

**Examining the Intellectual Structure of Knowledge Management, 1990-2002 – An Author
Co-citation Analysis ***

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MISRC WORKING PAPER # 03-23



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We are thankful to Prof. Andy Van de Ven for his comments that improved the quality of the paper.

Examining the Intellectual Structure of Knowledge Management, 1990-2002 – An Author Co-citation Analysis

Abstract

The emergence of Knowledge Management (KM) as an important topic in management research is of particular relevance to information systems researchers as the functionalities based on information technologies play a critical role in shaping organizational efforts in this area. IS researchers, drawing on their familiarity with studying phenomena related to IT, therefore have the opportunity to be at the forefront of research in this area and contribute significantly to the scholarly discourse in knowledge management. This is indeed an important opportunity for the field of MIS, a relatively recent academic discipline.

A high level view of the intellectual structure of the emerging discipline is necessary for IS researchers to take advantage of this important opportunity. This paper draws on author-co-citation analysis, a bibliometric methodology to examine KM research from 1990-2002 and highlight the intellectual structure of management research in knowledge management. The results reveal the existence of eight subfields of research on the topic. These sub-fields reflect the influence of a wide array of fundamental disciplines such as management, philosophy, and economics. However, the results provide no evidence of the impact of early IS research in KM on research in this area. The results thus highlight the significant challenge confronting academic IS researchers: to evolve a distinct focus, draw on prior theory and build a critical mass of research to be viewed as a significant contributor to knowledge in this domain. The results, we hope, will inform this important mission for the field.

Keywords: knowledge management, author co-citation analysis, bibliometrics

Introduction

There is increasing recognition in the popular business press (Stewart 1997) as well as in the scholarly literature (Ofek and Sarvary 2001) of the importance of Knowledge Management (KM) for organizations. The ability of firms to marshal and deploy expertise is viewed as a key source of sustainable competitive advantage. The intangible *resources* that are the source of such firm capabilities are embedded in the knowledge of their employees, in the design of organizational structures, in the operational processes and in the complex synergistic interaction of these factors.

Research into KM phenomena has grown considerably in the past decade, both in terms of depth as well as in scope. From its beginnings in work based on anecdotal evidence of such initiatives in the business press (Stewart 1997) and early research in the strategy literature (Hedlund 1994), we are beginning to see a variety of mature theoretical approaches to the examination of knowledge work and the management of knowledge and its link to organizational outcomes such

as innovation, performance and effectiveness in a variety of fields. This includes economics (Ba et al. 2001; Rivkin 2001), innovation research (Galunic and Rodan 1998), organization theory (Hargadon and Fanelli 2002), (Birkinshaw et al. 2002), information systems (Massey et al. 2002) (Schultze and Leidner 2002), marketing (Madhavan 1998), management strategy (Dyer and Nobeoka 2000) (Grant 1996) and entrepreneurship (Yli-renko et al. 2001). With a considerable volume of research on this topic from a variety of disciplinary perspectives, there is an ever present danger that researchers studying KM issues can be working at cross-purposes and missing the opportunity to build synergistically on the work of colleagues in related disciplines. Further, parallel ongoing efforts in multiple disciplines increase the likelihood of researchers in one area inadvertently overlooking prior contributions in an allied field that may have considerable relevance to their own efforts. Teece sounds an early warning that research in knowledge management may be facing such a situation :

“As research advances, it ought to be especially sensitive to preserving and building upon the already significant literatures on the management of technology, entrepreneurship, innovation, and business strategy. Indeed, there is a real danger that knowledge management will become discredited if it proceeds in ignorance of these large extant literatures, thereby creating unnecessary intellectual clutter and confusion.” (Teece 1998, page 298)

At this juncture, what is needed is a high level view of research in KM to reveal the intellectual structure of the emerging discipline and articulate the distinct set of fundamental concepts in the field. Such an exercise has the potential to enable a deeper understanding of the central theoretical approaches to KM. It can reveal both opportunities for extension and elaboration of prior theoretical approaches as well as gaps for exploration and systematic theory construction. This research responds to this need by employing author co-citation analysis (White and Griffith 1982, Culnan 1986, Culnan 1987, McCain 1990), a well accepted bibliographic technique, to articulate the central theoretical and conceptual approaches in knowledge management research revealed by joint citations of the contributions of key researchers.

While there have been prior attempts to highlight patterns in KM research, this work represents a departure from these studies in several important ways. Researchers in multiple disciplines have analyzed the approaches to KM evident in prior studies within their fields or pertaining to issues relevant within their fields. These studies limit themselves to focusing on a subset of research into knowledge management and to suggest frameworks to help guide research within their

