included pairs of the selected 57 authors. We placed the total number of times a third author co-cited a pair of authors at the intersection of author pairs in a 57x57 matrix. We computed the diagonals by taking the three highest intersections of each author and dividing by two, which indicated the relative importance of a particular author in the field (Culnan, 1987; McCain, 1990; White & Griffith, 1981). After deleting one author who failed to co-cite with any other author, we converted the resultant 56x56 raw co-citation matrix to a Pearson correlation matrix (Culnan, 1986, 1987; Culnan & Swanson, 1986; McCain, 1990; White & Griffith, 1981; White & McCain, 1998). The principles and detailed procurement of co-cited author retrieval have been extensively discussed elsewhere for those seeking a deeper understanding of the co-citation methodology (Bayer, Smart, & McLaughlin, 1990; Braam, Moed, & Van Raan, 1991; Culnan, 1986, 1987; Culnan et al., 1990; Paisley, 1990; White & Griffith, 1981; White & McCain, 1998).

After collecting the data and measuring the strength of the ties among authors, we analyzed the raw matrix and correlation matrix to create a visual schema of the predominant subfields in IS. First, we analyzed the raw co-citation matrix with a principle components analysis with varimax rotation. Because all authors contribute to each factor to some degree, some researchers recommend limiting factor membership to only the authors who load at .7 or higher. While considering this point, we choose to set a threshold of .4 to so that we might discern any emerging cross-field activity among authors whose influence was wider than it was deep (Culnan, 1987; McCain, 1990). Consistent with the recent ACA efforts in our literature (Taylor et al., 2010), we elected to use a two-dimensional MDS map to interpret our data. The resulting map of the field visually depicts the field's intellectual structure. To visually interpret our data, we used the PCA results to draw subfield borders on the MDS map. We assigned meaning to the factors by analyzing the keywords of our co-citing papers to obtain the frequencies of content-bearing words. We decomposed the bibliographic citations of the clustered authors' titles and obtained relative frequencies of content-bearing words and phrases by using a neural network software package (CATPAC). We examined the neural network key word histograms generated from paper titles in each factor and assigned factor descriptions (names) based on the proximity and incidence of the key words. Appendix A extensively discusses this process, and Appendix C shows the keyword histograms.

3.3 Study 2 (1997-2010)

As in study 1, for study 2, we began by identifying a representative author set. We began with a list of authors based on Hirsch-family impact ratings found in Truex, Cuellar, and Takeda (2009) because this system relies on citation counts to create a measure author prominence by considering authors' productivity and citation density. Though all measures of impact have trade-offs, the measure we selected mitigates some of the possible flaws related to the social process of publication. To further guard against overlooking influential authors whose works were not yet heavily cited, we compared our Truex list with the results of Venkatesh's (2010) online database, which computes scores based on productivity weighted by the inverse of the number of authors on each paper. Finally, to round out our list, we consulted Gallivan and Benbunan-Fich's (2007) list of authors with more than seven citations in a slightly more inclusive list of journals than Venkatesh uses. We included twenty researchers who scored better than average in Venkatesh's system or had more than the mean number of publications in Gallivan and Benbunan-Fich's index in our tentative list of ninety researchers. To prevent excluding researchers relevant to this study, we confidentially circulated our tentative list to a random selection of 30 authors we had already identified as prominent in the field to solicit their feedback. From their responses, we identified a further ten researchers for our list. Table B2 in Appendix B shows the final list of authors.

Because the SSCI excludes co-authors in some searches, we took additional steps to ensure a complete dataset. As a result, we searched the SSCI was for all papers citing any work by any author on our list published from 1997 to 2010. We then used the records to create a 10,000 cell (100x100) matrix of raw citation counts. We calculated the diagonals by computing the three highest intersections of each author and dividing this total by two. The resulting index provides a measure of each author's relative importance with the field (Culnan, 1987; McCain, 1990; White & Griffith, 1981). Appendix A more extensively discusses this process. Finally, consistent with previous co-citation studies (McCain, 1990; Taylor et al., 2010), we removed authors who appeared to be almost completely independent from the others in our study (who had been co-cited less than five times).

As in study 1, we mapped the co-citation analyses to a two-dimensional space. The resulting map of the field visually depicts the relation among authors and research topics. We used factor analytic techniques to identify subfields that would overlay the author map. We used keyword analyses and the self-reported interests of each author to attach meaning to the factors. First, we extracted keywords from 24,300 papers and grouped them by factor. We removed commonly occurring words such as "information", "system", and "technology" and ranked the remaining words by factor. We combined these rankings with the self-reported interests of each author to create a general impression of the content of each factor. Appendix A more extensively discusses this process, and Appendix C lists the keywords and author interests for each factor.

4 Results

4.1 Factor Analysis

The factor analysis for study 1 yielded a nine-factor solution based on the scree plot, interpretability of each factor, and a requirement to have at least two factors loading 0.3 and above. While the author set is limited, it is representative and, therefore, useful for describing the field's current research interests. During the period of interest, the field had two main research interests: group decision support systems (GDSS) and technology acceptance. These two factors accounted for approximately 47 percent of the variance explained by our factor structure, which is more than the sum of the remaining factors. In total, the identified factors accounted for 80.4 percent of the variance in the data, which gives us confidence that the identified structure reasonably well represents IS's subfields. As discussed earlier, the names given to the factors are not arbitrary but instead represent the research of the authors in the subfield and, as such, serve as useful indicators of subfields' evolution. The structure from this period seems to indicate a strong focus on issues such as the strategic implications of IS and GDSS at the organizational level and individual-level phenomenon such as user acceptance of and involvement with technology. Tables 1 and 2 show the factors, authors, and author loadings for study 1. Table 3 visualizes the relative importance of each factor across all three studies.

Table 1. Author Factor Loading for Study 1 (Factors 1-5)

Factor 1		Factor 2		Factor 3		Factor 4		Factor 5	
GDSS		**Technology acceptance**		**Strategic IS planning**		**Social process of IS development**		**Strategic IS Impact**	
Nunamaker	.96	Davis	.92	Lederer	.87	Kling	.89	Bakos	.86
Dennis	.95	Igbaria	.90	Boynton	.88	Markus	.85	Gurbaxani	.81
Watson R.	.87	Doll	.90	Earl	.86	Orlikowski	.83	Clemons	.81
DeSanctis	.88	Guimaraes	.85	Niederman	.83	Hirschherer	.82	Mukhopadhyay	.78
Gallupe	.88	Swanson	.80	Henderson	.81	Lee	.82	Brynjolfsson	.80
Valacich	.84	Ives	.79	Brancheau	.76	Robey	.55	Banker	.71
Poole	.84	Robey	.74	Goodhue	.52	Bostrom	.51	Venkatraman	.43
George	.74	Zmud	.75	King	.51	King	.46	Sethi	.38
Kraemer	.78	Torkzadeh	.77	Venkatraman	.44	Swanson	.41	Grover	.40
Turoff	.81	Barki	.62	Clemons	.42	Zmud	.37	Kemerer	.32
Hiltz	.58	Goodhue	.59	Grover	.32	Kraemer	.34		
Bostrom	.53	Brancheau	.51	Watson H.	.32	Ives	.36		
Jarvenpaa	.52	Watson H.	.49	Nelson	.36	Rice	.32		
Rice	.33	Nelson	.47						
Benbasat	.32	Bostrom	.44						
Liang	.34	Benbasat	.43						
Short	.31	King	.38						
Grover	.36								
Sethi	.36								

Table 1. Author Factor Loading for Study 1 (Factors 1-5)

Hirschherer	.33								
Eigenvalue	14.8		11.65		4.76		4.16		2.83
Variance %	26.5		20.8		8.49		7.43		5.06

Table 2. Author Factor Loading for Study 1 (Factors 6-9)

Factor 6		**Factor 7**		**Factor 8**		**Factor 9**	
Cognitive aids and information processing		**Computer-mediated communication**		**Information technology structures**		**Software models**	
Todd	.87	Short	.84	Venkatraman	.68	Kemerer	.73
Benbasat	.76	Rice	.84	Barki	.59	Banker	.63
Vessey	.87	Hiltz	.73	Grover	.47	Nelson	.45
Jarvenpaa	.70	Higgins	.63	Sethi	.44	Henderson	.32
Courtney	.64	Markus	.35	Nelson	.45		
Liang	.63						
Desanctis	.40						
Zmud	.31						
Eigenvalue	2.46		1.73		1.44		1.17
Variance %	4.4		3.1		2.58		2.08

Table 3. Author Factor Loading for Study 2 (Factors 1-4)

Factor 1		**Factor 2**		**Factor 3**		**Factor 4**	
Use, acceptance, and adoption		**Economic impact**		**Organizational learning**		**GDSS**	
Davis_FD	.98	Barua	.92	Lyytinen	.91	Dennis	.97
Venkatesh	.96	Kauffman	.92	Hirschheim	.89	Connolly	.90
Straub	.93	Brynjolfsson	.90	Baskerville	.87	Nunamaker	.88
Agarwal	.92	Kekre	.88	Walsham	.86	Valacich	.84
Gefen	.90	Gurbaxani	.88	Robey	.84	Northcraft	.79
Davis	.87	Mukhopodhyay	.87	Mingers	.82	Bostrom	.78
Bhatterchee	.87	Kraemer	.85	Ciborra	.76	Huber	.69
Higgens	.85	Hitt	.82	Orlikowski	.74	Alavi	.66
Tam	.84	Kemerer	.81	Galliers	.72	Jarvenpaa	.65
Mclean	.78	Zhu	.81	Heeks	.72	Davison	.62
Keil	.78	Banker	.80	Lee	.71	Poole	.59
Huff	.78	Whinston	.75	Swanson	.61	Benbasat	.57
Burtonjones	.78	Grover	.73	Kling	.60	Webster	.56
Pavlou	.78	Weill	.72	Benbasat	.58	Zmud	.52
Goodhue	.78	Gosain	.71	Keil	.58	Sarker	.51
Igbaria	.76	Venkatraman	.68	Zmud	.57	Orlikowski	.46
Jarvenpaa	.72	Rai	.68	Davison	.57	Ives	.45
Jiang	.71	Sambamurthy	.67	Sarker	.56	Lee	.42
Webster	.70	Benbasat	.57	Willcocks	.55		

Table 3. Author Factor Loading for Study 2 (Factors 1-4)

Benbasat	.66	Kettinger	.56	Powell	.55		
Zmud	.61	Smith	.56	Love	.49		
Rai	.61	Swanson	.56	Rai	.45		
Grover	.60	Gupta	.53	Alavi	.43		
Watson_HJ	.60	King	.52	Jiang	.43		
Lederer	.59	Love	.52	Ives	.42		
Sambamurthy	.57	Lederer	.51	King	.42		
Ives	.55	Zmud	.48	Grover	.42		
Alavi	.54	Powell	.48	Sambamurthy	.42		
Guimaraes	.54	Goodhue	.48	Swan	.40		
Sarker	.53	Huber	.46	Lederer	.40		
Orlikowski	.51	Ives	.45				
Poole	.49	Tam	.43				
King	.49	Jarvenpaa	.42				
Bostrom	.45						
Kling	.42						
Kettinger	.41						
Massey	.41						
Eigenvalue	36.87		10.80		7.83		5.10
Variance %	36.87		10.80		7.83		5.10

Table 4. Author Factor Loading for Study 2 (Factors 5-7)

