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NETWORKS OF INNOVATION IN IS RESEARCH: AN EXPLORATION OF THE RELATIONSHIP BETWEEN CO-AUTHORSHIP NETWORKS AND H-FAMILY INDICES

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Abstract

Assessing the work of scholars is of great importance in the life of academic institutions, disciplines and scholars. Research suggests that that the notion of 'scholarly influence' should be substituted for current approaches towards judging scholarship (Truex et al. 2009). This paper seeks to examine the nature of the construct 'scholarly influence' by reconceptualising the activity of academic research as a social process of peer production enacted through networks of innovation. It combines techniques used to assess 'ideational influence'– a measure of the productivity and the uptake of an author's ideas – and techniques used in social network analysis to assess 'social influence' – patterns of social interaction measured as co-authored publications in journals and conferences. The analysis suggests that social and ideational influence appear to be inter-related; those with high citation indices are also well connected. Rather than argue causality we have proposed that the two are mutually reinforcing and that an assessment of researcher impact should take account of both when looking for indicators that might have predictive power. Given that citations are backward looking it is possible that measures of social influence, such as closeness to highly ranked scholars as evidenced by co-authorship networks, will provide a useful forward looking indicator. Promotion boards might consider social network and citations when considering a researcher in the round.

Keywords: Peer production, open innovation, scholarly influence, social network analysis (SNA), ideational influence, social influence, H-family indices, bibliometrics.

1 Introduction

In both research oriented and teaching oriented institutions, the evaluation of scholarly output has been of key importance to retention, promotion, and tenure decisions. This raises the question of how do we evaluate and compare the scholarship and influence of one researcher to another, both in one's own field and between fields of study. Scholar evaluation is a pragmatic concern because deans and resource awarding bodies consider such comparisons in awarding grants and other resources. The key question is "what is the best method of doing so?" The received methodology has been to count publications in "quality journals", with the appropriate number comprising the cut-off for a determination of "quality scholarly research." Voices have been raised critiquing the subjectivity and 'fairness' of this method as being a biased and inaccurate representation of scholarly output (Chua et al. 2002; Singh et al. 2007; Truex et al. 2009; Walstrom et al. 1995).

Following MacDonald and Kam (2007) we argue that all of the extant approaches are insufficient to the task of assessing and measuring scholarly output. To provide a better method of evaluating scholarly contribution, the concept of influence has been proposed as an alternative evaluation mechanism in replacement of "quality". While any measure or composite measure is still going to have some built-in bias, we contend that a socially constructed methodology based on co-authorship and bibliometric measures assesses academic 'influence' better than an evaluation based on the opinions of a handful of scholars. Accordingly, the use of several of the Hirsch family of indices, the h (Hirsch 2005), the h_c (Sidiropoulos et al. 2006), and the g indices (Egghe et al. 2006) has been proposed as a means of creating a profile of measures of influence ((Truex et al. 2009; Truex III et al. 2009)). Using these metrics, a profile of a scholar's influence can be assessed and then compared with other "benchmark" scholars to make a determination of the value of the scholar's intellectual contributions. Such a methodology shifts the focus from the publication venue to the uptake of the scholar's ideas.

Counting publications favours the view of the academic as lone researcher, working independently of other academics and relying on publication outlet reputation to promote the uptake of ideas. In practice, much academic research is produced through co-authorships whereby publications are peer-produced. Benckler and Nissenbaum (2006) argue that peer production is a model of social production and that it is orthogonal to "contract- and market-based, managerial-firm based and state-based production" (p. 400). Peer production is typified by two characteristics: decentralization - the authority to act is at the discretion of the individual rather than a central organizer – and the use of social cues rather than prices or managerial direction to motivate and coordinate participation in the peer production network (ibid, p. 400). We further argue that one measure of an academic's influence is the strength of their network, i.e., the social capital they possess in their academic community. By leveraging their existing network capital (through building new and maintaining existing co-authorship relationships) the academic researcher has access to further peer-production opportunities.

The current research is a continuation of a line of meta-research in the IS field that is interested in the nature of the IS field, how IS research is output, and how IS researchers are evaluated. Meta-research in IS has a long history in the IS field reaching back to the beginnings of the IS field. Mason and Mitroff (Mason et al. 1973) came up with a IS research agenda back in 1973. The first ICIS conference had two papers on IS meta research (Hamilton et al. 1980; Keen 1980) and meta-research continues to this day (Basden 2010). The current research is continuing the evaluation of scholars in IS meta-research.

All this suggests that to evaluate scholarly influence we need to consider both 'ideational influence'– a measure of a scholar's productivity (measured in research publications), the degree to which others refer to his work (citations analysis), **and** the concept of social influence, i.e., the social capital that a scholar accrues through participation in the peer-production of scholarly outputs. In this paper we hypothesize that social influence and ideational influence are associated and mutually reinforcing.