disciplines. For instance, Schultze and Leidner examined patterns of discourse in research in Information Systems (Schultze and Leidner 2002), and Alavi and Leidner reviewed KM research to study roles information systems could play (Alavi and Leidner 2001). Sapsed et. al. reviewed approaches to teamwork in KM research (Sapsed 2002), Santhanam and Elam examined studies of knowledge-based systems in the decision science literature (Santhanam and Elam 1998), and Dingsøyr and Conradi reviewed the use of knowledge management systems in software development (Dingsøyr and Conradi 2002). Though useful for researchers within these sub-fields, these studies fail to provide a perspective on the larger body of KM research. Similarly, efforts such as those by Teece (Teece 1998) to synthesize prior work and provide directions for future research although valuable, are based only on the personal judgments of a particular author. In contrast, our study provides an inclusive and cross-disciplinary view of the cluster of concepts, the *invisible colleges* within the field of KM research, which represent sets of similar approaches to issues within the expansive body of work. Further, our approach is based on the composite judgment of hundreds of authors citing key researchers in KM and represents *the field's view of itself* (Culnan, 1986) as opposed to the judgment of a small group of authors. The results of our analysis thus highlight the paradigms in knowledge management emerging from the ideological consensus of researchers. Our work also extends a prior effort using bibliographic methods to examine knowledge management research in its early stages from 1994 to 1998 (Ponzi, 2002) and offers a more comprehensive and contemporary view of the intellectual development of KM. With the interest in KM increasing within the IS community, the findings of this study will be immensely useful in guiding KM-related IS research.

The research methodology is described below. This is followed by a presentation of the results and their analyses. A summary of the findings and directions for future research are then provided.

Methodology

Our methodology, author co-citation analysis (ACA), is a bibliometric technique devised by researchers in information science to determine the intellectual structure of disciplines (White and Griffith, 1982). Authors who have made seminal contributions to a discipline are the units of analysis in this technique (McCain, 1990) since the citation of an author represents a reference to the concept (or concepts) for which the author is known (Culnan, 1986). Co-citation analysis

thus infers the relationship between key concepts based on the extent of joint citations of authors making seminal contributions to a field. The approach relies on the intuition that authors contributing to concepts viewed as being overlapping or closely related are more likely to be cited together by other researchers than authors contributing to concepts viewed as distinct or distant. Drawing on the pattern of citations of authors contributing key concepts in a field, the analysis of citations identifies groups of authors who are frequently co-cited. Authors are grouped together based on their co-citations as well as on the similarity of their patterns of citations with other authors (McCain 1990). In effect, authors fall into distinct clusters or groups because of the conceptual correspondence of their works (White and Griffith, 1981; McCain, 1990). ACA has been used in prior research to elicit the specialties within disciplines (e.g. Culnan 1986, Culnan 1987, McCain 1990), discerning ideational links between research traditions (Cottrill et al. 1989), studying paradigmatic changes in fields (Nerur 1994; White and McCain 1998), and understanding conceptual differences to identifying discontinuities in the cumulative tradition of a field (Sircar et al. 2001).

Our procedures are consistent with those in prior research (Culnan 1986, Culnan 1987, McCain 1990, White and McCain 1998). The first step in ACA is to identify a list of seminal authors in the field (McCain 1990). We compiled a list of the 52 most cited authors using the phrase *Knowledge Management* in the titles, descriptors, and abstracts of papers published between 1990 and 2002 included in the Social Science Citation Index and Science Citation Index. We created the final set of 58 key contributors used in the co-citation analysis based on discussion with an expert who was also included in the set of key contributors (Please see Table 1).

Table 1: List of authors identified for analysis

Alavi M *	Hansen M	Oleary D *	Stewart T
Argyris C	Hedlund G	Orlikowski W	Sveiby K *
Barney J	Holsapple C *	Polanyi M	Szulanski G
Blackler F	Huber G	Porter M	Teece D
Brown J	Kogut B	Prahalad C	Tsoukas H
Cohen W	Lave J	Prusak L *	Vonhippel E
Daft R	Liebowitz J *	Quinn J	Vonkrogh G
Davenport T	LeonardBarton D	Romer P	Walsh J
Drucker P	Machlup F *	Ruggles R *	Weick K
Duguid P*	Malhotra Y *	Sanchez R	Wenger E
Edvinsson L *	March J	Schumpeter	Wiig K *
Garvin D	Mintzberg H	Senge P	Winter S
Ghoshal S	Nelson R	Simon H	Zack M *
Grant R	Nonaka I	Spender J	
Hamel G	Odell C *	Stein E *	

For each author, a file of articles citing their works (each identified by a unique number) was created by searching the Science Citation Index and the Social Science Citation Index over the period 1990 to 2002. These files were compared to create a 58 X 58 matrix of raw co-citation counts between each pair of authors. Following prior research (White and Griffith 1981; Culnan 1986), we computed the diagonal by adding the three highest co-citation counts in each column (or row) and dividing by two. A partial matrix of raw co-citation counts is in Figure 1.

	Argyris	Barney	Blackler	Brown
Argyris	683.5	86	37	124
Barney	86	765	8	30
Blackler	37	8	64	36
Brown	124	30	36	384.5

Figure 1: Partial matrix of raw co-citation counts

Mean co-citations were then computed for each author and only authors with average co-citation rates of 13 and above were retained for final analysis (one for each year of the study, as suggested by Marion and McCain, 2001) to minimize instabilities from variances in co-citation frequencies in the dataset (McCain 1990). The final analysis was performed on a co-citation matrix of 43 authors. The authors that were excluded in this process are indicated in Table 1.