Factor 5		**Factor 6**		**Factor 7**	
General IS		**Communication**		**Outsourcing**	
Guimaraes	-.77	Davenport	.84	Willcocks	.76
King	-.74	Swan	.81	Love	.71
Ives	-.74	Orlikowski	.74	Lacity	.65
Lederer	-.69	Alavi	.74	Akkermans	.61
Kettinger	-.67	Earl	.69	Zairi	.61
Grover	-.60	Huber	.66	Grover	.54
Watson_HJ	-.58	Robey	.64	Whinston	.51
Goodhue	-.56	Zmud	.59	Gupta	.49
Jiang	-.55	Kling	.58	Rai	.48
Igbaria	-.54	Jarvenpaa	.57	Weill	.48
Galliers	-.53	Sarker	.55	Venkatraman	.48
Huber	-.53	Benbasat	.54	Hirschhein	.44
Alavi	-.51	Walsham	.54	Sambamurthy	.42
Benbasat	-.50	Ciborra	.53	Galliers	.40
Rai	-.49	Swanson	.53	Jiang	.40
Weill	-.47	Poole	.52	Pavlou	.40
Sambamurthy	-.47	Sambamurthy	.51		
Venkatraman	-.45	King	.51		

Table 4. Author Factor Loading for Study 2 (Factors 5-7)

Bostrom	-.42	Venkatraman	.51		
Hirschhein	-.42	Grover	.51		
Jarvenpaa	-.41	Ives	.50		
Earl	-.41	Webster	.48		
		Zairi	.47		
		Gosain	.47		
		Goodhue	.45		
		Weill	.44		
		Kettinger	.43		
		Galliers	.42		
		Akkermans	.41		
Eigenvalue	3.54		2.38		2.07
Variance %	3.54		2.38		2.07

The results of the PCA analysis for study 2 indicate seven factors groupings for this period based on the scree plot. In concordance with prior work, we eliminated any factor loadings lower than 0.4 (Culnan et al., 1990; Fabrigar, Wegener, MacCallum, & Strahan, 1999; Hair, Anderson, Tatham, & Black, 1995). The field seems to have one primary research focus—use, acceptance, & adoption—and several tertiary concerns. The use and adoption factor was so prevalent during this period that it accounted for more variance (36.87%) in the data than the summation of the remaining six factors (31.7%). Though factor one overwhelmed the remaining factors, the entire structure accounted for only 68.6 percent of the variance, which indicates that our factor model does not represent nearly one third of the research activity during this period. This finding may be due to the growth of some streams or the decay of others, but it seems to indicate that the field is undergoing a kind of transition such that a large portion of its research is in fragments and does not fit neatly into one of the identified streams. Again, the names given to the factors prove valuable in classifying the streams of research in the field. The structure from this period seems to indicate a focus on particular organizational issues such as organizational learning and knowledge management. The analysis also shows an interest in the economic and structural impact information technology can have on an organization. See Tables 3 and 4 for the authors and loadings for study 2. Table 5 presents the relative importance each subfield (variance explained in the factor structure)[4].

Table 5. Development of Intellectual Structure: Subfield Influence

	Culnan (1980-85)	**Study 1 (1990-97)**	**Study 2 (1997-2007)**
Factor 1	Foundations 36.7%	GDSS 26.5%	Use, acceptance, and adoption 36.87%
Factor 2	Individual (micro) approaches to mis design & use 13.8%	Technology acceptance 20.8%	Economic impact 10.8%
Factor 3	MIS management 9.1%	Strategic IS planning 8.49%	Organizational learning 7.83%
Factor 4	Organizational (macro) approaches to MIS design & Use 6.6%	Social process of IS development 7.43%	GDSS 5.1%
Factor 5	MIS curriculum 4.6%	Strategic IS impact 5.06%	General IS 3.54%
Factor 6		Cognitive aids and information processing 4.4%	Communication 2.38%

[4] It is interesting to compare our results with Iivari's (2015) highly cited papers in these roughly equivalent areas.

Table 5. Development of Intellectual Structure: Subfield Influence

Factor 7		Computer-mediated communication 3.1%	Outsourcing 2.07%
Factor 8		Information technology structures 2.58%	
Factor 9		Software models 2.08%	

4.2 Multidimensional Scaling

The MDS map in study 1[5] shows clear clustering in the field. Groups of authors appear as dots on a map. Several clusters congregate on the edges of the map with only a handful of authors populating the center of the visual space. Once one applies the factor overlays, the clusters become more apparent as intellectual boundaries separate one subfield from another. The resulting map is a valuable tool for analyzing a field's subfields because it visually represents relationships that are difficult to see in a correlation matrix. This MDS shows clear clustering around a core group of authors for most clusters along with some authors who serve as integrators for other clusters. The nucleus is most apparent in factors 1 (GDSS), 2 (technology acceptance), and 5 (strategic IS impact) where the central authors are tightly positioned and surrounded by researchers who occasionally drift from the core of the subfield. The map also visualizes the degree of isolation or integration among fields. Our analysis shows limited integration among factors 2 (technology acceptance), 3 (strategic IS planning), 4 (social processes of IS development), and 6 (cognitive aids and information processing). These factors have some common authors, but they also have a fair degree of uniqueness. We can see isolation most clearly in factor 5 (strategic IS impact), which is quite distant from the other clusters in the field, but, even here, there are some integrators at work.

[5] We used the PROXSCAL MDS program in SPSS v20.0 for our calculations. As McCain (1990) recommends, we specified a non-metric approach, an ordinal level of measurement, and the Euclidean distance model for plotting points.

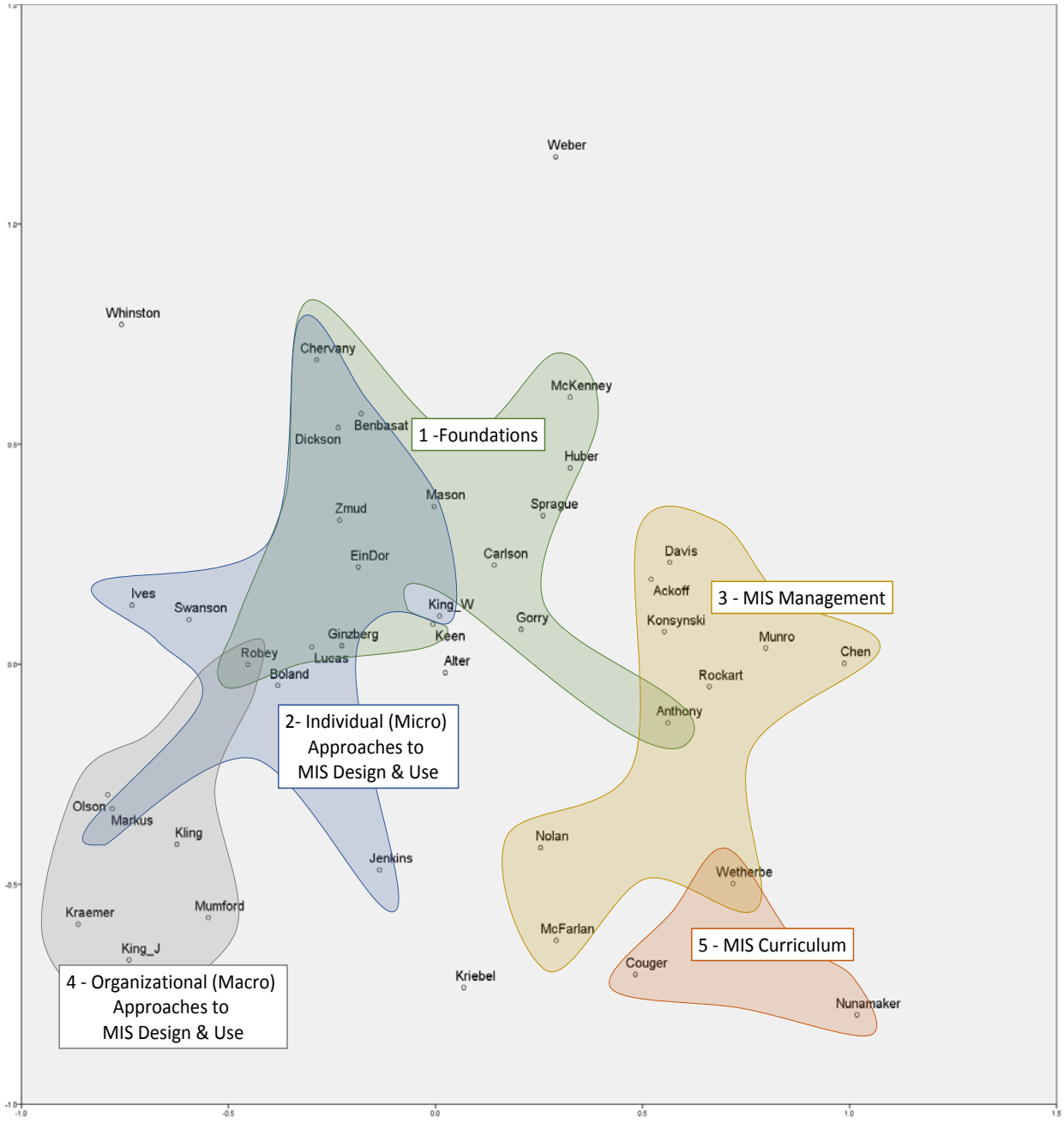

Figure 2. Development of Intellectual Structures: Culnan's (1987) Subfield Integration

As in study 1, the MDS proves to be a useful tool for identifying and understanding the field's subfields in study 2. Before merging the factor structure with the MDS, particular centers of activity are difficult to identify. One hub is readily apparent, but the remainder of the authors seem to be evenly distributed throughout the relationship map. After mapping the factors onto the intellectual space, we can see that the difficulty in identifying cluster nuclei is due to the high level of integration that exists among the subfields. Researchers seem to be spanning the boundaries between clusters, which results in a stretching of the core to such a degree that the subfield seems to lose its central mass. We can most clearly see these boundary-spanning activities in the center of the map where all seven factors overlap to some degree, which indicates that there is a core group of researchers who tend to co-cite each other. This finding could indicate that they take a more holistic view of IS issues and draw from common theoretical and methodological frames, or it could indicate a tendency toward studying common questions (that may or may not reflect the most important questions of the time). For instance, studies of technology adoption seem to be important in this period and could be examined through a psychological lens or by examining

organizational structures or through an economic framework. It is clear, however, that, in comparison with the prior study, this map shows far less isolation. Though some researchers may tend toward the edges of their subfields, the field's overall tendency is toward centrality.