The rest of the paper proceeds as follows: in the next section we examine the nature of social influence in scholarly research, then methods of assessing social influence including social network analysis which we will propose as a means of assessing social influence as expressed in cohort networks in the IS community. We then describe the methodology used to create an IS scholars social network. Then we analyze the social network of prominent IS scholars and show how social influence may drive the ideational influence of scholars. In doing so, we will describe the data collection and analysis methods used in this study. We then present and discuss the findings and limitations of this research, before finally, considering the implications and how they may inform future research.

2 Theory Development

2.1 The Concept of Social Influence Defined

The development of scientific knowledge is a social phenomena (Bhaskar 1997; Pinch et al. 1984). Kuhn (1996) argues that paradigms are established or changed when the community of scientists determine that the existing paradigm should be replaced. This replacement process, which he terms a revolution, is a political process enacted within the field. Latour (1987) proposes that scientific knowledge develops based on a dialogic interaction between those who make claims and those who support or refute them. Eventually, this builds to a critical mass to where the proposed knowledge is accepted as "true" or "blackboxed" (Latour, 1987) so that it is no longer contested but accepted and then not subject to further dispute without additional evidence. Similarly, Pinch and Bijker (1984) describe an approach to the sociology of knowledge they call the "Empirical Program of Relativism". There are three stages to this approach. First, the interpretive flexibility of results; that results are open to more than one explanation. Second, the interpretive flexibility is limited by social constraints imposed when a field gains consensus on an issue. Third, the social constraint is arrived at through social-cultural interaction. From the critical realist position, Archer (1988) provides a methodology for analyzing cultural social structure change. She argued that cultural social structures are changed or maintained through the use of social interaction. Bourdieu (1984, 1985) developed a similar concept of 'capital' as cultural capital, social capital, and economic capital. In Bourdieu's framework social capital arises from the networks of shared interests and influence (Bourdieu 1984; Bourdieu 1985).

One common aspect to all of these approaches is the concept of social interaction. In interpreting findings or developing theories, scientists interact with each other to test these theories either formally through the publication process or informally through interactions at conferences and other meetings. These interactions mould and shape the ideas of those interacting and eventually help foster the consensus that determines what the field regards as "truth". The informal interactions sometimes lead to formalization of relationships in terms of co-authoring or forming virtual research teams.

Now, in this process of interaction, some scholars are more persuasive than others in terms of influencing others as to the validity of their ideas. Others are less capable of that type of influence. The differences in these levels of influence arise through differential social skills, affinity between scholars, commonality of thought, etc. This ability to influence others through the processes of social interaction we term "*Social Influence.*" A scholar may be said to have higher social influence if he/she is able to change the thought of other scholars through social interactions. Ideational influence on the other hand is in view when the influence is exercised strictly through their published works.

2.2 The Concept of Ideational Influence Defined

The main way that researchers output their research findings are by publishing. These are results of research and ideas that are being put out to the intellectual market. While the publication count will measure the ideational output of a researcher, the impact on the field is not seen by just the publication count. However, the uptake of the ideational output can be seen by using citation counts. Thus, "*ideational influence*" is defined not only by the output of ideas by a researcher but the output of ideas and the subsequent uptake of the researchers ideas by the field.

2.3 Operationalizing Social Influence

Since social interaction takes place in largely informal situations, operationalization would seem to be difficult. However as this interaction often formalizes into partnerships, we can use these partnerships to assist in operationalizing the concept of social influence. These partnerships such as doctoral student-advisor and co-researchers are often difficult to collect data on. Therefore, we suggest that both relationships will likely result in co-authored citable research artefacts (conference and journal papers, panels, and edited collections). As advisors take their students through the process of learning how to conduct research, the advisor teaches the student proper methods and also introduces them to the field's literature and interprets it with him/her. This is a position of great influence. The student often shows the advisor new streams of literature or performs innovative research that contributes new knowledge. Thus the student is reciprocally influential to the advisor. Similarly, the relationship between research partners has significant communication between them exchanging ideas and interpreting the findings. Accordingly each exerts influence on each other. One of the results of these processes of interaction is jointly produced co-authored research artefacts reporting their collaboration. Their joint vested interest in seeing the fruits of their joint research labours in the best possible venue further cements the relationship. These publications, therefore, represent the result of joint activity between them and can serve as a proxy for the social influence that occurred between them.

2.4 Social Influence and Ideational Influence

As shown above the workings of social influence and ideational influence are intertwined. Social influence represents the influence that occurs through the social interactions while ideational influence represents the uptake of his idea in the field. Social influence is assessed via co-authorship while ideational influence is assessed via citation analysis. We expect to see that those authors that have high social influence numbers (via centrality measures) will have high citation analysis numbers (via h-index). We argue for this on the basis that an author who has high centrality will have grater opportunity for co-authorship and thus be able to publish more papers and the potential to attract higher citation numbers.