Analysis

Factor Analysis: The subfields in knowledge management are revealed by a factor analysis of the co-citation data. The analysis groups authors (concepts) that are perceived by other researchers (citing their work) to be similar or closely related. Authors making related intellectual contributions to a subfield tend to load highly on the same factor. Authors with loadings above ± 0.4 or ± 0.5 are deemed to be important in the construction of a factor, although very often only authors with loadings greater than or equal to 0.7 are useful in interpreting the factor (McCain 1990).

The results of principal component analysis with oblimin rotation are in Table 2. Table 2 includes only authors with factor loadings greater than or equal to 0.4. Authors with lower loadings whose contributions span multiple factors (e.g. Leonard-Barton, Nonaka, Polanyi) are

considered to have a *pervasive* and *diffuse* identity, while those who load highly on only one factor are considered to be *crystallized* (White and Griffith 1982; White and McCain 1998).

***** Insert Table 2 Here *****

	1	2	3	4	5	6	7	8
1	1.000							
2	0.175	1.000						
3	0.204	-0.019	1.000					
4	0.214	-0.074	-0.070	1.000				
5	0.152	0.191	0.032	-0.062	1.000			
6	0.378	0.138	0.076	0.128	-0.008	1.000		
7	0.162	0.205	0.214	-0.234	0.172	0.002	1.000	
8	0.214	0.368	0.013	-0.062	0.424	0.068	0.271	1.000

Figure 2: Correlations among the factors

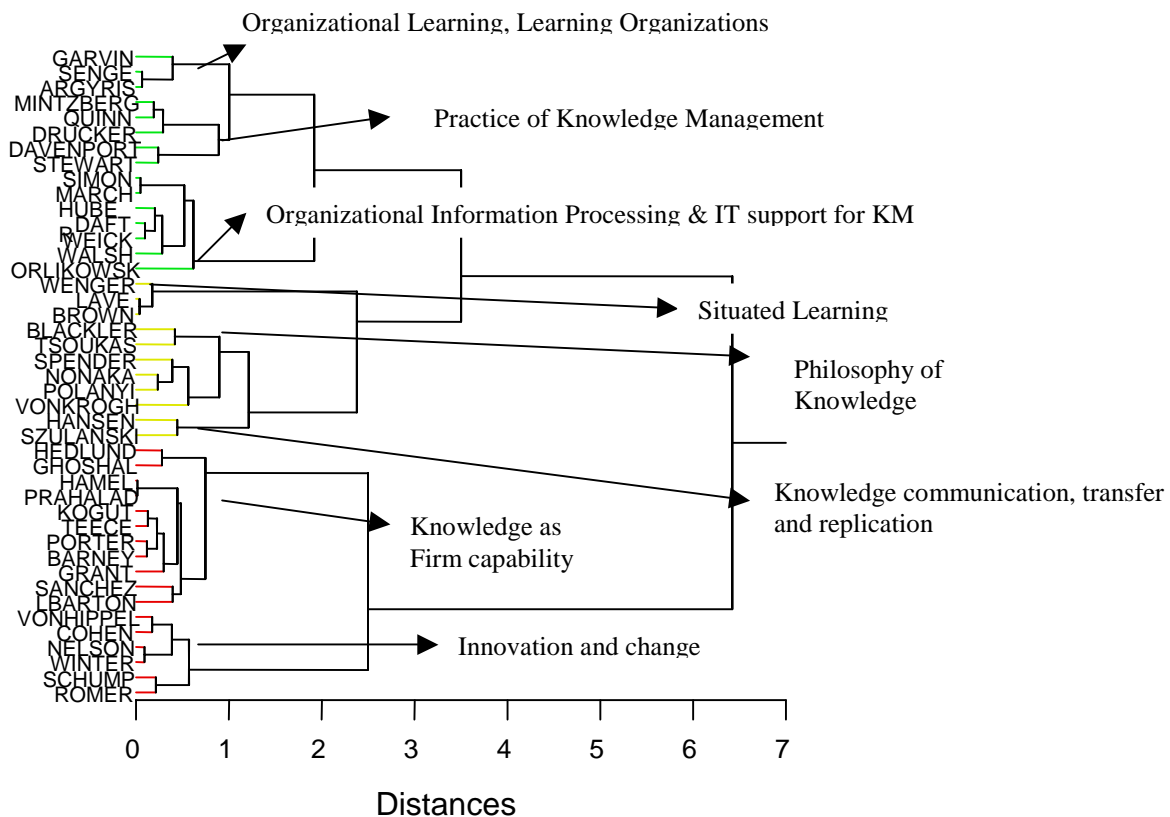


Figure 3: Cluster analysis using the Ward's method

Cluster Analysis: A cluster analysis of co-citation data allows a visualization of how the authors (concepts) cluster together. It permits us to easily see the proximity of an author to others as well as to visually inspect the closeness of one cluster to others. Consistent with prior research (e.g. Sircar et al. 2001) we used Ward’s method, a hierarchical clustering technique. The results of using the Ward’s method are shown in Figure 3. The overall cluster compositions are fairly consistent with the factors obtained through factor analysis as shown in Figure 3. Shorter linkage distances between authors (and their respective groups) imply stronger conceptual relationships.