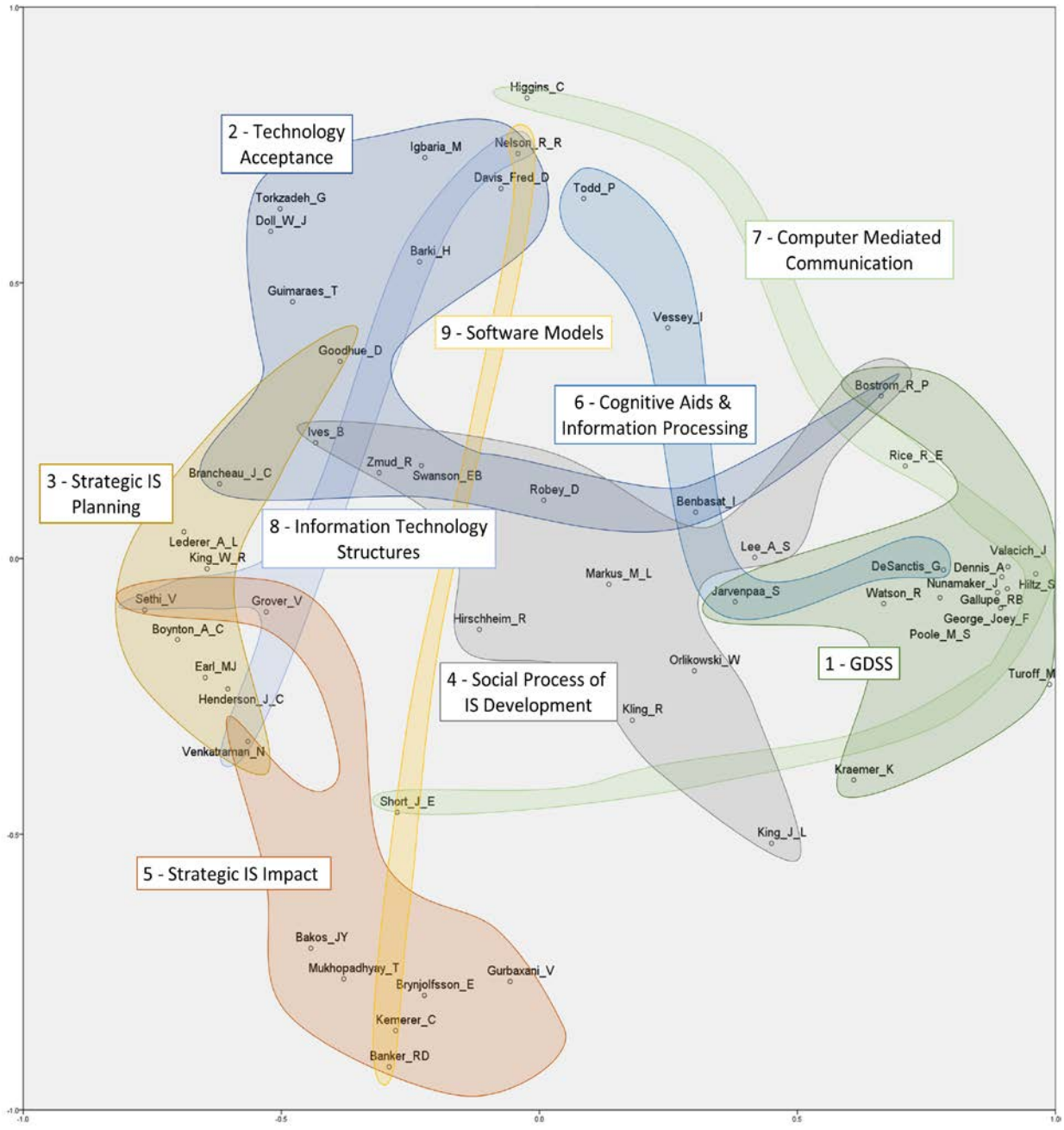

Figure 3. Development of Intellectual Structures: Study 1 Subfield Integration

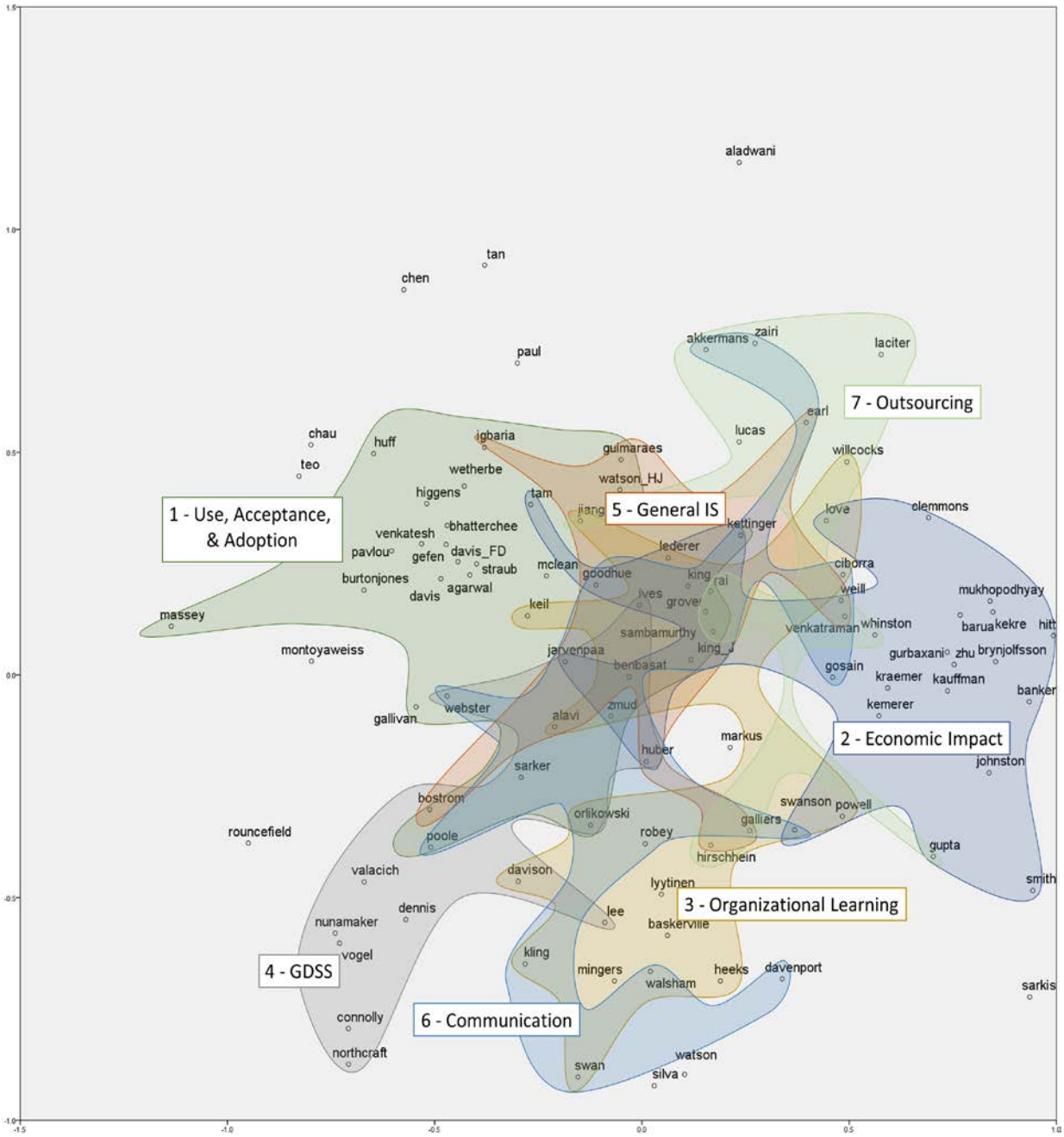

Figure 4. Development of Intellectual Structures: Study 2 Subfield Integration

5 Discussion

We have argued that introspective studies of the field that do not consider where the field has come from will be hampered in their ability to adequately describe where the field is. We do not indict prior introspective studies but instead remind readers that we humans are flawed and biased toward the now. We always feel our current reality more acutely than we do prior experiences or institutional memories. Certainly, this fact may be more true of IS researchers who, whether due to the constant need to fend off barbs from without and within (Carr, 2003; Markus, 1999), to the unceasing battle for relevance and a seat at the management table (Lucas, 1999; Watson, Sousa, & Junglas, 2000), or to a natural inclination, tend toward pessimism regarding the state of the field. If the present makes us biased, the past makes us honest.

5.1 Building Structures

In evaluating the field's evolution, we worked with the thesis that, if the field indeed follows technological trends, then it will remain more of a "theme" defined more by the faddish technology it studies than by the content of its research. Such fields would be characterized by diverse clusters loosely based on technology and weak integration. Alternatively, a cohesive pattern that reflects the proximity of fewer research subfields reflects more of an integrative field in which members sample from and contribute to of its subfields. The latter might better indicate Keen's (1980) ideal of a field with a cumulative tradition and a shared body of knowledge. In the following paragraphs, we discuss the field's intellectual structure as each study represents it and juxtapose this discussion by observing the corresponding institutional structures during the same period. As a result, we create a narrative linking the field's intellectual and institutional evolution, which, together, provide a richer consideration of the field's development than would be possible if one considered each structure in isolation.

In observing the combined factor structure and MDS map during the three periods, we note that a single foundational factor marks the first period (Culnan), which reflects systems thinking that researchers such as Anthony, Sprague, Mason, Dickson, Benbasat, among others epitomize—those who penned foundational, seminal papers about the fundamental nature of information systems. During this period, the factor analysis identified five subfields (four representing the management and use of systems and one indicating an emerging curriculum), which indicates low diversity in the field. This level of diversity also well represents the period's technology environment because information systems were just emerging from back-office operations and onto the desks of managers and support staff.

Culnan's (1987) five-factor model classified a majority of the co-citations occurring between 1980 and 1985. However, the identified factor structure left 29.2 percent of the variance in the co-citation matrix unexplained, which hints at some degree of dispersion on the fringes of the field. The MDS map reveals a mix of integration and isolation among the five factors. Three of the factors indicated some level of interaction, while the other factors remained in isolation with few boundary-spanning researchers. The dominance of a single, foundational subfield in addition to low levels of diversity and integration among the subfields suggest the first period indicates that the field was establishing its identity. To some degree, we expected these results. Culnan admits the study tracks the five years following the inaugural ICIS conference. Keen's keynote address would have echoed throughout this period because there were few additional sources of noise in the field at the time—the field had only two journals prior to the study and no competing conferences. As a result, Culnan's co-citation data revealed streams of research mirroring Keen's call-to-action with exploration of emerging areas and dependent variables (e.g., user satisfaction).

The second period (our study 1) transitions away from Culan's (1987) results and indicates a variety of emergent subfields with no single dominant factor. Though Culnan's study is limited to what one period saw, our study 1 offers some possibilities as to what it did not see. The more complex factor structure (5 vs. 9) along with the higher variance explained (70.8 vs. 80.4) suggests the convergence of subfields that were nascent but active in the earlier study. Over time, the systems concepts were integrated into the organizational context, which produced new or evolved subfields. While GDSS and technology acceptance were prominent areas, other specialized areas pertaining to strategic IS planning, social processes, IT impacts, and so on emerged.

Moreover, all authors present in both Culnan's study and study 1 were also present in study 2. That is to say, several researchers (Benbasat, Ives, J. King, W. King, Kling, Kraemer, Markus, Nunamaker, Robey, Swanson, Zmud) have been highly productive and influential in all three periods. While their presence has likely influenced the structure of the factors and MDS maps, the majority of the intellectual structure of each study almost entirely (79%) comprised new emerging researchers. Though this creates a sense of dynamism in the field, the lack of coherence between the two author sets complicates the analysis of subfields' evolution because few authors were available to serve as benchmarks for subfields across periods. Of the authors who were present in both study 1 and study 2, those studying individual- and organizational-level phenomena continued in their subfield even as the topics morphed into technology acceptance and social process of IS development, strategic IS planning, and strategic IS Impact. One author (Nunamaker) found a new home in GDSS research.

