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# A Longitudinal Scientometric Analysis of Research Published in IFIP 9.4 (2002-2013)

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## ABSTRACT

The use of scientometric techniques for analyzing trends and patterns in IS research is becoming increasingly common. We describe how such techniques have been used to answer questions for the IS field as a whole and for specific research communities, journals, and topics. While scientometric analyses of ICT for development journals and conferences are starting to emerge, such studies have not employed longitudinal methods to analyze trends over time. We pose several questions that longitudinal scientometric methods can answer and then apply such methods to papers published in the oldest, largest conference in the area of ICT for development: IFIP 9.4. For the years 2002-2013, we identify the most frequent authors contributing to IFIP 9.4, as well as changes over time in terms of most frequent contributors and the institutions and countries represented. We also identify the frequently-cited sources in IFIP 9.4 papers, showing how they have changed over time. Finally, we use co-citation analysis to identify the topics analyzed in IFIP 9.4 papers, based on citations shared among papers. We conclude with directions that future research may address – such as comparing our results with other ICT4D conferences or journals.

**Keywords:** research community, scientometrics, citations, cocitation analysis, longitudinal study

## INTRODUCTION

The use of scientometrics techniques for understanding trends and patterns in IS research has become increasingly popular. In an editorial introducing two scientometric studies that analyzed the extent to which IS contributes to other disciplines, Straub (2006, p. 241) characterized scientometric research as: “work that deals with fundamental questions of how scientific disciplines evolve.” Moreover, he advocated the use of scientometric techniques for IS research:

there is every reason for professional disciplines to have an inherent interest in understanding themselves better .... [T]he creation of knowledge and the dissemination of that knowledge should resonate .... whether we are talking about how a ‘Big Four’ accounting firm operates or

how the IS professoriate functions (Straub, 2006, p. 242).

Scientometrics represents a collection of quantitative, bibliometric techniques that examine evidence of scholarly work – including publications, citations, and networks of coauthorship linkages and citation linkages. Since scientometric techniques have not previously been applied specifically to ICT for development (ICT4D) conferences – but are now starting to appear for ICT4D journals (e.g., Gomez et al. 2013) – our key objective is to demonstrate the use of these techniques for the oldest and largest ICT4D conference, IFIP 9.4, for the years 2002-2013. We emphasize the use of longitudinal scientometric methods, since they are rarely used to analyze the IS field, as a whole, and have not been employed to analyze ICT4D journals or conferences.

The specific goals of this study are: first, to provide an overview of scientometrics; second, to show how these methods have been used to describe patterns of research output and communications among scholars in certain venues – such as for specific journals, conferences, or topics. We apply a array of scientometric techniques to the leading ICT4D conference (IFIP 9.4) from 2002 to 2013 and identify insights from our analysis. When combined with other literature review approaches – such as narrative reviews (e.g., Walsham & Sahay 2006) – scientometric methods can shed light on the strengths and weaknesses of a given topic or research community, as well as key changes over time. In recent narratives review papers (Heeks 2009; Walsham & Sahay 2006), as well as in scientometric studies of ICT4D research (Gomez et al. 2013), scholars have cited quality problems. For example, Gomez et al (2013, p. 2) cite Heeks (2009) in criticizing the fact that “ICTD outputs to date reflect: (i) a bias to action and not a bias to knowledge, (ii) a preference for what is narrowly descriptive, and (iii) a field that is not analytical enough.” Moreover Gomez et al. (2013) also criticize ICT4D research for various weaknesses including “a lack of theory, conceptual definition, interdisciplinary approach ... and longitudinal research.”

In the past decade, scholars have applied scientometric methods to analyze many conferences such as ICIS (Xu & Chau 2006), ECIS (Vidgen et al. 2007), IRIS – the Scandinavian IS conference (Molka-Danielson et al. 2007), and IFIP 8.6 (Dwivedi et al., 2010). Scholars have also applied scientometric techniques to compare multiple conferences – such as ICIS, PACIS and ASAC (the Canadian management conference) (Cocosila et al. 2011), or a set of conferences on human-computer interaction (Henry et al. 2007). Our use of these methods to analyze the IFIP 9.4 community thus has strong precedent in the IS field, as well as in other areas related to ICT4D, such as international management journals (Acedo & Cassilas 2005).

We seek to demonstrate how such techniques have been used in the past; moreover, given the absence of any longitudinal, scientometric analyses of ICT4D journals or conferences, we offer an example of such analyses for IFIP 9.4 for the years 2002 to 2013. In providing this analysis, we identify the most frequent contributors to IFIP 9.4 and the countries they represent during these years, as well as the sources that such authors cite most often in their papers. Finally, based on our analysis of Google Scholar citations data, we identify the most-frequently cited IFIP 9.4 papers, as well the main topic areas represented at IFIP 9.4 during this decade, using an advanced computational technique called “co-citation analysis” (Culnan 1985; Culnan 1987).