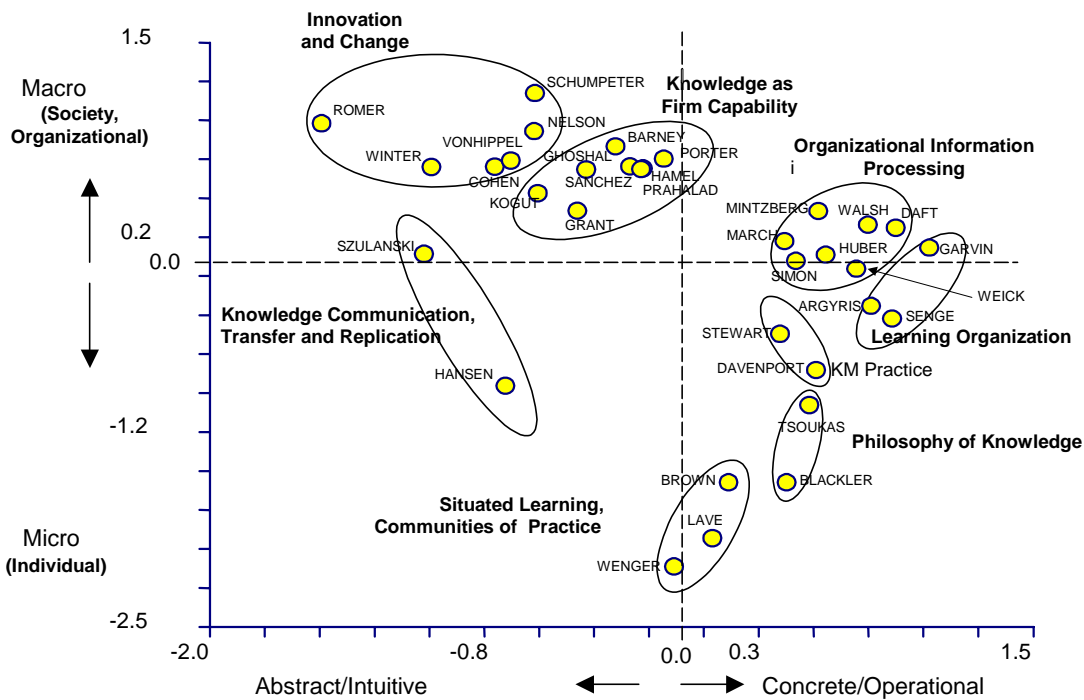


Figure 4: MDS Map of Knowledge Management

Multidimensional Scaling: A multidimensional scaling map (MDS) uses the correlation matrix to provide a spatial representation of authors. Such a graphical rendition of co-citation data can help discern evolution of thought in the field as well as to interpret the dimensions in which the various intellectual perspectives are displayed. While there is some loss of information in collapsing higher-dimensions into a two-dimensional map, it is easier to interpret. The Kruskal loss function was used to generate the map shown in Figure 4. A stress value of 0.17 and an R-Square value of 86.5% indicate a “good fit” (McCain 1990). In order to enhance the interpretation, only authors with loadings greater than or equal to ± 0.7 are shown in the figure.

Results and Discussion

The results of the three analyses are consistent and suggest similar groupings of authors (concepts). Each factor or cluster reflects a subfield represented by the set of conceptual ideas contributed and disseminated by the authors loading significantly on it. The grouping of concepts into distinct factors allows us to infer corresponding distinctions between KM research building on these ideas.

The factors were named based on an interpretation of the areas represented collectively by the authors (concepts) loading on each factor. The results suggest that research in KM can be viewed as being comprised of eight domains: 1) Knowledge as Firm Capability; 2) Organizational Information Processing and IT Support for KM; 3) Knowledge Communication, Transfer and Replication; 4) Situated Learning and Communities of Practice; 5) Practice of Knowledge Management; 6) Innovation and Change; 7) Philosophy of Knowledge; and 8) Organizational Learning and Learning Organizations.

The eight factors accounted for about 83 percent of the variance with the first five factors explaining over 50 percent. Quinn, Teece, and Polanyi loaded on more than one factor, suggesting that their works span or influence more than one subfield. Leonard-Barton failed to load on any of the factors. However, she loaded on both factor 1 (Knowledge as firm capability) and factor 2 (Innovation and change) with a factor loading greater than or equal to ± 0.3 , suggesting that her ideas are pervasive but have not crystallized into any distinct group (White and Griffith 1982).

These factors are also consistent with the map created by multi-dimensional scaling technique (Figure 4). We describe each of the factors (subfields of KM research) below.