The four factors (6-9 in Figure 3) with no ancestry appear to be consistent with practice and practitioner concerns. According to three surveys of IT trends (1987, 1991, 1996) conducted by the Society for Information Management (SIM) during the period that our study 1 assessed, developing effective IT infrastructure, improving communication networks, improving software planning and development, and

exploiting IS resources all ranked among IT executives' top-ten concerns in at least two of the survey periods (Brancheau, Janz, & Wetherbe, 1996; Brancheau & Wetherbe, 1987; Niederman, Brancheau, & Wetherbe, 1991). Based on assessing the content-bearing words that gave meaning to the factors (Appendix C), we found that each of these practitioner concerns fell in the bounds of the four newly emerging research streams. This finding signals an effort by the field's leaders to address practitioner concerns by maintaining a link between the academy and practice.

Figure 3 reveals both the evolution of the individual- and organizational-level factors and the emergence of distinct, original subfields. In each of these subfields, a clear nucleus of researchers formed at the center of several subfields. This clustering indicates the high frequency at which the central authors are cited together in papers. While not always the case, authors who are cited together are often included to bolster the citing author's thesis. Therefore, the presence of authors at the center of a subfield suggests the emergence of a cumulative tradition as researchers in those subfields began to rely more heavily on the work of a core group of authors. Despite the intra-subfield cohesion, the inter-subfield dispersion remained high. That is, the field as a whole remained fragmented because individuals in a subfield relied more heavily on intra-subfield research while making few efforts to integrate ideas and perspectives from those outside of their area of interest.

The effect of this activity was to force the research clusters to the borders of the spatial map. Some of these tribes (computer-mediated communication, cognitive aids and information processing, and software models) are particularly interesting because they are less evolutions of prior research and more representative of the emergence of new knowledge subfields appearing to arise ex nihilo. Whether developing from the practitioner concerns mentioned above or some other source, we propose that loosely linked researchers populated these areas during Culnan's study and, thus, were unlikely to develop the critical mass needed to form a distinct subfield. However, changes in the field's institutional structures provided the gateways that would facilitate scholars to communicate with each other and ideas to converge. During this period, four regional IS conferences, four additional basket journals, and the AIS all began. Pockets of researchers began converging on research streams at a point in the field's history during which new opportunities for communication and collaboration opened to IS researchers across the world.

With regards to the lack of inter-subfield correspondence, the limited interaction across the subfields is perhaps due to each area having its own protocols for conducting studies and even its own theoretical perspective. For instance, GDSS and technology acceptance research followed different archetypes: one focused on management theory and experiments and the other drew from psychological theories and surveys. Also, strategic IS planning drew from literature in strategy, while strategic IS impact drew from economics. Though the identified structure suggests a consolidation of authors in silos of interest, a group of boundary-spanning authors began to form during this period. Therefore, a fragmented adhocracy best characterizes this era.

In the third period (our study 2), we see a clear change: closer clustering around fewer areas with less distance between the areas and greater overlap. The subfields were less technology specific and focused more on IT use, learning, and impact. It seems that, as researchers observed phenomena, they did not branch their study off into new subfields but integrated them into existing theoretical frames. For instance, one can examine economic impacts, acceptance, and use in a variety of contexts and emerging technologies. So, even though the technology use and acceptance sub-area dominated, it seems that it was well integrated with other themes (unlike the dominant GDSS subfield in the prior period).

The cohesion among subfields may be due to the lower levels of author attrition between study 1 and study 2. Study 2 saw a carryover of 41 (41%) authors from the previous two studies, which, though still a minority of authors, provide some insight into the evolution of research streams. Several of the authors from Culnan's set (Benbasat, Huber, J. King, W. King, and Zmud) joined authors from our study 1 (Goodhue, Grover, and Jarvanpaa) to form a core group of researchers. Each of these author's contributions are present in at least four of the seven factors representing the field. While their presence in each field does not necessarily indicate the convergence of knowledge between subfields, it does represent the value other authors have placed on their work. Whereas previous maps showed cores in clusters, this map shows clusters around a core as the work of core researchers begins to span the boundaries between subfields. The cross-pollination of the work and ideas of highly connected authors into several of the field's subfields could have driven the convergence of factors at the center of the map—a sign of increased cohesion.

In addition to these core, boundary-spanning authors, many other researchers remained active and influential across both study periods. Study 2 contained 34 of the authors from study 1. These overlapping authors should provide insight into the evolution of the field's subfields. Most authors remain in factors that correspond with the prior period, though the names may differ slightly. In most cases, the factors take on a more expansive meaning to subsume niche streams from study 1 as in the case of information technology structures and cognitive aids' and information processing's merging into the catchall general IS factor. As GDSS aged, it splintered and hemorrhaged members who have joined with those once associated with social processes of IS development to form a new stream focused on organizational learning. This dynamism reflects the changing nature of technology as its impacts broaden from a functional orientation (GDSS) to a broader platform-based orientation.

Also encouraging is the field's posture toward practice. The SIM IT trends survey occurred six times (2004, 2005, 2006, 2008, 2009, 2010) during the time period represented by study 2, and the field's subfields represent a majority of the top-ten concerns (Luftman, 2005; Luftman & Ben-Zvi, 2010a; Luftman & Ben-Zvi, 2010b; Luftman & Kempaiah, 2008; Luftman, Kempaiah, & Henrique, 2009; Luftman, Kempaiah, & Nash, 2006; Luftman & McLean, 2004). Though the rankings varied from year to year, several concerns were static such as IT and business alignment, IT strategic planning, IT governance, and IT value, and the streams we identified in study 2 represent each concern. Also, in the final survey of the study period, globalization broke into the top 10. Because co-citation analyses consider all citations over a given period, we can argue that the field's focus on outsourcing research predates practitioner concerns. However, there is clearly room for improvement because topics such as IT security, IT training, complexity reduction, and speed were high-ranking concerns among professionals and yet poorly represented in IS research.

However, the field may already be adjusting to these trends. We identified seven factors, but they only accounted for 68.59 percent of the variance in the co-citation data. With nearly one-third of the variance unexplained, the factor structure suggests activity in emerging or fringe topics. The new digital revolution involving social, mobile, analytics, and cloud technologies will further metamorphose these structures. Perhaps such topics will always be a part of IS's intellectual structure.

Overall, this period was marked by high levels of boundary-spanning activity. Increases in inter-subfield research increased the overlap between subfields and decreased the distance between each subfield's core even though large portions of each subfield remained segregated from the others.

Table 6 summarizes the observations from the three periods. We can see a clear trajectory of cohesion among subfields and clear movement toward research concerned with the implications of IS in terms of usage and impact. We could interpret these findings as signaling positive trends in the field toward a common core of knowledge (theories) that inform various phenomena. Alternatively, we could pessimistically argue the findings suggest the IT artifact remains "black-boxed" and under theorized despite explicit calls for improved conceptualizations of the IT artifact (Orlikowski & Iacono, 2001; Benbasat, 2003). Regardless, these findings suggest increased cohesion and could present an opportunity for the field to formalize a shared body of knowledge that distinguishes IS from other reference fields and provides a foundation for future inquiry into IT phenomena.

Table 6. Development of Intellectual Structure: Subfield Influence

	Culnan (1980-85)	Study 1 (1990-97)	Study 2 (1997-2010)
Dominance of a single subfield	Yes	No	Yes
Cohesion among subfields	Low	Moderate	High
Diversity of topics	Low	High	Moderate
Emphasis	Approaches and Methods	Models and Processes	Usage and Impact
Theme	Identification	Fragmentation	Pre-Integration

6 Limitations

In analyzing IS's subfields' historical evolution, we made several subjective decisions that could impact our findings. The limitations of our research fall into two groups: front-end and back-end limitations.

Co-citation analyses are subject to bias at both ends of the process. On the front-end, the researchers must establish the boundary conditions for the ACA. First, we established the inclusion criteria for authors. In this step, we identified a set of authors who represent the field. Though no perfectly objective process by which one can identify these authors exists, we chose to operationalize an author's importance to the field as a function of impact rating, publication volume, and (others') expert opinion. Unfortunately, some of these objective measures have subjective foundations. For example, many of the measures used to rank researchers rely on basket journals, which have been shown to have a North American bias and be possibly unreliable guides of the most influential IS research (Iivari, 2015). A second limitation of author selection involves the time sensitivity of an author's contributions to the field. We did not require that an author maintain a minimum level of influence throughout the time periods that each study covered, which could lead to over-representing researchers whose influence waxed toward the end of the study period. Also, because each study focused on the leading authors in terms of publications and impact during a given period, they may have over-represented fading topics and under-represented growing or loosely linked bodies of research.

Despite these limitations, their impact would be mitigated to the degree that the sample of authors remained representative of the field because a representative sample, though insufficiently time sensitive or biased toward North American researchers, would still produce an accurate view of the field's intellectual structure. With the benefit of hindsight, we can compare our collection of authors to author sets from similar research. Several studies have used author lists as a means of structuring some aspect of the field (Athey & Plotnicki, 2000; Im, Kim, & Kim, 1998; Iivari, 2015; Lowry, Karuga, & Richardson, 2007; Taylor et al., 2010; Truex et al., 2009), and each used subjective and/or objective measures to operationalize an author's influence and import to the field. Appendix B shows tables that compare the author lists. Though the other studies employed a variety of methods to create their lists of influential authors, our two studies' author lists fairly agree with the others for both study periods. In study 1, we identified 82 percent of the authors in Im et al.'s (1998) study, 66 percent of the authors in Athey and Plotnicki's (2000) study, but only 26 percent of the authors in Iivari's study (2015). The high degree of overlap with the shorter author lists suggests our methods were quite consistent in identifying the upper echelon of researchers but lack the sensitivity needed to distinguish excellence among those in the second tier. The poor fit with Iivari's list may be due to his interest in authors of highly cited papers, while we focused on authors' general influence in the field. Study 2 also somewhat agreed with the other studies' author lists. We identified approximately 50 percent of the authors in Lowery et al.'s (2007) and Taylor et al.'s (2010) lists and 67 percent of the authors in Truex et al.'s list. The higher level of agreement with Truex et al.'s study is encouraging due to their explicit effort to develop a list of authors that corrects for the North American bias common to prior studies. The comparison of author lists with prior research highlights two main limitations of research that relies on representative lists of influential authors: because the field's researchers are active and the content dynamic, an author's status as an influential researcher may depend on the dates of the study window; our means of operationalizing influence tend to bias one aspect of productivity in lieu of others.

In addition, how one identifies "data sources" is, again, a subjective endeavor. As with other bibliometric techniques, we collected data based on our research question: "how have the IS field's intellectual structures evolved?". Because evolution is an inherently cumulative, procedural phenomenon, we felt that the field's top journals would provide the deepest stocks of knowledge that were most capable of influencing the field's growth (White, 1998). Others have opted for breadth when analyzing the field's intellectual structure by refusing to limit the journals and, thus, the publications included in their analyses (Culnan, 1986, 1987; Taylor et al., 2010). However, we do recognize the tradeoffs in our approach. First, by limiting inclusion criteria to a basket of journals, we correspondingly limit the breadth of our analysis. While doing so created a more manageable dataset, we possibly biased our subfields by top journals' tendency to accept certain kinds of papers and avoid others. Scholars have argued that the biases of top journals generally favor North American researchers (Lyytinen, Baskerville, Iivari, & Te'eni, 2007), which suggests localized research topics common to international journals may be significantly under-represented in our analyses. Also, our selection approach necessarily excluded many influential academic sources such as research published in books, conference proceedings, reference journals, and research published in practitioner or trade journals. Second, our using a subset of journals meant that we potentially created a North American view of the field by relying on English language journals that favor North American authors and disadvantage authors who work with and write for non-English-speaking audiences. As we and others have argued (Chua et al., 2002), though the United States has been central to its growth, the field has benefited from the contributions of its international members, which indicates any

North American bias would be problematic. Though our methods are common to the ACA methodology, we believe that future attempts to structure our field might consider a more inclusive approach.