From the preceding discussion in which we saw that scholars exercised social influence on each other through the interaction that occurs around a joint research endeavour, there results a knowledge of each other's results and publications. Given this common research interest and knowledge of each other's publication record, we can surmise that this will result in the research partners citing each other. Given this idea, we propose the following:

> ***Proposition:*** *Social influence and Ideational influence are positively related*

2.5 Assessing Social Influence

In evaluating social influence, we need a methodology that allows us to assess scholar relatedness expressed in co-authorship in such a way to determine influence on the ideas of each other. We propose using methods commonly used in social network analysis (SNA) to assess these relationships. In SNA, formal (e.g., such as the co-authoring relationship described above) and informal (e.g., who you have dinner with when attending conferences) relationships between researchers can be mapped (Vidgen et al. 2007). One of the results from SNA is the analysis of centrality, or the types and quantity of connections that one member of the network has to other members of the network. By examining the centrality measures of the various members of the community, we can arrive at a profile of measures that assess the social influence of the members of a research community. Proper comparison of these profiles would allow evaluators to assess the social influence of the scholar and along with the ideational measures provided by the Hirsch indices create an assessment of the scholar's intellectual contribution. Such an assessment we argue would be superior to that provided by the simple publication count metric. However, these measures are likely to be related: researchers with high social influence are likely to have high social capital which will lead to higher levels of citation.

Although it might seem unlikely that the reverse is true, i.e., that high levels of citation will lead to stronger social influence, this may well be the case if promotions and funding are allocated on the basis of citations and researchers with high citation counts become courted by other researchers.

Network analysis is being used fields from neurobiology to statistical physics. In our literature SNA is increasingly featured in papers (Nerur et al. 2005; Polites et al. 2008; Takeda 2010), including examination of social networking sites such as MySpace and Friendster (Howard 2008; Kleinberg 2008). SNA "can in fact uncover subtle, unrecognized relationships between journals, and thus can aid in the development of more accurate classification schemes in the future" (Polites et al. 2008).

SNA can be used to map networks of co-citations (when one author cites another author's work) and networks of co-authorship (when scholars co-author a research publication). We choose to use co-authorship as a measure of social influence as it is a more direct and personal linkage between scholars that requires two-way communication. The strength of the tie between co-authors is indicated by the number of times that they have written together. In SNA graphical representations typically show darker and thicker lines to represent higher frequency of co-authorship relationships.

When performing a SNA, several aspects of a network – nodes, edges, connectivity, distance, and components (or clusters) – are identified and examined. A node is defined as a point on the network (Barbasi et al. 1999; Coleman 1988; Kleinberg 2000; Travers et al. 1969). In co-authorship networks, the authors are placed as the nodes. An edge of a network is defined as a line connecting two nodes (Barbasi et al. 1999; Coleman 1988; Kleinberg 2000; Travers et al. 1969). An edge can be non-directional, directional, or bidirectional. A co-authorship is represented as a non-directional edge made between the author/nodes. Distance is the length of the shortest path, measured in links, between two distinct nodes (Travers et al. 1969). Distance is measured by counting the minimal number of edges it takes to go from one node to another node. Connectivity is a notion of how a node (an author) in the network is connected to others via an edge. Depending on the research question, connectivity can be measured by the pure number of edges coming out of any given node. The researcher may want to discover how an author is connected so a weight/distance measure to other nodes may be incorporated. Strength of edges and nodes may also be included in the measure. Connectivity may be shown on the network by proximity of nodes – how authors form clusters. Proximity measures can show how many authors are closely related to one author, or how many authors are within a given cluster (Albert et al. 2002; Barbasi et al. 1999; Barbasi et al. 2002; Henry et al. 2007; Vidgen et al. 2007).

In SNA there are three core measures of centrality (Freeman 1977): degree centrality, closeness centrality, and betweenness centrality. *Degree* is simply a measure of the number of direct connections that an author has, i.e., their co-authorships. The more co-authorships an author has then the higher their degree. If author A co-authors three times with author B, once with C, and twice with D then A's degree is six. In an undirected network, such as co-authorship, the in-degree and the out-degree are the same. In a directed network, such as friendship, then in-degree and out-degree can be different (e.g., A likes B but the friendship is not reciprocated). Although degree centrality is a useful measure of popularity (and possibly promiscuity) it does not say anything much about how powerful an author's position in the network is. However, keeping busy may bring its own rewards and we hypothesize:

> *H1: A scholar with a higher degree centrality will tend to have a higher ideational influence in the field.*

Betweenness reflects the power of an author's network position. An author might have less direct co-authorship connections than other authors (degree) and not be as close to the centre (closeness) but occupy a position of power through being a gatekeeper. An author with high betweenness who spans otherwise unconnected constituencies can exercise control over the flow of information and ideas, either improving network flow or impeding it. Betweenness is calculated using the geodesic – the shortest path between two authors. The more times an author is on the geodesic path then the higher that author's betweenness score. In a co-authorship network, betweenness can be thought of as brokerage, for example a single author might connect a cluster of authors working in IS strategy research with a separate cluster of researchers interested in business process management research.

H2: A scholar with a higher betweenness centrality will tend to have a higher ideational influence in the field.