Knowledge as firm capability

This factor represents KM research drawing on the organizational strategy literature and highlighting the role of Knowledge as a “firm capability” delivering competitive advantage. This reflects the knowledge based view of the firm in which knowledge is viewed as the central productive asset manifested in organizational routines, expertise resident in individuals and social networks within organizations, and in the organizational network of suppliers and

customers. In such work, the firm is seen as creating value by effectively integrating knowledge with other firm assets to create and deliver products and services. Research in this theme focuses on activities and integrating mechanisms that help firms coordinate, transfer, and deploy the knowledge of the firm's employees and the knowledge resident in the firm's organizational network. The role of social capital and the shared vocabulary, formal structure of interactions and the cooperative context within firms that enables them to create, coordinate, and integrate knowledge is also evident in the body of research within this subfield. Knowledge intensive processes underlying the ability of firms to perform on an ongoing basis in the midst of changes in inputs, employee turnover, and changes to organizational goals are other key areas of KM research investigated by the authors loading on this factor.

The cumulative tradition within this aspect of KM research builds on a broad range of ideas related to the core competencies of firms (Prahalad, Hamel), the combinative capabilities of firms (Kogut and Zander), the resource based view (Grant, Barney, Prahalad), social capital (Ghoshal), knowledge articulation within firms (Sanchez, Hedlund) and dynamic capabilities (Teece). The focus of this stream is on explaining firm level outcomes and the choice of organizational competitive strategies (Porter). Overall, this factor (accounting for 18.7 percent of the variance) reflects the predominant focus in KM literature on the role of intangible assets in providing organizational competitive advantage. An examination of the factor correlations shows that this factor is correlated with factor 6 (Innovation and change).

Organizational Information Processing and IT Support for KM

This factor represents KM research drawing on organizational theories and focusing on phenomena linked to information processing within organizations and the role of information and communication technologies. This includes work focused on the role of information systems in developing organizational memory and generally, the role of knowledge management in enhancing decision making in organizations. This factor also reflects work in the KM literature on communication media and their role in knowledge management. Work drawing on structuration theory that highlights the duality of technology in organizations and information technology support for knowledge management efforts of organizations is also included in this factor.

This area of KM research draws on prior work in organizational information processing (Simon, Weick), organizational memory (Walsh) media theories (Daft, Weick), information processing behaviors of managers (Mintzberg), the structuring of organizations (Mintzberg, Orlikowski) and research on information systems (Walsh, Orlikowski). This accounts for 14.7 percent of the total variance in the co-citation data. This area of research along with factor 5 (Practice of knowledge management) is correlated with concepts of organizational learning and learning organizations expounded by the luminaries who load on factor 8.

Knowledge Communication, Transfer and Replication

The two authors (Gabriel Szulanski, Morten Hansen) loading on this factor focus on *intra-organizational knowledge transfer* such as the replication and diffusion of manufacturing and operational processes or the sharing of expertise by consultants and highlight it as a costly and complex process on account of the social, structural and cognitive barriers that need to be overcome. Their work highlights factors that contribute to stickiness or difficulty in transferring knowledge and draws attention to factors influencing the efficacy of knowledge transfer such as source, recipient and context characteristics and the differential utilities of network ties in facilitating knowledge location and knowledge sharing. This body of work conceives knowledge transfer within sub-unit boundaries as a complex process involving reconstruction and recombination rather than the simpler process of transmission and reception.

This strong focus of this work knowledge sharing within organizations (e.g. the transfer of skills and knowledge within consulting project teams, across organizational sub-units etc.) distinguishes them from research on Situated Learning and Communities of Practice (Factor 4) that is primarily focused on knowledge sharing at the individual level within groups. Further, the strong orientation of this work on examining purposive and formal organizational initiatives to transfer knowledge across sub-units differentiates it from the work on Communities of Practice where the knowledge creation and sharing are viewed as an emergent phenomenon. This factor captures 5.6 percent of the variance in the co-citation data.

Situated Learning and Communities of Practice

The perspective that learning and knowing are activities strongly situated and linked to the characteristics of the specific context in which they occur is dominant in the research drawing on this subfield. This casts learning and knowledge creation as occurring social phenomena with socialization of participants playing a major role and outcomes determined by the dynamics of interaction of individuals in groups. This factor represents KM research drawing on the notion of situated learning and of communities of practice where a consensually formed group is viewed as the repository of knowledge with individual participants possessing partial and overlapping subsets. Knowledge creation and sharing is viewed as occurring through interactions in such communities; facilitated by the vocabulary and experiences shared by members within communities. Work related to the acquisition by individuals of tacit and socially complex skills through apprenticeships and other forms of legitimate peripheral participation are also grouped under this factor.

The conceptual foundation of this area of KM research rests on the ideas of situated learning, social cognition, legitimate peripheral participation, and communities of practice contributed by Lave, Wenger and Brown. Their writings, however, are strongly focused at the individual level of analysis, even though the larger community is the backdrop as well as the context for the phenomena they examine. Further, researchers drawing on Lave, Wenger and Brown are likely to view knowledge phenomena as being 'bottom-up' and driven by individual motivations and interests while those drawing on Hansen and Szulanski are likely to view knowledge phenomena as being 'top-down' and driven by the organization's perceived need to disseminate knowledge of best practices, efficient routines, and innovations across organizational boundaries.