The backend of the co-citation analysis is a sensemaking process. As such, a degree of subjectivity is necessary. While we selected methods to insulate our analyses from this problem, the potential for bias warrants our discussing our chosen procedures. First, we assigned factors with titles based on analyzing papers' titles or keywords. This method benefits in that one can add objective measures to a subjective process; however, researchers forfeit some control, which may result in an author being caught in a web of co-authors. Though previous bibliometric studies have used this method, it is not the only method available to co-citation researchers. A second limitation relates to how we interpreted the MDS maps. Though we may look at the maps and see a shift toward cohesion and integration, another may see a shift away from specialization and toward confusion. We interpreted authors' proximity in overlapping subfeilds as greater co-citation, which, in turn, indicates closeness of ideas. Others may challenge this interpretation and suggest that authors themselves might work in multiple subfields that do not cite one another.

7 Conclusion

Where are we? According to Burke, to answer this question, we must first consider where we have been. Our observation of the historical evolutions of IS's institutional and intellectual structures suggests we have been on quite a journey. In the early years, IS was little more than a theme that emerged in a variety of reference fields. As interest coalesced, the field's members began to establish the institutional structures that support, encourage, and enhance knowledge creation in a given field: academic programs, journals, conferences, and professional associations. Though our field is young, the resulting quality of each of these institutional structures compares well with those of peer fields.

Despite clear growth in institutional structures, examining and assessing intellectual structures is value laden and subject to much debate. In this study, we simply describe the field's historical evolution and its intellectual structures using a well-established approach. The early periods of development were marked by identification as researchers sought to distinguish IS from its reference fields. Though much research focused on identifying the field and its boundaries, these efforts tended to occur in isolation. Isolation gave way to fragmentation as changes in the technological and institutional environment surrounding the field created a fertile breeding ground for communication and collaboration among researchers. During this middle period, researchers began to identify conceptual relationships among central figures in a subfield, and the cores of many subfields started taking shape around topics, reference theories and methodological approaches. The final period showed a clear increase in researchers' boundary-spanning activity throughout the field as subfields increasingly overlapped. Authors seem to increasingly have associated with multiple subfields, and their cross-pollinating research created more cohesion in a fragmented field. Over the course of three periods, the field transitioned from a state of identification through fragmentation to greater integration.

So how does this descriptive representation of history help us? "Are we doing the right things?" or "are we going in the right direction?". It seems that the field has achieved greater cohesion and, perhaps, a stronger identity. However, cohesion could be due to one genre of research's overrepresentation at the cost of more important questions. Cohesion could also be an artifact of engaging every IS phenomena with common theoretical frames, which limits indigenous theoretical innovation. So, in presenting these results, we hope to open up a discussion that evaluates and assesses the field's trajectory. It is useful to debate whether our cohesion is coming at a cost. Of course, the answer to this question will largely depend on where we want to be as a field.

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Appendix A: Author Co-citation Analysis Methodology

Co-citation analyses b on the assumption that citation patterns may serve as a proxy for intellectual cohesion among authors. When one author cites a second and third author, one believes that the first author cited the two supporting authors because they represent a common stream of research. In reality, two authors are cited together in any given research paper for a multitude of reasons and, thus, there is little foundation for the assertion that a single common pairing represents a shared research interest among scholars. However, justification that co-citation patterns may serve as a useful metric for grouping authors based on shared intellectual interests increases as the co-citation frequency increases. Co-citation analyses follow a well-established process (see Figure A1) and have been used to map the intellectual structure and evolution of many fields (Culnan,, 1986; Culnan,, 1987; McCain,, 1990; Taylor, et al., 2010; White and McCain,, 1998). The process begins with collecting data. During this step, one identifies representative authors and obtains citation data. Following this step, one analyzes the data. Co-citation researchers typically rely on some combination of three multivariate approaches: 1) factor analysis, 2) cluster analysis, or 3) multidimensional scaling (McCain, 1990). Each technique provides additional nuance to the analysis. The final step involves synthesizing the chosen analytic approaches into a cohesive story. We adhered to this process and discuss how we adapted each step below.

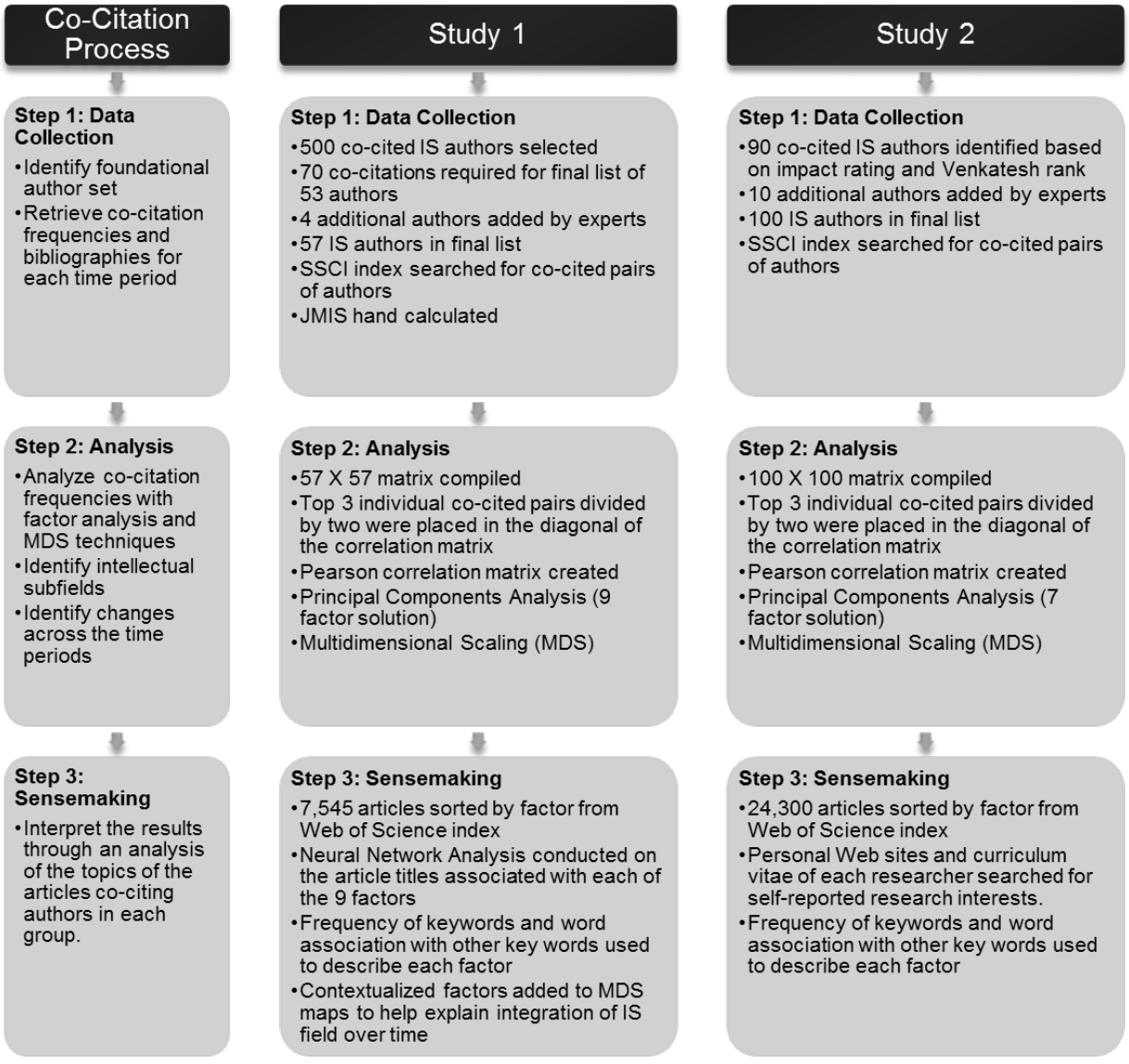

Figure A1. The Author Co-citation Analysis Process

Step 1: Data Collection

Sample Selection

Co-citation research must begin with a predetermined author set. This author set defines the scholarly perspective being sketched to capture the full range of variability in IS specialization's and methodologies. In study 1, we began by counting the most published IS researchers. We systematically counted the numbers publications by authors in leading IS publications (*Information Systems Research, MIS Quarterly, Journal of Management Information Systems, Communications of the ACM, Management Science,* and *Decision Science*) from 1991 through 1996. Additionally, we determined a listing of the 500 most frequently cited authors based on the number of times they were cited in leading IS publications from the Social Sciences Citation Index (SSCI). *JMIS* citations do not exist in the SSCI for the period studied and, as such, we compiled them manually. We used a minimum cutoff number of 70 citations during the period to parse down the number of authors. We compiled these two lists into a list of 53 prominent IS researchers, which we confidentially mailed to each authors. We asked them to identify additional authors who they felt were influential or major contributors to the IS field. These prominent authors responded with recommendations for four additional authors. In study 2, we started with a list of authors based on Hirsch-family impact ratings (Truex et al., 2009), which ranks authors based on citation count and density. Next, we consulted Venkatesh's online database, which ranks authors based on productivity, weighted by the inverse of the number of authors on each paper (Venkatesh, 2010). Then, we turned to Gallivan and Benbunan-Fich's list of authors with more than seven citations (Gallivan & Benbunan-Fich, 2007). We included 20 researchers who scored better than average in Venkatesh's system or had more than the mean number of publications in Gallivan and Benbunan-Fich's index in our tentative list of 90 researchers. Finally, as in study 1, we confidentially circulated our tentative list to a random selection of 30 of the authors we had already identified as prominent in the field and solicited their feedback. From their responses, we identified a further 10 researchers to include in our list.

Creating the Co-citation Matrix

In both studies, we built a square raw co-citation matrix with authors in both the vertical and horizontal dimensions. Next, we searched the SSCI for papers that cited pairs of authors together. Though other citation indexing services are available (Science Citation Index Expanded (SCIEXPANDED), Arts & Humanities Citation Index (A&HCI)), we relied on the SSCI because our studies limit the journal population to those in the "basket of eight" journals, which the SSCI covered. We placed the total number of times a third author cited a pair of authors at the intersection of author pairs. We computed the diagonals by taking the three highest intersections of each author and dividing by two, which indicated the relative importance of a particular author in the field (Culnan, 1986; Culnan, 1987; McCain, 1990; White & Griffith, 1981). After deleting authors who failed to co-cite with any other author, we converted the resultant raw co-citation matrices to a Pearson correlation matrix using SPSS v20.0. We used Pearson r as a measure of similarity between author pairs because it registers the likeness in shape of their co-citation count profiles over all other authors (White & McCain, 1998). These principles and procedures are in accordance with and have been extensively discussed in prior research (Bayer, Smart, & McLaughlin, 1990; Braam, Moed and Raan, 1991; Culnan, 1986; Culnan, 1987; Culnan & Chatman, 1990; Paisley, 1990; White, 1981; White & Griffith, 1981; White & McCain, 1998). For study 2, we employed some further steps to account for limitations in the SSCI such that authors were not credited for papers in which they were not the primary author, which lead to an underrepresentation of co-authors in co-citation data. Our desire to correct for this limitation required the discrete analysis of each author's citation data. We constructed Excel spreadsheets containing citation data (dates of publication, citation, keywords, and other data associated with the citing paper) for each author in Table B2 for a total of 100 unique worksheets with more than 65,000 records. We wrote a custom application to analyze the data and create the raw citation matrix. To compile the complete matrix, the application required over 8 hours of runtime on a PC running Windows XP, with a 2.1 GHz processor and 3 GB of RAM. Compiling a data set this complete by hand would have been infeasible. The resulting grid of 10,000 cells contains the data on which this study is based.