Closeness is concerned with how quickly an author can access all the other authors in the network. A measure of 'farness' is calculated using the geodesic distance (i.e., the shortest path) between pairs of authors and closeness is then simply the inverse of the farness score. The author with the highest closeness score therefore has the shortest paths to all the other authors in the network and this "closeness" will help them hear information and new ideas quickly and be able to disseminate their own ideas quickly and efficiently.

H3: A scholar with a higher closeness centrality will tend to have a higher ideational influence in the field.

2.6 Assessing Ideational Influence

We measure ideational influence by using the Hirsch family of indices. An author's **Hirsch index h (h-index)** is defined as being the number of papers "h if h of his/her N_p papers have at least h citations each, and the other (N_p - h) papers have no more than h citations each" (Hirsch 2005). To increase one's h-index one must continue to publish (productivity), and those publications must garner multiple citations (influence). Hence the h-family indices assess both productivity and influence (Hirsch 2005).

3 Research Method

To test our hypotheses, we ran a correlation analysis of the social influence against the ideational influence for a set of the field's top ranked scholars. The list was taken from the 100 scholars detailed in Truex, et al (2009, Table 8) in which they derived the h-family indices for a list of IS scholars reported in Lowry (2007). Lowry's work used MISQ, ISR, and the IS articles of Management Science. Truex et al. (2009) augmented Lowry's original with a list of European scholars derived from EJIS, ISJ, and JSIS. We do NOT claim that this table is a definitive list of 'The' top IS scholars, but that it is a representative list of scholars from both the US and Europe who have high ideational influence, i.e., h-index. For the purposes of this research by choosing such a list, we have a list of authors who have a large number of papers each and thus a larger number of co-authors.

3.1 Measures

We operationalized the concept of social influence by use of three SNA centrality measures: degree, betweenness, and closeness were used as part of a profile describing the scholar's social network. In this research the social network is defined by the set of authors who have co-authored research publications in the IS field. The network takes the set of all papers submitted to IS journals and conferences (including panels and edited collections) in which there is co-authorship of a citable scholarly production. Sole-authored publications are excluded from the network. SNA's main metric is distance: how many co-author connections does it take to reach another author. For example, if A and B co-author and B and C co-author and C and D co-author, the distance between A and B is one, between A and C is two (via B) and between A and D is three (via B and C). To operationalize ideational influence, we used the Hirsch statistic as described above for each of the scholars.

3.2 Data

The sources of data for the research are shown in Table 1. Data was collected from a range of sources (conference websites, AIS) as Endnote databases (DBs). The DBs were consolidated into a single file of citable research artefacts, including conference papers, journal papers, edited collections, and panels, giving a total of more than 18,000 publications. The DBs were then exported to text and a program was written to break the records into their constituent parts for loading into a database. A number of the Endnote records were inaccurate, for example, fields were missing and names mistyped.

Closer inspection revealed that an author could be entered into Endnote in different ways, e.g., with a single initial, with first and middle initials, with variations such as 'Bob' for 'Robert' and with various misspellings. For example, if a researcher's name were John Quincy Public, we would find entries such as John Quincy Public, J. Q. Public, John Q. Public, John Public, J. Quincy Public, J. Public and John Q. P. For the high-scoring 100 h-index authors we cleaned the data in the database by searching on parts of their family name and then combining the variants into a single author code.

The h-index was computed using the 'Publish or Perish' (Harzing 2010) tool by the authors of that paper. PoP[1] is a tool that can be used to measure bibliometric properties of a researcher, including the h-index. The researcher name needs to be input to the PoP tool. While the tool is very proficient at finding the bibliometric measures, we did find similar data errors mentioned above during the data collection for the SNA. These were manually corrected for our research. The h-index measures were collected in May of 2008.

All the publications in the database that matched the high-scoring 100 authors that had two or more authors were extracted from the database for input to the social networking analysis software, UCINET. Not all authors had co-authored with others in the top 100, resulting in 84 authors being extracted. We then extracted the main component, arriving at a population of 78 authors (six authors were not connected to the main group of authors), which forms the basis for the subsequent analysis.

Journals	Conferences
CAIS - Communications of the Association for Information Systems (1999 – 2010) EJIS - European Journal of Information Systems (1993 – 2007) ISJ - Information Systems Journal (1991 – 2010) ISR - Information Systems Research (1990 – 2009) JAIS - Journal of the Association for Information Systems (2000 – 2010) JITTA - Journal of Information Technology Theory and Application (1999 – 2010) JMIS - Journal of Management Information Systems (1984 – 2009) JSIS - The Journal of Strategic Information Systems (1991 – 2009) MISQ - Management Information Systems Quarterly (1977 – 2010) SJIS - Scandinavian Journal of Information Systems (1989 – 2009)	ACIS – Australian Conference on Information Systems (2001 – 2008) AISHCI - AIS Transactions on Human-Computer Interaction (2009) AMCIS – Americas Conference on Information Systems (1998 – 2009) BLED – Bled Conference on E-Commerce (2001 – 2009) CONFIRM – International Conference on Information Resources Management (2008) ECIS – European Conference on Information Systems (1993 -2009). GLOBDEV – ICT and Global Development (2008) ICDSS – International Conference on Decision Support Systems (2007) ICIS – International Conference on Information Systems (1994 – 2009) IRWITPM - International Research Workshop on IT Project Management (2006 – 2009) MCIS - Mediterranean Conference on Information Systems (2007 – 2008) MWAIS - Midwest AIS Conference (2006 – 2009) PAJAIS - Pacific Asia Journal of the Association for Information Systems (2009) PACIS - Pacific Asia Conference on Information Systems (1993 – 2009) RELCASI - Revista Latinoamericana Y Del Caribe De La Associacion De Sistemas De Informacion (2008 – 2009) SIGHCI - Special Interest Group on Human Computer Interaction Conference (2003 – 2009)