Practice of Knowledge Management

This factor includes the concepts contributed by Tom Davenport, Tom Stewart, Peter Drucker and James Quinn, suggesting a strong orientation towards informing managerial practice. Thus, this reflects the research on KM that focus on descriptive, rich, anecdotal accounts of knowledge management initiatives providing inductive insights that can contribute to theory building as well as informing practice. This factor accounts for 7 percent of the variance. This factor is correlated significantly with Factor 8 (Learning Organizations) reflecting a secondary emphasis in

managerially oriented KM research on phenomena like double-loop learning characterizing Factor 8.

Innovation and Change

This factor comprises leading scholars focusing on different aspects of innovation, change, and growth. The concepts contributed by Schumpeter and Romer reflect the importance of incentives for innovation and knowledge creation. Nelson and Winter identified organizational routines as a key conceptual mechanism to describe the ongoing repeated action within organizations, while Cohen and Leventhal suggested the notion of absorptive capacity as a major determinant of learning and innovation. Von Hippel highlighted how the locus of innovation and problem solving was influenced by the stickiness of knowledge. This factor also includes the ideas of Teece who proposed that the complexity of knowledge could be the basis of competitive advantages and on the recognition that new knowledge can either be competence enhancing or competence destroying. These results suggest that research drawing on these ideas represent a key domain of research in KM. This factor accounts for 13.8 percent of the overall variance.

Philosophy of Knowledge

The leading proponents of this area of research are Tsoukas, Blackler, Spender, Von Krogh, and Polanyi who investigated the origin and nature of knowledge. These researchers investigate the foundations of human knowledge to identify different types of knowledge. They have also attempted to explicate the relationships and interactions between these types of knowledge as well as develop knowledge schemata.

This factor, accounting for 7 percent of the total variance, represents research in KM that extends the tradition of philosophical inquiry into the nature of knowledge. It is also interesting to note that these authors are, as a group, largely from Europe (with the exception of Spender) and reflect the constructivist approach to management research on the continent as opposed to the predominantly positivistic approach to inquiry in the US.

Organizational Learning, Learning Organizations

This factor accounts for 8.3 percent of the total variance and comprises the set of work in KM building on ideas of Peter Senge, Cris Argyris, and David Garvin. The foundation of the ideas in this set was laid by Argyris and Schon who proposed several models of organizational learning and also evolved practical guidelines for managers. The work of Senge elaborated on the notion of double loop learning, mental models and defensive reactions, proposing that effective links between cause and effect in organizations need to incorporate 'systems thinking' and 'team learning'. Garvin contributed to the application of the principles of learning organization to organizational practice.

The correlation between factors (Figure 2) provides insights into the level of the proximity of the conceptual groups. The strongest correlation is between the factor representing 'Organizational Learning' (factor 9) and that representing the 'Practice of KM'(factor 6), reflecting the orientation of the contributions of authors in both groups towards influencing managerial action and application in organizations. Similarly, the correlation between the factor representing 'Knowledge as Firm Capability' and the cluster of ideas on 'Innovation' (factor 6) reflects the common roots in economics of both these clusters. The correlation between 'Organizational Information Processing' (factor 2) and Organizational learning (factor 8) is harder to interpret and perhaps reflects the shared commonality of ideas related to decision making and information processing.

The results of multidimensional scaling presented in Figure 4 complement our understanding of the subfields in KM research revealed by factor analysis. The axes of the map can be interpreted on the basis of the commonality of the concepts and the relative position of the clusters. The X axis can be seen to represent the continuum of methodological approaches: from Abstract/Intuitive approaches to KM to Concrete/Operational approaches. Thus, the work of Romer and Winter that reflect intuitive insights on organizational processes and the concept of *stickiness* of Szulanski are arrayed to the left with the concepts of Senge and Garvin on the extreme right that are relatively strongly grounded in organizational contexts. The vertical axis represents the breadth of the conceptualizations or the scope of theoretical propositions: from the micro/individual level at the bottom to the macro/organizational at the top. Thus, the works of Brown, Lave and Wenger highlighting individual behavior is at the bottom while the work of

Schumpeter focusing on innovation and change at the level of technologies and societies is at the top.