Step 2: Analysis

Factor Analysis

We chose to use principle component analysis with varimax rotation (SPSS v20.0) and multidimensional scaling (SPSS v20.0) as complementary methods to understand the relationships between authors. Principle component analysis with varimax rotation produces factors that are uncorrelated with most authors loading on only one factor. In author co-citation analysis (ACA), factors are populated by subsets of authors. Interpreting these author sets reveals an underlying subject matter as perceived by their peers. Because every author loads on or contributes to every factor, how one interprets factors depends on those authors with high factor loadings. Because authors may load on more than one factor but appear only once in a map (multidimensional scaling), factor analysis may provide insights into an author's breath of work that other statistical techniques do not. Previous ACA research suggests that only authors with factor loadings greater than 0.7 are likely to be useful in interpreting factors (McCain, 1990). However, we report factor loadings greater than 0.4 in an attempt to understand sub-groupings between factors, particularly when authors load on more than one factor (Culnan, 1990; Hair, et al., 1995). We chose a nine-factor solution based on the scree plot, interpretability of each factor, and a requirement to have at least two factors loading 0.5 and above.

Multidimensional Scaling

Multidimensional scaling (MDS) requires the same input matrix as factor analysis. The major use of MDS is to create an information rich display (map) of the co-citation linkages to identify the relationships underlying the placement of authors on the map (White & Smith, 1981). Heavily co-cited authors will appear grouped in space. Authors with many links to others tend to be in a central position, while authors weakly linked will be placed on the periphery. Thus, the concepts of central and periphery help one to determine research specializations or schools of thought. We used the PROXSCAL MDS program in SPSS v20.0 for our calculations. As McCain (1990) recommends, we specified a non-metric approach, an ordinal level of measurement, and the Euclidean distance model for plotting points. We also specifically defined the cutoff value for missing data as -1.0 to accommodate negative correlation values.

The space defined by the author counts varies from map to map, and axes are not necessarily symmetrical. A major purpose of multidimensional scaling is to capture as much of the original data as possible in only two or three dimensions. This simplification is valuable in interpreting the results but distorts the data and cannot account for all the variance. MDS programs summarize this distortion with a statistic they call “stress”. The stress measure is a criterion for determining the best fit between the original input matrix distances and the estimated distances found in the two-dimensional solution. For study 1, the Dispersion Accounted For (DAF), a measure of variance explained, was .969 and Kruskal's S-Stress was .066. For study 2, DAF was .933 and Kruskal’s S-Stress was .169. Because co-citation data is inherently noisy, one can consider a higher stress value but less than .2 as acceptable when the R2 is high (McCain, 1990).

Step 3: Sensemaking

Topic Area Analysis Using Neural Network Software

The final task is to name the topic areas that the factor structure identifies. For each study, our methods varied slightly. In study 1, we followed a similar but more sophisticated approach to this task as other authors (Culnan & Swanson, 1986; McCain, 1990). We decomposed the bibliographic citations of the clustered authors’ paper titles and obtained relative frequencies of content-bearing words and phrases by using a neural network software package (CATPAC). We suggest using a cutoff figure of a factor loading of 0.5. High factor loadings suggest authors writing about similar research areas. Factor loadings between .3 and .5 may also be related but also may capture other research areas. The factor loadings suggest some authors write in multiple IS areas. Co-citation literature has used .7 as a cutoff but seldom analyzes such a large matrix (56X56). A smaller matrix derived from a smaller, more elite group of authors would likely give a more distinct factor loading but would not be able to characterize smaller sub-groupings off authors and their sub-areas. Thus we chose this trade-off between more authors and greater understanding of the IS field. We analyzed 7545 papers subdivided by the factors determined from the principle component analysis. Frequency and proximity to other key words based on their use allowed us to make generalizations about the characteristics of individual factors. As we progressed from factor 1

through factor 9, the total variance explained decreased. As a result, the total number of papers analyzed for each factor also decreased. Alternatively, we analyzed fewer authors, which provided more focus on a particular area. Typical results provide frequency counts of individual words, the percent each word was used in the total sample, and a histogram showing the proximity of key words to each other based on the usage in the titles of author publications. Appendix C shows histograms for each factor, the associated key words, and our explanation of the meaning of the factor analyzed.

Appendix B: Author Lists for Study 1 and 2 and Comparison Lists from Other Studies

Table B1. Study 1 Authors and Comparison Lists

Study 1	Im (1998)			Athey (2000)	Iivari (2015)
1990-1997	1991-1996			1992-1996	1990-1997
Publication and citation counts in major journals (6); expert opinion	Publication and page counts in major journals(6)			Publication count in major journals(10)	Citation counts from Web of Science
	Normal count	Adjusted count	Productivity score		
Bakos	Barki	Barki	Barki	Alavi	Adams
Banker	Baroudi	Baroudi	Baroudi	Baroudi	Agarwal
Barki	Benbasat	Benbasat	Benbasat	Benbasat	Alavi
Benbasat	Bostrom	Bostrom	Bostrom	Brynjolfsson	Bakos
Bostrom	Brynjolfsson	Brynjolfsson	Brynjolfsson	Chau	Barki
Boynton	Clemons	Clemons	Clemons	Clemons	Barua
Brancheau	Dennis	Dennis	Dennis	George	Baskerville
Brynjolfsson	George	George	George	Grover	Benjamin
Clemons	Grover	Grover	Grover	Guimaraes	Boland
Courtney	Guimaraes	Guimaraes	Guimaraes	Igbaria	Boynton
Davis	Higgins	Higgins	Higgins	Jarvenpaa	Brancheau
Dennis	Igbaria	Igbaria	Igbaria	Kemerer	Brinkkemper
DeSanctis	Ives	Ives	Ives	King	Brynjolfsson
Doll	Jarvenpaa	Jarvenpaa	Jarvenpaa	Lederer	Chau
Earl	Kemerer	Kemerer	Kemerer	Lucas	Chidambaram
Gallupe	Kettinger	Kettinger	Kettinger	Nunamaker	Chidamber
George	King	King	King	Orlikowski	Chin
Goodhue	Mukhopadhyay	Mukhopadhyay	Mukhopadhyay	Palvia	Clemons
Grover	Nunamaker	Nunamaker	Nunamaker	Robey	Conner
Guimaraes	Rainer	Rainer	Rainer	Sprague	Constant
Gurbaxani	Robey	Robey	Robey	Szajna	Cooper
Henderson	Row	Row	Row	Todd	Davenport
Higgins	Sethi	Sethi	Sethi	Vessey	Davis
Hiltz	Teng	Teng	Teng	Zack	DeLone
Hirschherer	Todd	Todd	Todd		Dennis
Igbaria	Valacich	Valacich	Valacich		DeSanctis
Ives	Vessey	Vessey	Vessey		Earl
Jarvenpaa	Vogel	Vogel	Vogel		Ellis
Kemerer					Fichman
King					Fulk
Kling					Gallupe
Kraemer					Gefen
Lederer					Georgakopoulos
Lee					Goodhue

Table B1. Study 1 Authors and Comparison Lists

Liang					Grover
Markus					Guarino
Mukhopadhyay					Gurbaxani
Nelson					Hart
Niederman					Hartwick
Nunamaker					Henderson
Orlikowski					Hitt
Poole					Huber
Rice					Iacovou
Robey					Igbaria
Row					Jackson
Sethi					Keil
Short					Kettinger
Swanson					Kiesler
Todd					Kirsch
Torkzadeh					Kraut
Turoff					Kumar
Valacich					Lacity
Venkatraman					Lee
Vessey					Leidner
Watson					Malone
Watson					March
Zmud					Markus
					Mata
					Mathieson
					Melone
					Moore
					Mukhopadhyay
					Mylopoulos
					Ngwenyama
					Nunamaker
					Orlikowski
					Pitt
					Powell
					Premkumar
					Reich
					Rice
					Ross
					Seddon
					Segars
					Smith
					Sowa
					Star

Table B1. Study 1 Authors and Comparison Lists

					Stein
					Straub
					Strong
					Swanson
					Szajna
					Tam
					Thomas
					Thompson
					Thong
					Todd
					Trevino
					Tyre
					van der Aalst
					Venkatesh
					Venkatraman
					Vessey
					Walls
					Walsham
					Wand
					Webster
					Weill
					Wilson
					Yates
Authors listed alphabetically					

Table B2. Study 2 Authors and Comparison Lists

Study 2	Truex (2008)	Lowery (2007)			Taylor (2010)
1997-2010	1990-2004	1990-2004			1986-2005
Google Scholar Hirsch family statistics; Venkatesh researcher rankings; citation counts; expert opinion	Publish or Perish and Google Scholar Hirsch family statistics	Web of Science citation counts for papers published in major journals(3)			Web of Science citation counts for papers published in major journals (6); LEO award winners; AIS Fellows; others identified by U.K. study of IS researchers
		Total citations		Total citations	
Agarwal	Agarwal	Adams	Adams	Adams	Ackoff
Akkermans	Akkermans	Agarwal	Agarwal	Agarwal	Agarwal
Aladwani	Alavi	Alavi	Alavi	Alavi	Alavi
Alavi	Alter	Bakos	Bakos	Bakos	Alter
Banker	Banker	Banker	Banker	Banker	Anthony
Barua	Barney	Barki	Barki	Barki	Barki
Baskerville	Barua	Barney	Barua	Barua	Baroudi

Table B2. Study 2 Authors and Comparison Lists

Benbasat	Baskerville	Barua	Beath	Beath	Barua
Bhattacherjee	Benbasat	Beath	Benbasat	Benbasat	Baskerville
Bostrom	Bostrom	Benbasat	Bharadwaj	Bharadwaj	Benbasat
Brynjolfsson	Brynjolfsson	Bostrom	Bostrom	Bostrom	Bjornandersen
Burton-Jones	Carroll	Brancheau	Brancheau	Boynton	Boland
Chau	Chalmers	Brynjolfsson	Brown	Brancheau	Bostrom
Chen	Chen	Chidambaram	Brynjolfsson	Brown	Cavaye
Ciborra	Ciborra	Choudhary	Chidambaram	Brynjolfsson	Checkland
Clemons	Connolly	Compeau	Choudhary	Chidambaram	Chen
Connolly	Crabtree	Connolly	Clemons	Choudhary	Chervany
Davenport	Davis	Cooper	Compeau	Clemons	Chin
Davis, G.	Davis	Davis	Cooper	Compeau	Churchman
Davis, F.	Dennis	Davis	Davis	Conner	Ciborra
Davison	Dix	Delone	Delone	Cooper	Clemons
Earl	Earl	Dennis	Dennis	Davenport	Couger
Dennis	Galliers	Dexter	Dexter	Davis	Davis
Galliers	Gefen	Earl	Earl	Delone	Dennis
Gallivan	George	Fuerst	Fichman	Dennis	DeSanctis
Gefen	Giaglis	Gefen	Gefen	Dewan	Dickson
Goodhue	Goodhue	George	Goodhue	Dos santos	Eindor
Gosain	Grover	Goodhue	Grover	Earl	Galletta
Grover	Guimaraes	Grover	Gurbaxani	Fichman	Galliers
Guimaraes	Heeks	Guha	Hartwick	Gefen	Ginzberg
Gurbaxani	Higgins	Guimaraes	Henderson	George	Goodhue
Gupta	Hirschheim	Gurbaxani	Higgins	Goodhue	Gorry
Heeks	Hitt	Hartwick	Hitt	Grover	Gray
Higgins	Huber	Higgins	Huff	Gurbaxani	Grover
Hirschheim	Huff	Hitt	Igbaria	Hartwick	Guimaraes
Hitt	Igbaria	Howell	Ives	Henderson	Higgins
Huber	Irani	Huff	Jarvenpaa	Higgins	Hiltz
Huff	Ives	Iacovou	Karahanna	Hirschheim	Hirschheim
Igbaria	Jarvenpaa	Igbaria	Kauffman	Hitt	Huber
Ives	Jiang	Ives	Keeney	Iacovou	Igbaria
Jarvenpaa	Johnston	Janz	Keil	Igbaria	Ives
Jiang	Jones	Jarvenpaa	Kekre	Ives	Jarvenpaa
Johnston	Kauffman	Kalathur	Kemerer	Jarvenpaa	Jenkins
Kauffman	Keil	Karahanna	Kettinger	Jessup	Kauffman
Keil	Kekre	Kauffman	King	Karahanna	Keen
Kekre	Kemerer	Kavan	Kirsch	Kauffman	Kettinger
Kemerer	Kettinger	Keil	Klein	Keil	King
Kettinger	Kettinger	Kekre	Koufaris	Kekre	King
King, J.	King	Kemerer	Kraemer	Kemerer	Kling
King, W.	Klein	Kettinger	Lee	Kettinger	Konsynski