## LITERATURE REVIEW

To date, no scientometric review has been published of any ICT4D conferences; however, scholars recently published scientometric studies of a basket of ICT4D journals (Gomez et al. 2013; Choudrie & Harindranath 2011). We start with a literature review that illustrates the range of scientometric methods that are used in IS and in related fields, such as operations management and international management. We organize our literature review into four sub-topics:

- scientometric methods applied to the IS field as a whole
- scientometric methods applied to specific IS journals
- scientometric methods applied to specific IS conference
- scientometric methods applied to other disciplines

### **Review of scientometric methods applied to the IS field as a whole**

Scientometric studies of the IS field have appeared over the past three decades. While many IS researchers are familiar with two genres of scientometric studies: lists of most productive authors (Huang & Hsu 2005) and lists of “citation classics” (Walstrom & Leonard 2000; Whitley & Galliers 2007), these are just two types of scientometric studies out of nearly a dozen possible types of scientometric research. Other types of scientometric studies that have analyzed the IS field, as a whole, include a series of author co-citation analyses by Mary Culnan during the mid-1980s (Culnan 1986; Culnan 1987), which identified several subject areas that constituted IS research during that era. Culnan’s author co-citation analyses each offered a static snapshot of the field; however, multiple snapshots may be compared over time, in order to trace the IS field’s evolution. For example, by comparing results across the separate co-citation analyses, Culnan

(1987, p. 341) concluded that during the early-to-mid 1980s, “management information systems made significant progress toward a cumulative research tradition.”

As we mention above, most readers are likely to be familiar with lists of “most productive” authors that frequently appear in IS journals (e.g., Athey & Plotnicki 2000; Huang & Hsu 2005) – whether based on counts of published papers or based on numbers of citations to their work (Lowry et al. 2007). Likewise, many readers will be familiar with “citation classics” – a related type of study that identifies highly-cited or well-regarded journal articles using scientometric methods (citation counts) (Walstrom & Leonard 2000) or opinion surveys of IS scholars.

### **Review of scientometric methods as applied to specific IS journals**

Scientometric techniques are increasingly being used to analyze papers published in a single journal. During the past five years, many European IS journals have featured a scientometric study that summarized papers it published, as well as names of leading authors, the institutions they represent, and topics appearing most often. Many single-journal scientometric papers were coauthored by Yogesh Dwivedi – such as ones appearing in *European Journal of Information Systems* (Dwivedi & Kuljis 2008), *Information Systems Journal* (Avison, Dwivedi et al 2008), and *Information Systems Frontiers* (Dwivedi et al 2009). Such papers are useful for showing patterns within a given journal. In some cases, single-journal studies analyze patterns longitudinally to show the evolution of a journal over time (e.g., Avison, Dwivedi et al. 2008).

In our opinion, such single-journal studies may appear to be rather simple in terms of their methods and results. Perhaps this is because such studies are often limited to descriptive lists of author names, affiliated institutions, and countries that are most often represented in a journal. Such single-journal analyses do not include any of the varied scientometric techniques such as analysis of social networks that can be applied to identify networks of citations across papers or networks of coauthors. The next section explains how these techniques can be used to provide graphical representations of linkages among different papers, authors, or topics.

### **Review of scientometric methods applied to specific IS conferences**

Several recent studies have applied social network analysis to identify coauthorship linkages among scholars who collaborated on papers or panels at specific IS conferences. Social network analysis represents a specific analytic technique that may be employed to identify networks of coauthors. In most cases, these studies yield interesting visual representations of the linkages

among coauthors and co-presenters, which are labeled “ego networks” for coauthors at such conferences as ICIS (Xu & Chau 2006), ECIS (Vidgen et al 2007), and IRIS – the Scandinavian IS conference (Molka-Danielson et al. 2007). In addition to social network analyses, reviews of IS conferences have analyzed the most frequently cited sources among papers published in these conferences (Whitley & Galliers 2007). For example, Whitley and Galliers (2007) concluded that the “citation classics” (i.e., books or articles most frequently cited) at ECIS differ from citation classics for the IS field as a whole (Walstrom & Leonard 2000), since they showed that nearly all of the “Top 12” most-cited sources at ECIS were books or articles appearing in practitioner magazines (e.g., *Harvard Business Review* and *Communications of the ACM*), rather than papers from academic journals. Scientometric analyses have been conducted for other conferences, as well, including IFIP 8.6 (focusing on transfer and diffusion of IT) (Dwivedi, Levine, et al. 2010).

### **Review of scientometric techniques as applied to other disciplines**

IS is not the only discipline to use scientometric methods. Here, we highlight the fact that fields closely related to IS and ICT4D have employed co-citation analysis methods to identify key topic areas within their fields. Acedo and Cassilas (2005) performed an author co-citation analysis of references cited in leading international management journals for years 1997-2000. Among their key findings were that studies corresponding to eight key subject areas appeared during these years, but no single research paradigm exists in international management. Another co-citation analysis of papers from leading operations management (OM) journals (Pilkington & Meredith 2009) showed that many of the frequently-cited sources in the OM journals are books rather than journal articles. Co-citation analysis can play an important role in identifying leading researchers in a given field. In strategic management, Nerur and colleagues (2007) delineated many sub-fields that comprised strategic management over 21 years. Focusing on leading authors whose work exceeded 100 citations, and using sophisticated analytic methods, Nerur et al. identified key authors who played a pivotal role in bridging two or more sub-fields. They also identified “thought leaders,” as well as changes in their degree of influence over time.

### **How are scientometric techniques useful in describing an ICT4D research community?**

Scientometric studies, in combination with other types of literature reviews – such as narrative review papers – can be useful in aggregating various studies and then “stepping back” to take stock of the findings that have emerged over time. By revealing what topics *have* been studied –

as well as other areas where few studies exist, such techniques can be useful in identifying gaps. Scientometric studies can provide an overview of the people, places, and things related to a given conference or community.<sup>1</sup>

As we stated above, no scientometric study has analyzed any of the available ICT4D conferences, although some recent work has examined a set of ICT4D journals (Choudrie & Harindranath 2011; Gomez et al. 2013). When combined with other types of reviews (e.g., narrative reviews), (Walsham & Sahay 2006), scientometric analyses can be useful in showing the types of research published in ICT4D conferences over time. As we describe in our methods section, we analyzed all papers from 2002-2013 to answer the following questions:

Who are the most frequent authors of IFIP 9.4 conference papers and panels?