Analysis of Conceptual Proximity

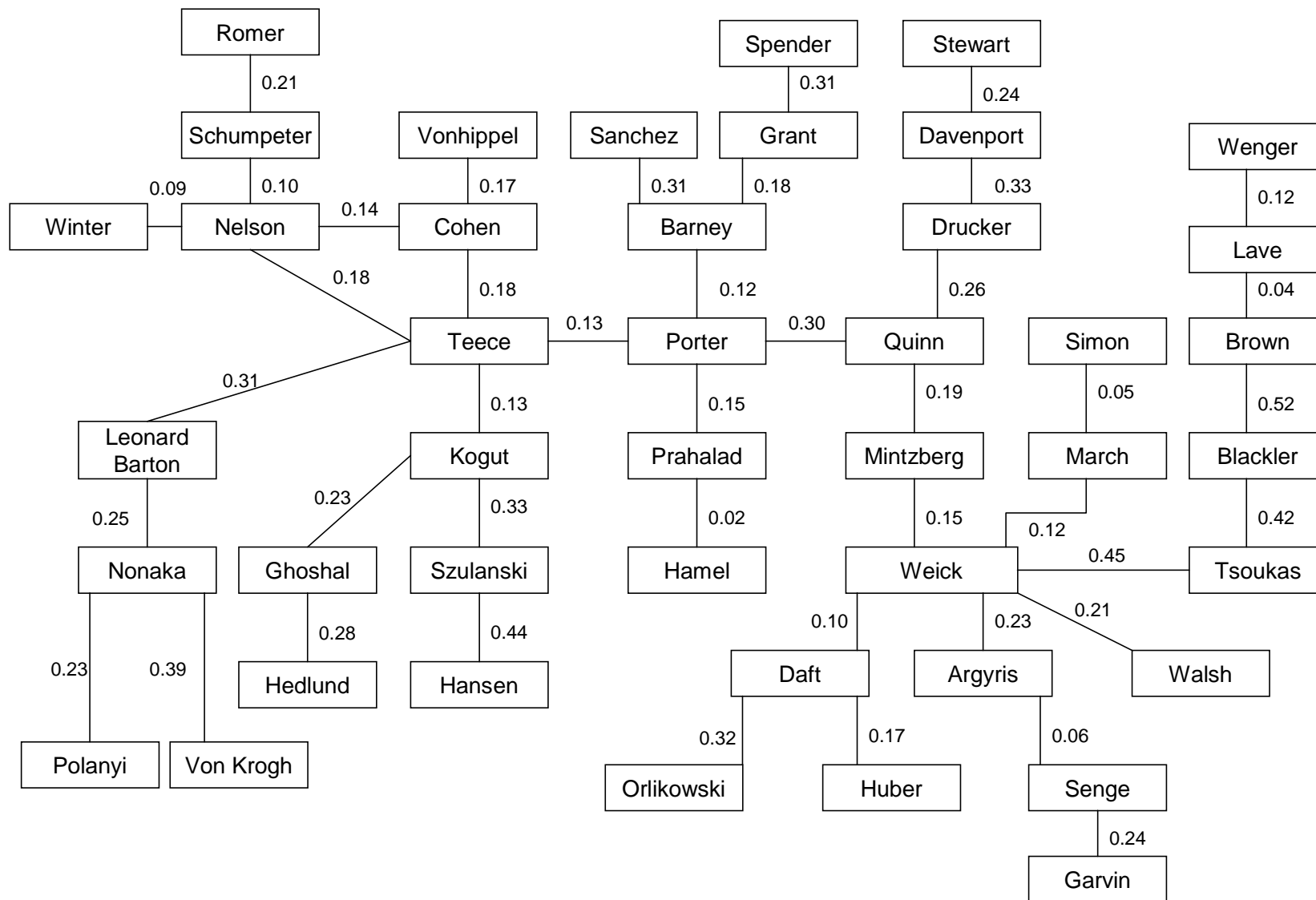
To derive a greater understanding of the nature of the relationships between key concepts, we performed a PFNet analysis of the cocitation data. The cocitation data is used to compute the strength of ideational linkages that reflect the proximity of concept clusters identified with specific authors. The results of the PFNet analysis are in Figure 5.

The analyses complement the results of the clustering and MDS analyses as they highlight the conceptual similarity of concepts. While the MDS analysis provides a spatial representation of linkages, PFNet analyses provide a quantitative assessment of the proximity of concepts. The network diagram in Figure 5 depicts key concepts in the literature (proxied by the authors) and their proximity. In a PFS diagram, only the most proximal concept (the one with the strongest linkage) is depicted for each construct. The weights of the linkages reflect proximities and hence smaller magnitudes represent strong concept relationships.

The number of linkages therefore represents the centrality of the concepts to those of other authors.

Concepts that are most central are clearly those that are most proximal to multiple concept clusters and would have the most linkages in the PFNet analysis. The pattern of concept proximity in Figure 5 suggests that the most central concepts are those contributed by Weick: (this is the most proximal to five concept clusters of Daft, Argyris, Walsh, Tsoukas and March) followed by concepts of Nelson, Porter and Teece (each of these is proximal to four other clusters). The diagram also highlights patterns of concept development. For instance, the concepts contributed by Argyris (e.g. double loop learning) are most influenced by the work of Weick. Argyris's work in turn is elaborated by Senge (e.g. the concept of the learning organization) and these ideas are further elaborated by Garvin (processes for quality improvement and organizational learning).

The results of PFS analysis thus provide a complementary perspective on the conceptual development of Knowledge Management as a discipline.



Notes: Figures on links reflect the proximity of concept relationships; smaller weights imply closer linkages

Limitations

The results need to be interpreted in the light of the limitations of the methodology. ACA assumes that there is no difference among the citations, i.e., all citations are given equal value. It also assumes that a citation reflects an ideational relationship between the citing and cited papers. The data are inherently noisy as they are obtained by automated methods by searching citation indices. Further, authors making recent contributions are underrepresented in the dataset because of the lag between publication and the citing of work in subsequent research as well as delays in getting recent publications and citations of recent work into citation indices (White 1990).