Table B2. Study 2 Authors and Comparison Lists

Kling	Klein	King	Leidner	Klein	Kraemer
Kraemer	Kraemer	Kirsch	Martocchio	Kraemer	Kriebel
Lacity	Lederer	Klein	Massetti	Kumar	Lacity
Lederer	Lee	Kraemer	Mathieson	Lee	Land
Lee	Leidner	Kriebel	Mclean	Leidner	Lederer
Love	Love	Lee	Melone	Loh	Lee
Lucas	Lyytinen	Leidner	Mendelson	Marakas	Leidner
Lyytinen	Martocchio	Martocchio	Moore	Massetti	Liang
Markus	Mathiassen	Mata	Morris	Mata	Lucas
Massey	Mingers	Mathieson	Mukhopadhyay	Mathieson	Lyytinen
McLean	Mukhopadhyay	Mclean	Myers	Mckeen	Markus
Mingers	Myers	Melone	Nelson	Mclean	Mason
Montoya-Weiss	Newell	Moore	Newman	Melone	McFarlan
Mukhopadhyay	Northcraft	Morris	Nidumolu	Moore	McKenney
Northcraft	Nunamaker	Mukhopadhyay	Niederman	Morris	Mclean
Nunamaker	O'Keefe	Myers	Nunamaker	Mukhopadhyay	Mingers
Orlikowski	Orlikowski	Nelson	Orlikowski	Myers	Mukhopadhyay
Paul	Paul	Newman	Palmer	Nelson	Mumford
Pavlou	Pitt	Niederman	Poole	Newman	Munro
Poole	Poole	Northcraft	Reich	Niederman	Nolan
Powell	Ramamurthy	Nunamaker	Robey	Nunamaker	Nunamaker
Rai	Robey	Orlikowski	Sambamurthy	Orlikowski	Olson
Robey	Rouncefield	Pitt	Seddon	Pinsonneault	Orlikowski
Rouncefield	Sambamurthy	Poole	Segars	Pitt	Rivard
Sambamurthy	Sarkis	Reich	Sethi	Poole	Robey
Sarker	Saunders	Robey	Silver	Reich	Rockart
Sarkis	Sharrock	Sambamurthy	Smith	Robey	Sambamurthy
Silva	Smith	Segars	Stein	Sambamurthy	Saunders
Smith	Srinivasan	Smith	Stoddard	Segars	Sprague
Straub	Straub	Srinivasan	Straub	Sethi	Straub
Swan	Swan	Stoddard	Swanson	Silver	Swanson
Swanson	Swanson	Straub	Tam	Smith	Tam
Tan	Thompson	Swanson	Taylor	Srinivasan	Todd
Teo,	Valacich	Taylor	Thompson	Stein	Valacich
Valacich	Venkatesh	Thompson	Todd	Straub	Venkatraman
Venkatesh	Venkatraman	Todd	Trauth	Swanson	Vessey
Venkatraman	Vogel	Trauth	Valacich	Taylor	Vitale
Vogel	Walsham	Valacich	Venkatesh	Thompson	Vogel
Walsham	Watson	Venkatesh	Venkatraman	Todd	Walsham
Watson, H.	Watson	Venkatraman	Walsham	Trauth	Ward
Watson, R.	Webster	Vogel	Watson	Venkatesh	Watson
Webster	Wei	Walsham	Watson	Venkatraman	Watson
Weill	Weill	Watson	Weber	Walsham	Weber

Table B2. Study 2 Authors and Comparison Lists

Wetherbe	Wetherbe	Watson	Webster	Watson	Wei
Whinston	Whinston	Webster	Weill	Watson	Wetherbe
Willcocks	Willcocks	Wei	Wetherbe	Webster	Whinston
Yan Tam	Y. K. Chau	Weill	Zack	Weill	Willcocks
Zairi	Zairi	Wetherbe	Zaheer	Wetherbe	Wiseman
Zhu	Zmud	Whinston	Zmud	Zigurs	Zmud
Zmud	Kalathur,S	Zmud	Zwass	Zmud	Zwass
Authors listed alphabetically					

Appendix C: Factor Names and Content-bearing Keywords

Table C1. Study 1 Content-bearing Words by Factor

Factors	Neural network key word histograms		General factor description
1	****** ****** **** *** *** ** ***** ***** * * * *	Idea Group Generation Mediated Computer Communication Implications GDSS System Support Decision Group	Group idea generation, group decision support systems, and computer-mediated communication.
2	********* ********* * * ******** ******** ******** ******* ******** **** **** ***** ***** *** ***	Research MIS Organizational Measure Information User Satisfaction Determinants Technology Study System Computer Management Participation Development	Technology acceptance, measures and determinants of user information satisfaction, participation in system development.
3	** *** *** ***** ****** ****** ******* ******** **** **** * *	Key Examination Computing IS Strategic Planning Systems Information Toward Theory Business Management	Strategic information systems planning and management.
4	**** **** ****** ******* ******* ** ***** ***** *** * *	Social Model Process Systems Development System User Participation Information Technology Case	Social processes and user participation in systems development.

Table C1. Study 1 Content-bearing Words by Factor

5	***** ***** ** **** ****** ******* ******* *** *** * *	Organizational Interorganizational Model Strategic Technology Systems Information Electronic Data Impact Business	The strategic impact of interorganizational systems on business.
6	* * * * *** ****** ******** ******** ******* * * **** ****	Processing Graphical Investigation Experimental Support Making Systems Information Decision Empirical Effectiveness Cognitive Aids	Cognitive aids and information processing in decision support systems.
7	** ** ***** ***** **** ****** ******* *******	Mail Electronic Group Face Media Mediated Computer Communication	Computer-mediated communication, electronic mail, and group media.
8	* ** *** ***** ****** ****** ****** *	Reexamining Model Evaluating Success Structural Information Technology Center	Evaluating information technology structures and success.
9	** **** ***** ***** *** *		Software models and measures.

Table C2. Study 2 Content-bearing Words by Factor

Factor	Author	Author interests	Paper keywords	Factor Name
1	Davis_FD	Adoption, computer-assisted decision making, training, motivation	Trust, technology acceptance model, knowledge management, internet, innovation, electronic commerce, adoption	Use, acceptance, and adoption
	Venkatesh	Diffusion of technology		
	Straub	(e-commerce), information security, technological innovation, IS methodological issues, and international IT studies		
	Agarwal	Health, org change, adoption, IT HR		
	Gefen	Trust, adoption, gender, culture		
	Davis	Productivity, KM		
	Bhatterchee	Adoption, IT-enabled services, healthcare informatics, KM, online social networks		
	Higgens	Champions of technological innovation, alternative work arrangements		
	Tam	Adoption, ecommerce, web pers., HCI		
	Mclean	Strategic planning for information systems, using information systems for competitive advantage, measuring IS success, decision support and end-user systems		
	Keil	PM, risk, barriers to use		
	Huff	Strategy, alignment, ecommerce, governance		
	Burtonjones	Usage, system analysis and design		
	Pavlou	Ecommerce, online auctions		
	Goodhue	Data management, task-tech fit, user evals		
	Igbaria	Use		
	Jarvenpaa	Virtual teams, virtual organizations, and virtual communities		
	Jiang	PM, service quality, user satisfaction		
	Webster	Distributed work, team effectiveness, organizational communication, employee recruitment and selection, employee monitoring, and training and learning		
	Benbasat	Evaluating human-computer interfaces, explanations in intelligent support systems, Measuring IT-related competencies		
	Zmud	Business value of information technology		
	Rai	IT-enabled innovation and the governance		
	Grover	Value from IT investments, business process change, electronic commerce, strategic information systems, telecommunications and inter-organizational systems, and the organizational impacts		
	Watson_HJ	Decision science?		
	Lederer	“How companies can more effectively plan their use of information technology to help them compete…”		
	Sambamurthy	Synchronize their business strategies and processes with their IT management actions to sustain competitive advantage		

Table C2. Study 2 Content-bearing Words by Factor

	Ives	Electronic commerce, virtual organizations, customer service, reengineering of management scholarship		
	Alavi	Group learning, org impact, KM in networks		
	Guimaraes	Management of technology, CRM, impact of technology on business organizations, expert systems, quality management, international competitiveness, strategic planning		
	Sarker	Organizational change, BPR, ERP implementation, virtual, mobile, global context, crisis, qualitative		
	Orlikowski	Sociological aspects of technology and work, organizing structures, cultural norms, communication genres, and work practices		
	Poole	Group and organizational communication, information and communication technologies, collaboration, organizational change and innovation, and theory construction, MMORPGs		
	King	Everything?		
	Bostrom	Facilitation, leadership, groupware, e-learning, and effective design of organizations		
	Kling	Social informatics, organizational informatics, information systems, information technology and social change		
	Kettinger	Quality, benchmarking and best practice management		
	Massey	Performance, design and usability of online service interfaces, knowledge-intensive business processes, and collaborative work		
2	Barua	Economics, ecommerce	Data envelopment analysis, electronic commerce, efficiency, returns to scale, productivity, performance	Economic impact
	Kauffman	Economics, market, inter-firm cooperation		
	Brynjolfsson	Economics		
	Kekre	OM, interdisciplinary, accounting		
	Gurbaxani	Economics		
	Mukhopodhyay	Economics		
	Kraemer	Technology policy, global IT, organizational impacts, I/S performance		
	Hit	Productivity, economics		
	Kemerer	Measurement issues		
	Zhu	Economics, globalization, supply chain, standards		
	Banker	Accounting, DEA, OM		
	Whinston	Artificial intelligence, e-commerce, information systems, the new economy		
	Grover	Value from IT investments, business process change, electronic commerce, strategic information systems, telecommunications and inter-organizational systems, and the organizational impacts		
	Weill	Value creation		