What institutions and countries are represented by these frequent authors?

What are the most frequently-cited sources in IFIP 9.4 conference papers and panels?

What are the most frequently-cited IFIP 9.4 papers, according to Google Scholar?

What are the topic areas investigated by IFIP 9.4, as revealed by co-citation analysis?

## RESEARCH METHODS

Since our goal was to focus on the post-millennial decade, our primary source of information was the IFIP 9.4 website (<http://www.ifipwg94.org/publications>), including links to conference program information, author information, abstracts and – where available – full-text copies of papers and panels. We found complete information for conferences held in 2013, 2011, 2009, and 2007 and we located a copy of the proceedings book for the 2003 conference in our library; however, we were only able to locate program information only (e.g., paper titles, author names and affiliations, and paper abstracts) and just a few full-text papers for the those appearing in the 2002 and 2005 conference proceedings.

The data collection steps varied, depending on the specific questions that we sought to answer. In most cases, simply having program information (including author names and affiliations, as well as titles of conference papers and panels) was sufficient to answer the questions for our analyses. However, in order to answer some specific questions, we had to “dig deeper” – by

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<sup>1</sup> People, places, and things refers to authors, their affiliated institutions or countries, and research topics.

capturing and analyzing the references appearing at the end of each conference paper or the published summaries of conference panels.

To identify leading authors in IFIP9.4 conference, we first coded the names and affiliations of all scholars who authored papers or served on panels, based on the detailed program information that was available for seven post-millennial conferences: 2002, 2003, 2005, 2007, 2009, 2011 and 2013. After many rounds of sorting, we were able to identify the frequent authors who published three or more papers during these years. After we identified these leading authors, we then created a database of references by capturing the complete references for those authors who published three or more papers between 2002 and 2013. This comprised 4,047 references that appeared in a total of 334 IFIP 9.4 conference papers from the authors with three or more papers.

Next, to conduct a co-citation analysis, we compiled two lists: one containing 62 cited sources for the 2002-2007 conferences and a second list of 69 cited sources for the 2009-2013 conferences. Each cited source on these lists had been cited a minimum of at least three times during the relevant time period. Next, we prepared both lists for co-citation analysis: we paired each of the 62 papers on the “early time period” list with every other paper on the same list, creating a 62 column x 62 row co-citation matrix for sources cited in the 2002-2007 conference papers. Likewise, we generated a 69 column x 69 row co-citation matrix for the sources cited in the “later period”. We transformed the co-citation matrix first into a Pearson’s correlation matrix, from which we were able to generate both factor analysis results, as well as graphical images that portray social networks diagrams for cited sources. We created these social network diagrams with UCInet software, whereby each node represents a given source that was cited multiple times by IFIP 9.4 conference papers and links between these nodes indicate that the two sources were co-cited together. By restricting the graphical results to limit the visible nodes to just those cases where the two papers were co-cited at least three times together, then we create visual representations that suggest common research topics – or else common theoretical lenses or methodologies used in various studies. In the social network diagrams, nodes that appear close to each other indicate cited sources that are frequently cited together in IFIP 9.4 papers.

In order to identify the names of common topics or theories, we drew circles or ovals around such closely-related nodes – in order to demarcate the topics – and labeled them with titles that we consider characteristic of the underlying themes. In our Results, we present and explain these social network diagrams for both the “early period” (2002-2007) and “late period” (2009-2013).



We also conducted a Principal Components Analysis for each time period, which provides an analysis of about 60-75 frequently-cited papers for each time period. Due to space limitations, however, we omit the PCA results and simply focus on the social network diagrams instead.

## RESULTS

Our first question was “Who are the most frequent authors of IFIP 9.4 papers and panels?” We identified 51 scholars who appeared as authors (or on panels) three or more times: 25 scholars with 4 or more papers (Table 1A), plus 26 scholars with exactly 3 papers (Table 1B). Sundeep Sahay (University of Oslo) was the most frequent contributor to IFIP 9.4 in both time periods, whereas the institutions represented most often were London School of Economics and Political Science and University of Oslo, Norway, for the two chronological time periods.

In comparing the frequent authors during the two time periods, we found that, in addition to Sundeep Sahay, five authors published at least 3 or more papers during both time periods: Crysanthi Avgerou (London School of Economics), Jørn Braa (University of Oslo), Niall Hayes (University of Lancaster), Brian Nicholson (University of Manchester), and Jens Kaasbøll (University of Oslo). Another five authors published at least two papers during both periods: Elaine Byrne, Bjorn Furuholt, Jackie Phahlamohlaka, Cathy Urquhart, and Chris Westrup.