Table 1. Publication sources (alphabetical list)

4 Results

The social network for the 78 scholars is shown in Figure 1. The 78 scholars are shown in Appendix A, together with their scores on the three measures of centrality: degree, closeness, betweenness, and their h-index score. Inspection of the table reveals those IS researcher with the highest citations and social influence.

A clique is a subset of authors in which every author in the clique is connected to every other author in the clique. Graphically, it is a subset of nodes in which every edge exists between every possible pair of nodes. In addition a clique cannot be a part of any other larger clique. In Figure 1 the actors

[1] The PoP tool may be downloaded from www.harzing.com. The tool can be used by individual researchers to find their h, h_c, and g indices.

represented as black symbols form a clique of 13, in which each of the authors has co-authored a research publication with all 12 of the other authors (Table 2).

BaskervilleRL	DavisGB	HirschheimRA	JarvenpaaSL	KraemerKL	WatsonRT	ZmudRW
DavisFD	GeorgeJF	IvesB	KemererCF	ValacichJS	WhinstonA	

Table 2. The central group

A clique of 13 is unusually large. The existence of this clique is evidence of a powerful central group in the network (Scott 2000). These authors score also the highest on closeness centrality and are clearly at the very heart of the network.

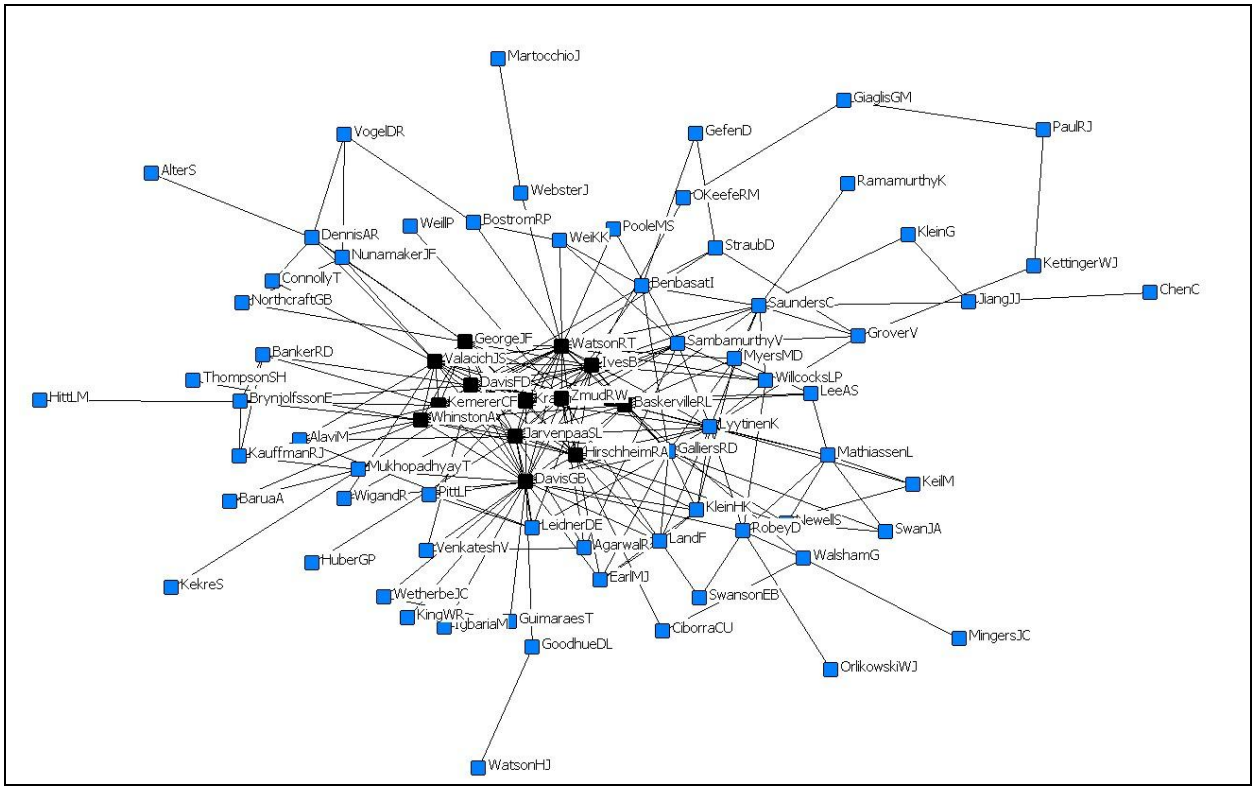

Figure 1. Social network of the 78 high-scoring authors (produced in Netdraw)