Table C2. Study 2 Content-bearing Words by Factor

	Gosain	Technology design, use, and value leverage, consumer behavior and information search		
	Venkatraman	Network-centric view of business strategy, IT strategy and IT sourcing		
	Rai	IT-enabled innovation and the governance		
	Sambamurthy	Synchronize their business strategies and processes with their IT management actions to sustain competitive advantage		
	Benbasat	Evaluating human-computer interfaces, explanations in intelligent support systems, Measuring IT-related competencies		
	Kettinger	Quality, benchmarking and best practice management		
	Smith	Efficient information exchanges		
	Swanson	Business innovations, enterprise systems		
	Gupta	KB, data mining, outsourcing, entrepreneurship		
	King	Everything?		
	Love	Construction, PM, OM, systems evaluation, engineering forensics		
	Lederer	“How companies can more effectively plan their use of information technology to help them compete…”		
	Zmud	Business value of information technology		
	Powell	Strategy and planning particularly for small businesses and in healthcare, IS evaluation, issues of flexibility in and from IS, inter-organization systems, and e-commerce		
	Goodhue	Data management, task-tech fit, user evals		
	Huber	Organizational change, organizational design, and organizational decision-making		
	Ives	Electronic commerce, virtual organizations, customer service, reengineering of management scholarship		
	Tam	Adoption, ecommerce, web pers., HCI		
	Jarvenpaa	Virtual teams, virtual organizations, and virtual communities		
3	Lyytinen	Design methodology, development	Knowledge management, case study, knowledge, evaluation, organizational learning, organizational change, knowledge transfer, knowledge sharing, computer-mediated	Organizational learning
	Hirschhein	Information systems development, impacts of IT, IT governance, IT outsourcing		
	Baskerville	Security, design		
	Walsham	Devlopment, use, management		
	Robey	System development and implementation		
	Mingers	Development, methodology, CS		
	Ciborra	The relationship between technology and organizations, TCM		
	Orlikowski	Sociological aspects of technology and work, organizing structures, cultural norms, communication genres, and work practices		

Table C2. Study 2 Content-bearing Words by Factor

	Galliers	Strategy, KM, inter-org, global, Enterprise Systems, change	communication, collaboration	
	Heeks	Development, e-government, ICT		
	Lee	Methodology		
	Swanson	Business innovations, enterprise systems		
	Kling	Social informatics, organizational informatics, information systems, information technology and social change		
	Benbasat	Evaluating human-computer interfaces, explanations in intelligent support systems, Measuring IT-related competencies		
	Keil	PM, risk, barriers to use		
	Zmud	Business value of information technology		
	Davison	KM, communication, culture, ethics		
	Sarker	Organizational change, BPR, ERP implementation, virtual, mobile, global context, crisis, qualitative		
	Willcocks	Outsourcing		
	Powell	Strategy and planning particularly for small businesses and in healthcare, IS evaluation, issues of flexibility in and from IS, inter-organization systems, and e-commerce		
	Love	Construction, PM, OM, systems evaluation, engineering forensics		
	Rai	IT-enabled innovation and the governance		
	Alavi	Group learning, org. impact, KM in networks		
	Jiang	PM, service quality, user satisfaction		
	Ives	Electronic commerce, virtual organizations, customer service, reengineering of management scholarship		
	King	Everything?		
	Grover	Value from IT investments, business process change, electronic commerce, strategic information systems, telecommunications and inter-organizational systems, and the organizational impacts		
	Sambamurthy	Synchronize their business strategies and processes with their IT management actions to sustain competitive advantage		
	Swan	KM		
	Lederer	“How companies can more effectively plan their use of information technology to help them compete…”		
4	Dennis	Collaboration technologies, knowledge management, data communications, the Internet	Group support systems, decision making, regret, computer-mediated communication, diversity, virtual teams,	GDSS
	Connolly	Database management systems, e-learning, games-based learning, object-oriented programming, object-oriented data modelling		
	Nunamaker	Collaboration technology		
	Valacich	Collaboration, tech-mediated learning		

Table C2. Study 2 Content-bearing Words by Factor

	Northcraft	Conflict, decision, collaboration, motivation, job design	brainstorming, decision support systems, groupware, collaboration, teams, knowledge management, group	
	Bostrom	Facilitation, leadership, groupware, e-learning, and effective design of organizations		
	Huber	Organizational change, organizational design, and organizational decision-making		
	Alavi	Group learning, org impact, KM in networks		
	Jarvenpaa	Virtual teams, virtual organizations, and virtual communities		
	Davison	KM, communication, culture, ethics		
	Poole	Group and organizational communication, information and communication technologies, collaboration, organizational change and innovation, and theory construction, MMORPGs		
	Benbasat	Evaluating human-computer interfaces, explanations in intelligent support systems, Measuring IT-related competencies		
	Webster	Distributed work, team effectiveness, organizational communication, employee recruitment and selection, employee monitoring, and training and learning		
	Zmud	Business value of information technology		
	Sarker	Organizational change, BPR, ERP implementation, virtual, mobile, global context, crisis, qualitative		
	Orlikowski	Sociological aspects of technology and work, organizing structures, cultural norms, communication genres, and work practices		
	Ives	Electronic commerce, virtual organizations, customer service, reengineering of management scholarship		
	Lee	Methodology		
5	Guimaraes	Management of technology, CRM, impact of technology on business organizations, expert systems, quality management, international competitiveness, strategic planning	Technology acceptance model, user satisfaction, knowledge management	General IS
	King	Everything?		
	Ives	Electronic commerce, virtual organizations, customer service, reengineering of management scholarship		
	Lederer	"How companies can more effectively plan their use of information technology to help them compete…"		
	Kettinger	Quality, benchmarking and best practice management		
	Grover	Value from IT investments, business process change, electronic commerce, strategic information systems, telecommunications and inter-organizational systems, and the organizational impacts		
	Watson_HJ	Decision science?		

Table C2. Study 2 Content-bearing Words by Factor

	Goodhue	Data management, task-tech fit, user evals		
	Jiang	PM, service quality, user satisfaction		
	Igbaria	Use		
	Galliers	Strategy, KM, inter-org, global, Enterprise Systems, change		
	Huber	Organizational change, organizational design, and organizational decision-making		
	Alavi	Group learning, org impact, KM in networks		
	Benbasat	Evaluating human-computer interfaces, explanations in intelligent support systems, Measuring IT-related competencies		
	Rai	IT-enabled innovation and the governance		
	Weill	Value creation		
	Sambamurthy	Synchronize their business strategies and processes with their IT management actions to sustain competitive advantage		
	Venkatraman	Network-centric view of business strategy, IT strategy and IT sourcing		
	Bostrom	Facilitation, leadership, groupware, e-learning, and effective design of organizations		
	Hirschhein	Information systems development, impacts of IT, IT governance, IT outsourcing		
	Jarvenpaa	Virtual teams, virtual organizations, and virtual communities		
	Earl	KM, strategy		
6	Davenport	KM, decisions	Knowledge management, Innovation, knowledge sharing, knowledge management systems, knowledge transfer, collaboration, case study, e-learning, organizational learning, knowledge creation, knowledge, decision support systems, computer-mediated	Communication
	Swan	KM		
	Orlikowski	Sociological aspects of technology and work, organizing structures, cultural norms, communication genres, and work practices		
	Alavi	Group learning, org impact, KM in networks		
	Earl	KM, strategy		
	Huber	Organizational change, organizational design, and organizational decision-making		
	Robey	System development and implementation		
	Zmud	Business value of information technology		
	Kling	Social informatics; organizational informatics; information systems; information technology and social change		
	Jarvenpaa	Virtual teams, virtual organizations, and virtual communities		
	Sarker	Organizational change, BPR, ERP implementation, virtual, mobile, global context, crisis, qualitative		
	Benbasat	Evaluating human-computer interfaces, explanations in intelligent support systems, measuring IT-related competencies		
	Walsham	Development, use, management		

Table C2. Study 2 Content-bearing Words by Factor

	Ciborra	The relationship between technology and organizations, TCM		
	Swanson	Business innovations, enterprise systems		
	Poole	Group and organizational communication, information and communication technologies, collaboration, organizational change and innovation, and theory construction, MMORPGs		
	Sambamurthy	Synchronize their business strategies and processes with their IT management actions to sustain competitive advantage		
	King	Everything?		
	Venkatraman	Network-centric view of business strategy, IT strategy and IT sourcing		
	Grover	Value from IT investments, business process change, electronic commerce, strategic information systems, telecommunications and inter-organizational systems, and the organizational impacts		
	Ives	Electronic commerce, virtual organizations, customer service, reengineering of management scholarship		
	Webster	Distributed work, team effectiveness, organizational communication, employee recruitment and selection, employee monitoring, and training and learning		
	Zairi	Benchmarking, best practices		
	Gosain	Technology design, use, and value leverage, consumer behavior and information search		
	Goodhue	Data management, task-tech fit, user evals		
	Weill	Value creation		
	Kettinger	Quality, benchmarking and best practice management		
	Galliers	Strategy, KM, inter-org, global, enterprise systems, change		
	Akkermans	Ecentralized inter-organizational supply chains and networks, simulation models		
7	Willcocks	Outsourcing	Outsourcing, project management, supply chain management, case study, critical success factors, TGM, risk management, rework	Outsourcing
	Love	Construction, PM, OM, systems evaluation, engineering forensics		
	Laciter	Benchmarking, outsourcing		
	Akkermans	Ecentralized inter-organizational supply chains and networks, simulation models		
	Zairi	Benchmarking, best practices		
	Grover	Value from IT investments, business process change, electronic commerce, strategic information systems, telecommunications and inter-organizational systems, and the organizational impacts		
	Whinston	Artificial intelligence, e-commerce, information systems, the new economy		

Table C2. Study 2 Content-bearing Words by Factor

	Gupta	KB, data mining, outsourcing, entrepreneurship		
	Rai	IT-enabled innovation and the governance		
	Weill	Value creation		
	Venkatraman	Network-centric view of business strategy, IT Strategy and IT sourcing		
	Hirschhein	Information systems development, impacts of IT, IT governance, IT outsourcing		
	Sambamurthy	Synchronize their business strategies and processes with their IT management actions to sustain competitive advantage		
	Galliers	Strategy, KM, inter-org, global, enterprise systems, change		
	Jiang	PM, service quality, user satisfaction		
	Pavlou	Ecommerce, online auctions		

About the Authors

Varun Grover is the William S. Lee (Duke Energy) Distinguished Professor of Information Systems at Clemson University. He has published extensively in the information systems field, with over 200 publications in major refereed journals. Over ten recent papers have ranked him among the top four researchers based on number of publications in the top Information Systems journals, and citation impact. He has an h-index of 74 and over 24,000 citations in Google Scholar. Thompson Reuters recognized him as a Highly Cited research in 2013. He is Senior Editor for *MISQ Executive*, Section Editor of *JAIS*, and Senior Editor (Emeritus) for *MIS Quarterly*, the *Journal of the AIS,* and *Database*. He is currently examining the impacts of digitalization on individuals and organizations. He is recipient of numerous awards from USC, Clemson, AIS, DSI, Anbar, PriceWaterhouse, and others for his research and teaching. He is a Fellow of the Association for Information Systems.

Jackie London is a PhD candidate at Clemson University. He has worked as an Information System and Technology consultant and has extensive experience in software development and process redesign.

Kevin Craig is an assistant professor at Baruch College, CUNY, and a PhD candidate at Clemson University. His work has appeared in journals such as IEEE Transactions of Engineering Management and in the proceedings of conferences such as ICIS. He also has extensive work experience in the IT domain