#	Surname	First Name	Country	Institution	2002-2007		2009-2013	
					#	Rank	#	Rank
28	Sahay	Sandeep	Norway	University of Oslo	16	1	12	1
10	Braa	Jørn	South Africa/ Norway	University of Western Cape / University of Oslo	7	3	3	7
10	Mbarika	Victor	USA	Southern University and A&M College	10	2	0	–
9	Nicholson	Brian	UK/Norway	Univ. of Manchester/ Univ. of Oslo	4	5	6	2
8	Kaasbøll	Jens	Norway	University of Oslo	3	13	5	3
7	Avgerou	Chrisanthi	UK	London School of Econ.	4	5	3	7
6	Hayes	Niall	UK	Lancaster University	3	13	3	7
6	Korpela	Mikko	Finland	University of Kuopio	6	4	0	–
6	Saebo	Johan	Norway	University of Oslo	1	32	5	3
5	Byrne	Elaine	South Africa/ Ireland	University of the Western Cape / Univ. of Pretoria	3	13	2	23
5	Westrup	Chris	UK	University of Manchester	2	24	3	7
4	Andrade	Antonio	New Zealand	University of Auckland	1	32	3	7

4	Bailur	Savita	UK	London School of Econ.	4	5	0	–
4	Brown	Irwin	South Africa	University of Cape Town	0	–	4	5
4	Furuholt	Bjorn	Norway	Agder University College	2	24	2	23
4	Kah	Muham- madou	USA	Rutgers University	2	24	2	23
4	Kanjo	Chipo	Norway	University of Oslo	0	–	4	5
4	Mursu	Anja	Finland	University of Kuopio	4	5	0	–
4	Phahla- mohlaka	Jackie	South Africa	Univ of Pretoria/ Council for Scientific Research	2	24	2	23
4	Puri	S.K.	Norway	University of Oslo	4	5	0	–
4	Reinhard	Nicolau	Brazil	University of São Paulo	4	5	0	–
4	Shaw	Vincent	South Africa	District Hospitals	4	5	0	–
4	Soriyan	Abimbola	Nigeria	Obafemi Awolowo University	4	5	0	–
4	Urquhart	Cathy	New Zealand	University of Auckland	2	24	2	23
4	Sein	Maung	Norway	Agder College University	3	13	1	32

**Table 1A. Authors with 4 or More Papers**

Surname	First Name	Country	Institution	2002-2007		2009-2013	
				#	Rank	#	Rank
Akpan-Obong	Patience	USA	Arizona State Univ.	3	13	0	N
Bass	Julian	UK	Robert Gordon Univ.	0	N	3	7
Best	Michael L.	USA	MIT Media Lab. eDevelopment Grp	1	32	2	N
Brooks	Laurence	UK	Brunel Univ.	0	N	3	7
Cantoni	Lorenzo	Switzer- land	Università della Svizzera italiana	0	N	3	7
Frasheri	Neki	Albania	Polytechnic Univ. of Tirana	1	32	2	23
Gregory	Judith	Norway	Univ. of Oslo	3	13	0	N
Ifinedo	Princely	Canada	Cape Breton Univ.	0	N	3	7
Joia	Luiz Antonio	Brazil	Brazilian School of Business Administration	2	24	1	32
Kabanda	Salah	South Africa	Univ. of Cape Town	0	N	3	7
Kossi	Edem	Norway	Univ. of Oslo	0	N	3	7
Lungo	Juma	Tanzania	Univ. of Dar es Salaam	0	N	3	7
Macome	Esselina	South Africa	Univ. of Pretoria	3	13	0	N

Madon	Shirin	UK	London School of Econ.	3	13	0	N
Meso	Peter	USA	Georgia State Univ.	3	13	0	N
Okunoye	Adekunle	USA	Xavier University	3	13	0	N
Poulymenakou	Angeliki	Greece	Athens Univ. of Econ. & Business	3	13	0	N
Rangaswamy	Nimmi	India	Microsoft Labs, India	2	24	1	32
Rega	Isabella	Switzerland	Università della Svizzera italiana	1	32	2	23
Sæbø	Øystein	Norway	Univ. of Agder	0	N	3	7
Titlestad	Ola H.	Norway	Univ. of Oslo	0	N	3	7
Twinomurinzi	Hossana	South Africa	Univ. of Pretoria	0	N	3	7
Vannini	Sara	Switzerland	Università della Svizzera italiana	2	24	1	32
Williamson	Louisa	Norway	Univ. of Oslo	1	32	2	23
<b>Table 1B. Frequent Authors with Exactly 3 Conference Papers</b> (sorted by name)							

We also identified authors who were prolific during one time period, but not the other. Seven authors published frequently during the early time period, but not later: Savita Bailur, Mikko Korpela, S.K. Puri, Nicolau Reinhard, Vincent Shaw, and H. Abimbola Soriyen. Likewise, four authors published at least 4 papers after 2009, but not earlier: Antonio Andrade, Irwin Brown, Kanjo Chipu, and Johan Sæbo. Despite these cases, the IFIP 9.4 community appears fairly stable, in terms of authors who were highly active in publishing papers during both time periods.

We also analyzed the countries represented by these authors overall, as well as during the two time periods. Table 2 lists the countries associated with the most published papers in the two time periods. While the UK and Norway were the leading countries in both time periods, UK authors had slightly more papers during the earlier time period, while Norwegian authors had more papers from 2009-2013. There was overall consistency between the two time periods, but a few countries changed positions dramatically between the two periods. Nigeria declined in rank from six in the early time period to the last position in Table 2, more recently. The likely explanation is that Nigeria's capital hosted the 2005 conference, and there were many papers by Nigerian authors in 2005 (which is part of the early time period) but not in the later period. New Zealand exhibited the opposite pattern: its rank order position rose from number 14 to number 8.