5 Discussion

The Hirsch index is a power function (Egghe et al. 2006) and by implication the g and hc being similar would also be power functions and hence the variables are, unsurprisingly, heavily left-skewed, requiring a non-linear transformation (using a log10 function) to create a more nearly normal distribution. Referring to the table of correlations (Table 3) for the transformed variables we see that all three measures of centrality are positive and statistically significant supporting our hypotheses H1, H2, and H3.

The degree of correlation between the h-index and the centrality measures is low-moderate with betweenness highest at .306. The degree of determination (r^2) for betweenness and closeness are .094 and .085 respectively and thus relatively low (Cohen et al. 2003). This would indicate that while social influence has an influence on ideational influence and/or vice versa, there are many other influences on them that drive the creation of these types of influence.

There is a clear core to the 'top 100' researchers – thirteen researchers who have each worked with each of the other twelve researchers in the clique (and in some cases, many times). One might argue that such an inner core would exert influence over journals (for example, the group is well represented by senior journal editorships) and to some extent be self-reinforcing. This is not to suggest a cause and effect relationship or a conspiracy theory, rather it is a virtuous circle of co-authorship and citations that would be expected of the leading and influential researchers in a field. However, a potential problem with a clique is that the authorship in the journals of our target list is centred in the clique. This makes it harder for others to break into the major IS journals and creates a rigid authorship structure in the IS field.

Correlations

		h-index	closeness	betweenness	degree
h-index	Pearson Correlation	1	.291**	.306**	.242*
	Sig. (2-tailed)		.010	.007	.033
	N	78	78	78	78
closeness	Pearson Correlation	.291**	1	.749**	.749**
	Sig. (2-tailed)	.010		.000	.000
	N	78	78	78	78
betweenness	Pearson Correlation	.306**	.749**	1	.659**
	Sig. (2-tailed)	.007	.000		.000
	N	78	78	78	78
degree	Pearson Correlation	.242*	.749**	.659**	1
	Sig. (2-tailed)	.033	.000	.000	
	N	78	78	78	78

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 3. Correlation Matrix

We have proposed that researcher impact be assessed using social **and** ideational influence. For example, a promotion committee interested in researchers having national and international networks might consider both citation counts and co-authorship networks. It seems likely that those researchers with a strong social network (measured objectively using SNA) will likely be more successful in the future: ideas do not circulate in a vacuum – they circulate in social networks. Clearly, there are more networks at play than simply co-authorship but this is one form of social network that all researchers, to a greater or lesser extent, are part of. Further, we would expect there to be a complex relationship between social influence and citation index. Researchers who are well connected in the co-authorship network will gain citations through their associations with other central players, while researchers with high citation indices may be attractive to other researchers when they are considering who to forge co-authorship links with. The combination of social and ideational influence may well be self-reinforcing and institutions would do well to consider both in making appointments and promotions. It is therefore not surprising that the link between citation and centrality has been demonstrated in a correlation that has a medium size effect (.306) with high significance ($p<0.01$).

5.1 Contributions

We have positioned academic research as the peer-production of knowledge through networks of open innovation. Thus, the position a researcher occupies in their academic community is an indicator of

their ability to be involved in influential research projects (their social influence). We further argue that the success of an academic's scholarly output should be measured by the uptake work of that work by others (their ideational influence) as measured by the H-family of indices.

We see eight contributions of this work. First, this paper is the first to define the concept of social influence and propose it as a means of assessing intellectual contribution to the field. In doing so, it, second, attempts to understand the connection between social influence (using SNA) and ideational influence (using the h-index). Third, to the authors' knowledge, this is the first attempt at creating the SNA using such a large number of IS venues, of the core top 100 IS researchers. Fourth, the research results show that there exists a 'circle of co-authorship and citations' in the top IS researchers. Fifth, it continues a line of research trying to better understand and develop measures for the construct 'Scholarly Influence'. Sixth, the topic is relevant to others outside our own field so if we make inroads to the understanding of the relationship between the social and ideational measures we have reason to anticipate that the work will have broad applicability beyond the field of IS research. Seventh, in confirming the structural relationship between social connections and ideational influence it is the only work we know that provides empirical and theoretical grounding for why a social network matters. Finally eighth, following Davis (1971), where a Sociology of the Interesting is juxtaposed with a Theory of Knowledge to create a typology of twelve sets of propositions of 'interestingness', our work challenges the notion that scholarly influence is a monolithic construct primarily associated with the generation of publications in a very limited set of premier journals and that the interaction of social and ideational influence is multifaceted and complex.