Summary and Conclusions

Cumulative traditions are built in disciplines through a complex and elaborate process of knowledge creation, replication, and extension. Communities of scholars, guided by shared values, assumptions and norms, form *invisible colleges* that build on each others' conceptual works (Crane 1972). The dynamics of citations and citation patterns provide useful insights into the conceptual structure of a field and help discern streams of research and the linkages among them. This is the first step in understanding a field in terms of its research themes, reference disciplines, problem-solving exemplars, goals and assumptions, and cumulative traditions.

KM has attracted considerable attention from researchers in a broad cross section of disciplines in the last decade. In this study, we have used ACA to synthesize the variety of concepts and perspectives on KM reflected in references to key contributors to KM in hundreds of articles spanning a broad spectrum of disciplines. Drawing on the *view of the field by the field*, our results reveal eight subfields that form the conceptual foundations of KM. The growth and maturity of KM depend largely on the extensions and enrichment of the concepts characterizing these research streams.

KM has been recognized as an important area by researchers in IS. An examination of the literature reveals a number of pioneering contributions to the understanding of KM phenomena contributed by IS researchers (Alavi and Leidner 1999; Zack 1999a; Zack 1999b) (Watts et al.

1997) (Alavi 2000) (Orlikowski 1993) (Boland and Tenkasi 1995) (Nelson and Coopriider 1996) (Sviokla 1996) (El Sawy and Bowles 1997) (Ackerman 1998) (Davenport et al. 1998) (Goodman and Darr 1998) (Balasubramaniam and Tiwana 1999) (Balasubramanian et al. 1999) (Baskerville and Pries-Heje 1999) (Earl 1999) (Gray 1999) (Jarvenpaa and Staples 2000) (Purvis et al. 2000). Many of these authors have contributed key concepts highlighting relationships between information systems and knowledge management that are important to understand phenomena related to KM in organizations. However, our results provide no evidence that the contributions of the majority of these researchers have been recognized. We find that the conceptual contributions of only two IS researchers (Wanda Orlikowski and Tom Davenport) are currently crystallized into sub-fields of KM research. A plausible explanation for this is the recency of contributions to KM among IS scholars as well as the fact that it takes a certain amount of time for articles citing such contributions to get published. Also, a lack of attention or awareness of research published in IS journals by the broader body of organizational researchers may offer another reason for the insignificant impact of IS scholars on KM research. We hope that the set of sub-fields in KM identified by us can lend greater focus and direction to KM research within the IS community so that our contributions to this important area can influence other researchers and IS researchers can receive due recognition for their work.

The results highlight important issues for future research. A more context sensitive understanding of the structure of KM research can be obtained by using complementary bibliometric techniques such as Co-citation Context Analysis and Document Citation Analysis (Small 1980). Co-citation context analysis provides insights based on the context of citations, while document citation analysis, can draw attention to the grouping of conceptually similar seminal concepts. The results of such analyses can validate, as well as complement and extend our findings based on author co-citation analysis. In general, this paper highlights the utility of bibliometric methodologies to derive a broader view of the growth of intellectual fields and we hope future researchers will apply this technique to enrich our understanding of the development and maturity of MIS as a field of scholarly research in management.

Table 2: Results of factor analysis

Factor	1	2	3	4	5	6	7	8
Descriptive Name	Knowledge As Firm Capability	Organizational Information Processing & It Support For KM	Knowledge Communication, Transfer, And Replication	Situated Learning And Communities Of Practice	Practice Of Knowledge Management	Economic And Analytic Views Of Innovation And Change	Philosophy Of Knowledge	Organizational Learning, Learning Organizations
	Prahalad 0.92 Hamel 0.88 Ghoshal 0.857 Barney 0.783 Kogut 0.769 Porter 0.737 Sanchez 0.723 Grant 0.71 Hedlund 0.692 Teece 0.608 Quinn 0.434	Daft 0.899 Weick 0.86 March 0.833 Huber 0.795 Walsh 0.766 Simon 0.747 Mintzberg 0.701 Orlikowski 0.699	Hansen 0.769 Szulanski 0.735	Lave -0.982 Brown -0.960 Wenger -0.943	Davenport 0.83 Stewart 0.786 Drucker 0.65 Quinn 0.468	Schumpeter 0.914 Nelson 0.913 Romer 0.871 Winter 0.837 Cohen 0.762 Von Hippel 0.708 Teece 0.548 Polanyi 0.47	Tsoukas 0.773 Blackler 0.738 Spender 0.622 Von Krogh 0.579 Polanyi 0.5	Senge 0.921 Garvin 0.874 Argyris 0.773 Nonaka 0.452
Variance Explained	8.022	6.332	2.413	3.231	3.012	5.953	3.037	3.572
% of Total Variance	18.656	14.726	5.611	7.515	7.004	13.844	7.062	8.308

Note: – Table indicates only authors with loadings ≥ 0.4

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