Country	Recent Count (2009-2013)	Recent Rank (2009-2013)	Early Count (2002-07)	Early Rank (2002-07)	Total Count (2002-2013)	Overall Rank (2002-2013)
Norway	33	1	39.5	2	72.5	1
UK	28.5	2	42.5	1	71	2
USA	23.5	4	28	4	51.5	3
South Africa	26.5	3	18	3	44.5	4
India	7	6T	9	8	16	5
Brazil	7	6T	6	6T	14	6
Sweden	7	6T	6	10	13	7T
Finland	1	15	12	11	13	7T
Nigeria	2	14	9	16	11	9
New Zealand	5	8	4.5	14	9.5	10T
Australia	3	11T	6.5	9	9.5	10T
Canada	3	11T	4	12T	7	12
Netherlands	3.5	10	2	15	5.5	13
Switzerland	4	9	1	6T	5	14
Ireland	3	11T	1.5	1	4.5	15T
Mozambique	0.5	16	4	12T	4.5	15T

**Table 2. Analysis of Countries Represented by Frequent Authors**

Our next question was: “What are the sources most frequently-cited in IFIP 9.4 papers and panels?” Noting that this analysis was limited to just the sources cited by the 55 frequent authors listed in Tables 1A and 1B, the most-cited sources (which can be either books, book chapters, journal articles or conference papers) appear in Table 3. There were many ties for sources cited between five and nine times. Among the “Top 12” most frequently-cited sources are 8 books – so fully half of the “Top 12” most frequently-cited sources are books.<sup>2</sup> Of the 8 sources other than books appearing in the “Top 12” – most are journal articles from scholarly journals: *MIS Quarterly* (3 papers), *The Information Society* (2 papers), and one each in *European Journal of Information Systems*, *Information Systems Research* and *Information Technology for Development*. A similar mix of books and journal articles appears throughout the list of 33 most-cited sources in Table 3. Overall, 52% of the frequently-cited sources are journal papers and 45% are

<sup>2</sup> Note that, due to ties, five sources were tied for 12<sup>th</sup> place – so a total of 16 sources appear in the “Top 12.” Since eight of these 16 sources in the “Top 12” are books, then exactly 50% of the “Top 12” cited sources are books.

books. Just a few texts other than books or journal articles appear in the list: a 2005 IFIP 9.4 conference paper (Sahay & Walsham 2005), plus a United Nations Human Development report.

In terms of scholars who frequently appear as authors of the frequently-cited sources in Table 3, some appear many times: Geoff Walsham (9 times), Sundeep Sahay (4 times), Jørn Braa and Chrisanthi Avgerou (3 times); Richard Heeks, Shirin Madon, and Wanda Orlikowski (2 times).

In terms of the sources cited most frequently by IFIP 9.4 papers during the two time periods, there was much consistency (i.e., sources cited often during 2002-2007 were also cited often during 2009-2013). There were a few obvious exceptions, however, where specific sources either increased or declined in relative number of citations over time. Not surprisingly, many sources that were published after 2008 (or even in the later years of the 2002-2007 time period) exhibited many more citations from 2009-2013, compared to their number of citations during the early time period. Examples are papers published by Braa, Hanseth et al (2007) and by Walsham & Sahay (2006), in *MIS Quarterly* and in *Information Technology for Development*, respectively.

Other sources declined in the proportion of citations they received over time from 2002-2007 to 2009-2013. Three sources that declined over time in terms of their proportion of citations were either guides to conducting interpretive research (Walsham 1995; Klein & Myers 1999), or a review paper that advocated for interpretive research in the IS field (Orlikowski & Baroudi 1991). Three other sources that declined in their relative frequency of citations over time include two focusing on structuration theory (Giddens 1984; Orlikowski 2000) as well as a paper that appeared in *The Information Society* (Braa & Hedberg 2002). Perhaps the latter source declined in its relative number of citations because a related but newer version of the study later appeared in *MIS Quarterly* (Braa, Hanseth et al 2007). Some exceptions to this pattern of declining citations are sources published very early in the decade – and which were thus available to cite by 2002 – but they still increased substantially in the number of citations over time. Four such sources that increased in relative number of citations were Rogers (1996), Latour (1987), Sen (1999), and Heeks (2002). With the exception of Heeks (2002), all of these older sources that increased in the proportion of citations during the recent time period are books. It is interesting that these older sources increased in relative number of citations over time, despite having been available by 2002 for IFIP 9.4 researchers to cite. One possible explanation is that IFIP 9.4 scholars are now citing more theory in their work – as some critics have called for (e.g., Heeks 2009; Gomez et al. 2013). Perhaps the increasing citations to these sources reflect the growing

use of theories like Diffusion of Innovations (Rogers 1996), Actor-Network Theory (Latour 1987), improvisational models (Heeks 2002) and Sen’s model of “development as freedom.”

Our fourth question is: “What are most frequently-cited IFIP 9.4 papers, according to Google Scholar?” In collecting and analyzing this Google Scholar data, we found that most IFIP 9.4 conference papers were *not* tracked by Google Scholar – meaning that we found no entry in Google Scholar for more than 50% of the papers. Next, we found that when coding the number of citations tracked by Google Scholar, the number of citations to these papers changes over time – often increasing, but sometimes decreasing over time. Finally, in analyzing citations to these papers, we found that it can be difficult to distinguish citations to a subsequent journal version of a paper (which often has the same title or a similar title) from citations to the conference version. We were careful to distinguish between Google Scholar citations to the IFIP 9.4 conference paper vs citations to other journal or conferences papers that had similar titles. Table 4 lists the IFIP 9.4 papers with 10 or more citations each. We did *not* employ longitudinal methods for comparing the most-cited IFIP 9.4 papers that were published in the two time periods; obviously papers published in an earlier time period have had more time to accumulate more citations. Of the 20 papers that accrued at least 10 citations each, 90% were ones published in 2003 and 2007. There were just two highly-cited papers from 2002, but no papers from 2005, 2009, or 2011.