5.2 Limitations

We see four limitations in this exploratory research. First, our current research, being an initial attempt at the SNA of IS scholars, took a small slice of the IS researcher pie. We started with a hybrid top 100 IS researcher list, which is incomplete and can be argued as not representing the IS field. Second, the SNA was created using publications that were limited to those in table 1. While table 1 includes many top IS research venues, one can argue that using this list does not take into account lesser known venues. Third, the research only incorporates three SNA measures. Finally, the ideational influence was measured using the h-index. Whenever a bibliometric measure is used citations are seen in the lens of the measure used, including inherent biases that are part of the measure. While quantifying of author citations is necessary for making comparisons in this research, this is only one view and it is shaped by through the lens of the bibliometric measure used. While these four measures were used as surrogates for measuring social and ideational influence, there are many other SNA and bibliometrics that could be used. It is possible that further insights may be attained using other SNA measures and bibliometrics.

5.3 Future Research

While we are satisfied with the size of our database for creation of co-authorship data for the SNA, we realize that our work still needs to integrate many other outlets of research. We are continually adding more IS venues as they become available. With the addition of other venues, we hope to create a better picture of the IS social network. The sole dependency on research artefact co-authorship for creating an SNA can be expanded. Other forms of relationships such as research groups, institutional affiliation, and advisor-advisee relationships can be used for creating an SNA. Having this database of authorship now affords an opportunity to add author characteristics including place of PhD investiture, PhD advisor, faculty memberships, gender, and so on, allowing for the generation of many different kinds of authorship networks. With the addition of abstracts and keywords and using latent semantic analysis techniques we can explore the evolution of topics and research cohorts over an author's publishing career. These various types of social influence networks can also be compared to h-family indices and other 'ideational' influence measures.

6 Conclusion

This research suggests that social and ideational influence appear to be inter-related; those with high citation indices are also well-connected. Rather than argue that one causes the other we have proposed that the two are mutually reinforcing and that an assessment of researcher impact should take account of both when looking for indicators that might have predictive power. Promotions boards might consider social network position and citations jointly when considering a researcher in the round. Given that citations are backward looking it is possible that measures of social influence, as evidenced by co-authorship networks, will provide a useful forward-looking indicator.

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Appendix A: The 78 Scholars analyzed using Hirsch index and Centrality Measures

author	h-index	author	degree	author	closeness	author	betweenness
WhinstonA	42	GalliersRD	44	DavisGB	65.15	DavisGB	24.54
BenbasatI	41	JarvenpaaSL	42	WatsonRT	63.53	WatsonRT	20.34
BrynjolfssonE	40	ValacichJS	40	BaskervilleRL	59.63	SaundersC	11.32
GroverV	40	WatsonRT	39	IvesB	58.87	IvesB	9.47
BankerRD	38	DavisGB	36	HirschheimRA	58.66	BaskervilleRL	9.24
NunamakerJF	37	LyytinenK	31	JarvenpaaSL	58.66	LyytinenK	8.11
HirschheimRA	36	WhinstonA	30	ZmudRW	57.79	ValacichJS	7.97
OrlikowskiWJ	36	NewellS	28	ValacichJS	57.03	ZmudRW	7.42
HuberGP	35	HirschheimRA	27	DavisFD	56.39	WhinstonA	7.00
JarvenpaaSL	35	ZmudRW	27	WhinstonA	56.17	GeorgeJF	6.37
KraemerKL	35	BaskervilleRL	26	KraemerKL	55.84	JarvenpaaSL	5.90
RobeyD	35	IvesB	26	GeorgeJF	55.74	HirschheimRA	5.83
StraubD	35	JiangJJ	24	KemererCF	55.52	GalliersRD	4.66
ZmudRW	34	SambamurthyV	23	LyytinenK	55.30	DavisFD	4.54
WillcocksLP	33	KleinG	22	GalliersRD	53.68	RobeyD	4.51
DennisAR	32	DavisFD	20	SaundersC	49.24	GroverV	4.19
IgbariaM	32	GeorgeJF	20	SambamurthyV	47.51	OKeefeRM	3.56
KingWR	32	DennisAR	19	RobeyD	46.75	KemererCF	3.50
IvesB	30	SaundersC	18	BenbasatI	45.67	MukhopadhyayT	3.40
LyytinenK	30	NunamakerJF	17	KleinHK	45.67	DennisAR	3.31
ValacichJS	29	KemererCF	16	WillcocksLP	45.67	WalshamG	2.81
WatsonRT	29	KleinHK	16	LandF	44.81	BenbasatI	2.67
CiborraCU	28	LeidnerDE	16	LeidnerDE	44.81	BrynjolfssonE	2.64
PooleMS	28	SwanJA	16	MyersMD	44.81	GoodhueDL	2.60
KemererCF	27	BaruaA	15	MukhopadhyayT	44.74	JiangJJ	2.60
AlaviM	26	GroverV	15	MathiassenL	43.29	WebsterJ	2.60
ChenC	26	KraemerKL	15	PittLF	42.47	SambamurthyV	2.25
DavisGB	26	MyersMD	14	EarlMJ	42.29	KettingerWJ	1.50
KauffmanRJ	26	GefenD	13	WeiKK	41.56	BostromRP	1.24
VogelDR	26	StraubD	13	StraubD	41.45	KraemerKL	1.22
GalliersRD	25	BenbasatI	12	GroverV	41.21	StraubD	1.18
GefenD	25	MathiassenL	11	VenkateshV	41.10	GiaglisGM	1.16
HittLM	25	AgarwalR	10	WigandR	41.10	MathiassenL	1.01
NorthcraftGB	25	BrynjolfssonE	10	LeeAS	41.06	NunamakerJF	0.75
AgarwalR	24	RobeyD	10	BostromRP	40.63	WillcocksLP	0.67
BostromRP	24	AlaviM	9	AgarwalR	40.41	MyersMD	0.51
DavisFD	24	KauffmanRJ	9	WalshamG	40.30	LeidnerDE	0.41
MukhopadhyayT	24	KettingerWJ	8	NewellS	40.13	WeiKK	0.32
ThompsonSH	24	PittLF	8	BrynjolfssonE	39.85	KauffmanRJ	0.29
WalshamG	24	VogelDR	8	GuimaraesT	39.81	KleinHK	0.21
WatsonHJ	24	WillcocksLP	8	DennisAR	39.74	VogelDR	0.17
VenkateshV	23	MukhopadhyayT	7	PooleMS	39.61	AgarwalR	0.17
KeilM	22	WeiKK	7	GoodhueDL	39.37	VenkateshV	0.16