#	Name	First Name	Paper Title	Cite #	Year	J
1	Avgerou	Chrisanthi	“The link between ICT and economic growth in the discourse of development”	103	2003	N
2	Zheng	Yingqin	“Exploring the value of the capability approach for e-development”	30	2007	Y
3	Ali Bailur	Maryam Savitha	“The challenge of “sustainability” in ICT4D – Is bricolage the answer?”	28	2007	N
4	Mosse Sahay	Emilio Sundeeep	“Counter networks, communication and health information systems: a case study from Mozambique”	26	2003	Y
5T	Bailur	Savitha	“The complexities of community participation in rural IS projects: A case of our voices”	24	2007	N
5T	Tucker Panteli	Robert Niki	“Back to basics: Sharing goals and developing trust in global virtual teams”	24	2003	N
7	Harindra- nath, Sein	G. Maung	“Revisiting the role of ICT in development”	21	2007	N
8	Adam Myers	Mariyam Michael	“Have you got anything to declare? Neo-colonialism, information systems, and the imposition of customs and duties in a third world country”	20	2003	N

9	Nahar Käkölä Huda	Nazmun Timo Najmul	“Software production in developing and emerging countries through international outsourcing”	19	2002	N
10 T	Dholakia Kshetri	Nikhilesh Nir	“The global digital divide and mobile business models: Identifying viable patterns of e-development”	16	2002	N
10 T	Aman Nicholson	Aini Brian	“The process of offshore software development: preliminary studies of UK companies in Malaysia”	16	2003	N
12 T	Braa Monteiro Sahay	Jørn Eric Sundeeep	“Scaling up local learning: Experiences from south-south-north networks of shared software development”	13	2007	Y
12 T	McGrath	Kathy	“ICTs supporting targetmania: How the UK health sector is trying to modernize”	13	2003	N
12 T	Pors Simonsen	Jens Jesper	“Coordinating work with groupware: The challenge of integrating protocol and artefact”	13	2003	N
12 T	Liu Westrup	Wei Chris	“ICTs and organizational control across cultures: The case of a UK multinational operating in China”	13	2003	N
16	Puri Sahay	S.K. Sundeeep	“Institutional structures and participation: comparative case studies from India”	12	2003	Y
17	Avgerou Ganzaroli Poulymen- akou Reinhard	Chrisanthi Abdrea Angeliki Nicolau	“ICT and citizens’ trust in government: Lessons from electronic voting in Brazil”	11	2007	Y
18 T	Macome	Esselina	“On implementation of an IS in the Mozambican context: the EDM case viewed through ANT lenses”	10	2003	N
18 T	Sahay Monteiro Aanestad	undeeep Eric Margunn	“Towards a political perspective of integration in IS research: the case of health information systems in India”	10	2007	Y
18 T	Standing Sims Stockdale Wassenaar	Craig Ian Rosemary Arjan	“Can e-marketplaces bridge the digital divide?”	10	2003	N

**Table 4: IFIP 9.4 Conference Papers with the Most Google Scholar Citations**

As a *post hoc* analysis, we sought to identify features that explain the number of citations to the conference version of IFIP 9.4 papers. In addition to the number of elapsed years from the conference year to the present date being a critical factor in explaining the number of citations to the papers listed in Table 4 (i.e., older papers accrue more citations), we found that *not* having a subsequent journal version of the paper was a key predictor of a conference paper accruing many citations. In most cases where a journal version of the paper was published within a few years after the conference paper, Google Scholar showed few or no citations to the initial conference

version. To underscore this point, we found that very few papers shown in Table 4 with more than 12 citations had a corresponding journal version. The few exceptions were papers by Zheng (2007) and Mosse & Sahay (2003) – each of which was published in a leading journal within two year of the initial conference version, and where both the conference and journal versions of each paper (e.g., Zheng & Walsham 2008; Mosse & Sahay 2005) were cited more than a dozen times.

Our last research question is: “What are the main topics investigated by IFIP 9.4 scholars, as revealed by co-citation analysis?” Based on the co-citation data, which we transformed into a matrix showing the number of *cited* references shared in common between *citing* papers, which we subjected to Principal Components Analysis, we identified six distinct factors. These include: ICT for development; economic development theory; healthcare IS; institutional theory; user empowerment; and classic texts for conducting qualitative, interpretive, or case study research.

Although we do not include the results from the Principal Components Analysis here, we show the social network diagrams for the separate time period analyses – both the “early period” (2002-2007) and “late period” (2009-2013). In order to identify the core topics and theories represented by closely-related nodes in these diagrams, we reviewed not only the titles of papers or books represented by each node, but also the author names and the relevant abstracts. The social network diagram for the “early period” (Figure 1A) portrays the sources cited by frequent IFIP 9.4 authors that were co-cited three or more times together. The topics they represent include Interpretive Research & Globalization (top of figure); general Economic Development (right side); Actor Network Theory (lower-right edge); Structuration Theory (center); and studies of Healthcare IT Based on Actor-Network Theory (bottom of figure).

The corresponding social network diagram for the “late period” (Figure 1B) shows analogous sources cited by frequent authors that are often co-cited together. From this figure, we identify five clusters of cited sources – those representing Sen’s (1999) “Capability Approach” for development (top), general Development Theory (bottom), Actor Network Theory (left side), Healthcare IT (left side, lower), and ICT for Development (center and left center). Based on our comparison of the two figures, the topic areas are similar; however, the later time period does not show a cluster of sources on Structuration Theory or Interpretive Research. The later time period *does* specify a cluster of papers related to the Capability Approach for development (Sen 1999).



## DISCUSSION AND CONCLUSIONS

We have provided answers to several questions involving longitudinal analysis of the IFIP 9.4 community. Similar to other studies that analyze a single research community – such as ACM SIG CHI (Special Interest Group on Computer-Human Interaction) (Kaye 2009) or IFIP 8.6 (Dwivedi et al. 2010), our study yield lists of frequent authors, frequently-cited texts – as well as a list of the major topic revealed by cocitation analysis for the IFIP 9.4 conference papers.

We believe that knowing the frequent contributors to IFIP 9.4 and the most frequently-cited texts within IFIP 9.4 papers and panels can help to identify the “thought leaders” within the IFIP 9.4 community. For example, we can deduce that the underlying theories employed by IFIP 9.4 authors, based on data in Table 3, are structuration theory, institutional theory, innovation diffusion theory, and actor-network theory. Conversely, we conclude that other theories typically featured in IS research – such as the Technology Acceptance Model (TAM), Task-Technology Fit, and economic theories – are *not* widely used by IFIP 9.4 scholars, since citations to these theories are absent from Table 3. Such insights are useful for understanding the types of theories, methods and “thought leaders” that exemplify research published in IFIP 9.4 conferences.

Our longitudinal comparison of the frequently-cited texts over time suggests that specific theories are “on the rise” (i.e., actor-network theory and innovation diffusion theory), while others appear to be in relative decline (i.e., structuration theory). We also observe that texts that either justify using interpretive methods (Orlikowski & Baroudi 1991) or that explain how to conduct interpretive studies (Klein & Myers 1999; Walsham 1995) have been historically among the most cited sources at IFIP 9.4. This emphasis on interpretive research, however, appears to be changing with many fewer papers in the recent time period citing these classic texts.

In order to gain perspective from our analysis of the most frequently-cited sources, it is useful to compare Table 3 to similar results from other studies that identified “citation classics” in the IS literature as a whole (e.g., Walstrom & Leonard 2000) or to citation classics for other conferences. We compared our Table 3 results to those of Whitley and Galliers (2007) who identified frequently cited “texts” in papers from the European Conference on IS (ECIS) from 1993-2002. Since their study and ours each list the frequently-cited “texts” from a single conference over the span of at least a decade, we conducted a *post hoc* comparison of our results with theirs. Books were a highly-cited genre both in IFIP 9.4 conferences (over 30% of the frequent-cited sources in our Table 3) and at ECIS conferences (55.8% of the frequently-cited sources (see Appendix A.1

in Whitley & Galliers 2007). Both ECIS and IFIP 9.4 conferences also feature many frequently-cited papers from *MIS Quarterly*, a leading IS journal. The most frequently cited sources within IFIP 9.4 are papers in other academic journals – *Information Society*, *Information Technology for Development*, and *Information Technology & People*. In contrast, however, the most frequently-cited “texts” in ECIS conference papers (other than books) appeared in practitioner magazines such as *Harvard Business Review*, *Communications of the ACM*, and *Sloan Management Review*. In this regard, IFIP 9.4 authors cite a different set of texts than ECIS conference authors (Whitley & Galliers 2007). Moreover, authors publishing in ECIS and IFIP 9.4, taken together, cite texts that differ from those cited often in North American IS journals, such as *MIS Quarterly*, *Journal of Management Information Systems*, and *Information Systems Research* (Lowry et al. 2007).

In our analysis of most-cited IFIP 9.4 conference papers, we found that the best predictors of having a large number of citations were: the number of years elapsed since the year in which the conference paper appeared, and *not* having a related paper appear in a scholarly journal. For the most part, IFIP 9.4 conference papers that did not subsequently appear in a scholarly journal had higher numbers of citations – with just a few exceptions (e.g., Mosse & Sahay 2003; Zheng 2007). Finally, based on our co-citation analysis, we identified common subject areas, based on the shared citations that often appear together. These subject areas remained relatively constant over the two-period analysis, however, the “Capabilities Approach” for economic development (Sen 1999) became a readily-identifiable topic area in the later topic period, while interpretive research and Structuration Theory are less important in the later time period, compared to earlier.

We conclude by identifying directions in which future work may build on our results. First, we can compare our results with similar studies that focus on a single conference, such as ECIS (Galliers & Whitley 2007), IFIP 8.6 (Dwivedi et al 2010), or ACM SIG CHI (Kaye 2009). Scholars may also compare our results to scientometric studies of various ICT4D journals (Choudrie & Harindranath 2011; Gomez et al 2013), global IS journals (e.g., *Journal of Global Information Management*), or a broader set of IS journals (Gallivan & Benbunan-Fich 2007).

We acknowledge several limitations to our study. First, our study deliberately focused on IFIP 9.4 conferences starting in 2002; thus, we ignored the first decade of this conference. Second, papers corresponding to some years are omitted in the analyses that yielded Table 4, because we lacked access to full-text papers for the 2002 and 2005 conferences. This constraint had a very limited impact on most of our analyses – because the full-text papers were only required for

analyzing the references cited at the end of these papers. However, for analyzing the references, we recognize that we lacked those references for the 2002 and 2005 papers or else we substituted references appearing in a subsequent journal version of the paper.<sup>3</sup> Finally, we recognize that our analysis cannot be generalized to other ICT4D conferences, such as the newer conference known as “ICTD” (see <http://ictdconference.org/>) or to journals focusing on global IT issues.

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<sup>3</sup> Thus, we were able to substitute citations appearing in the journal versions of these IFIP 9.4 papers. We acknowledge that we have no way to know whether the sources cited in a later journal version of a paper bearing a similar title are the same ones cited in the initial IFIP 9.4 paper; however, the cited sources are likely very similar.