author	h-index	author	degree	author	closeness	author	betweenness
MathiassenL	22	WigandR	7	IgbariaM	39.16	NewellS	0.15
PaulRJ	22	BankerRD	6	WetherbeJC	39.16	PaulRJ	0.13
SambamurthyV	22	GuimaraesT	6	NunamakerJF	39.09	LeeAS	0.13
SwanJA	22	LandF	6	WebsterJ	39.00	SwansonEB	0.10
WebsterJ	22	VenkateshV	6	KauffmanRJ	38.87	CiborraCU	0.08
BaruaA	21	EarlMJ	5	AlaviM	38.83	LandF	0.05
ConnollyT	21	HittLM	5	KingWR	38.51	PittLF	0.04
GuimaraesT	21	IgbariaM	5	SwansonEB	38.51	AlaviM	0.04
KettingerWJ	21	KeilM	5	BankerRD	38.12	BaruaA	0.03
MingersJC	21	LeeAS	5	OKeefeRM	37.77	BankerRD	0.02
WeillP	21	BostromRP	4	CiborraCU	37.75	PooleMS	0.02
WetherbeJC	21	WalshamG	4	KeilM	37.58	SwanJA	0.02
BaskervilleRL	20	CiborraCU	2	ConnollyT	36.71	GuimaraesT	0.02
KekreS	20	ConnollyT	2	SwanJA	36.54	AlterS	0.00
OKeefeRM	20	GiaglisGM	2	BaruaA	36.49	ChenC	0.00
RamamurthyK	20	GoodhueDL	2	HuberGP	36.23	ConnollyT	0.00
SwansonEB	20	KingWR	2	NorthcraftGB	36.06	EarlMJ	0.00
WeiKK	20	NorthcraftGB	2	WeillP	35.91	GefenD	0.00
EarlMJ	19	OKeefeRM	2	ThompsonSH	35.30	HittLM	0.00
GeorgeJF	19	PaulRJ	2	JiangJJ	33.90	HuberGP	0.00
GoodhueDL	19	PooleMS	2	KleinG	33.25	IgbariaM	0.00
KleinG	19	SwansonEB	2	GefenD	32.79	KeilM	0.00
LeidnerDE	19	WebsterJ	2	RamamurthyK	32.38	KekreS	0.00
MartocchioJ	19	WetherbeJC	2	VogelDR	32.23	KingWR	0.00
MyersMD	19	AlterS	1	OrlikowskiWJ	31.41	KleinG	0.00
NewellS	19	ChenC	1	KekreS	30.74	MartocchioJ	0.00
AlterS	18	HuberGP	1	KettingerWJ	30.15	MingersJC	0.00
GiaglisGM	18	KekreS	1	GiaglisGM	28.83	NorthcraftGB	0.00
JiangJJ	18	MartocchioJ	1	MingersJC	28.57	OrlikowskiWJ	0.00
KleinHK	18	MingersJC	1	WatsonHJ	28.29	RamamurthyK	0.00
LeeAS	18	OrlikowskiWJ	1	MartocchioJ	28.16	ThompsonSH	0.00
PittLF	18	RamamurthyK	1	HittLM	28.05	WatsonHJ	0.00
SaundersC	18	ThompsonSH	1	AlterS	27.99	WeillP	0.00
LandF	17	WatsonHJ	1	PaulRJ	25.30	WetherbeJC	0.00
WigandR	17	WeillP	1	ChenC	25.19	WigandR	0.00