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**Table 3 Results: Sources Most Frequently Cited in IFIP 9.4 Papers and Panels**

Reference Paper Title	2002-2013				2002-2007		2009-2013	
	Authors	B or J	Total # of Citations	Rank	# Cites	Rank	# Cites	Rank
"Networks of Action: Sustainable Health IS across Developing Countries," <i>MIS Q.</i>	Braa, J. and Monteiro, E.	J	28	1	10	2	18	1
"IS and developing countries: Failure, success, and local improvisations," <i>Information Society</i>	Heeks, R.	J	20	2	5	9	15	2
<i>IT in Context: Studies from the Perspective of Developing Countries</i>	Avgerou, C. & Walsham, G.	B	20	2	9	4	11	3
<i>The Rise of the Network Society: The Information Age: Economy, Society, and Culture</i>	Castells, M.	B	17	3	8	5	9	4
<i>Interpreting Information Systems in Organizations</i>	Walsham, G.	B	18	5	11	1	7	7
"The Struggle for District-Based Health Information Systems in South Africa," <i>Information Society</i>	Braa, J. & Hedberg, C.	J	15	6	10	2	5	18
<i>Development as Freedom</i>	Sen, A.	B	14	7	5	9	9	5
"Studying IT in Organizations: Research Approaches and Assumptions," <i>Information Systems Research</i>	Orlikowski, W. J. & Baroudi, J.J.	J	13	8	7	6	6	12
<i>Making a World of Difference: IT in a Global Context</i>	Walsham, G.	B	12	9	6	7	6	12
"Developing Health IS in Developing Countries: The Flexible Standards Strategy," <i>MIS Quarterly</i>	Braa, J., Hanseth, O., et al.	J	11	10	3	30	8	6
<i>Information Systems and Global Diversity</i>	Avgerou, C.	B	11	11	6	7	5	18
<i>Diffusion of Innovations</i>	Rogers, E.M.	B	10	12	4	18	6	12
"GIS for District-Level Administration in India: Problems and Opportunities," <i>MIS Quarterly</i>	Walsham, G. & Sahay, S.	J	10	12	5	10	5	18
"Interpretive Case Studies in IS Research: Nature and Method," <i>European Journal of IS</i>	Walsham, G.	J	10	12	6	7	4	28
"Research on IS in developing countries: Current landscape and future prospects," <i>Information Technology for Development</i>	Walsham, G., & Sahay, S.	J	10	12	3	30	7	7
<i>Science in Action: How to Follow Scientists and Engineers through Society</i>	Latour, B.	B	10	12	4	18	6	12
<i>Constitution of Society. Outline of the Theory of Structuration</i>	Giddens, A.	B	9	18	5	10	4	28

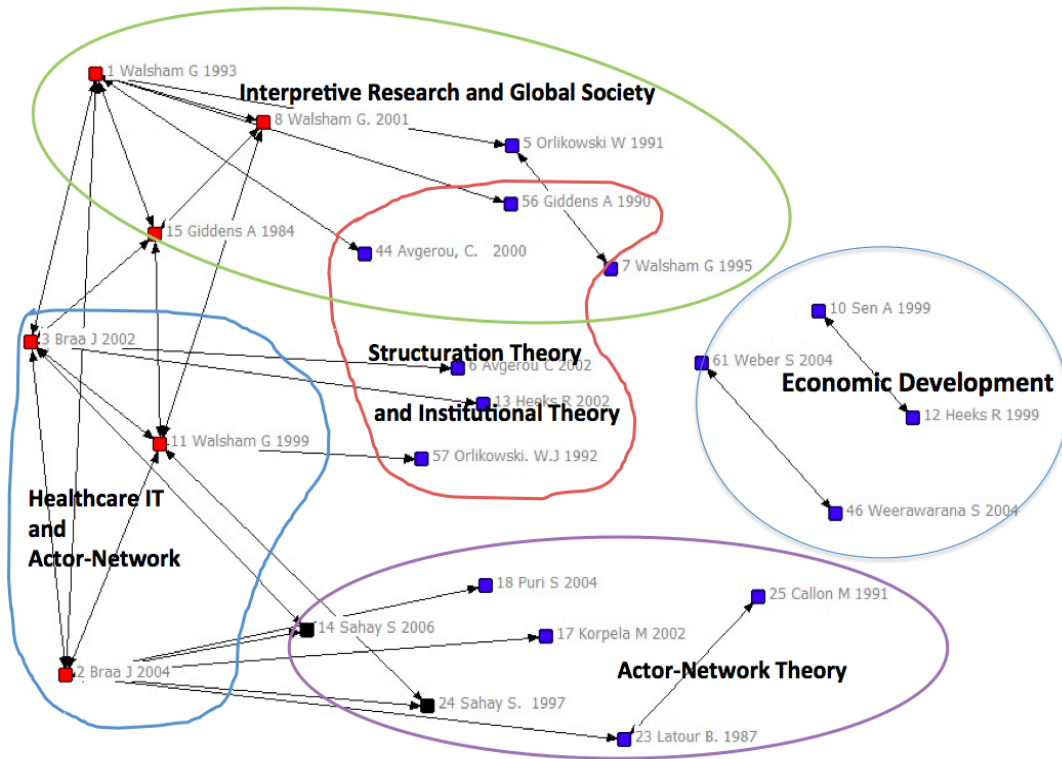
"A set of principles for conducting and evaluating interpretive field studies in IS" <i>MIS Q.</i>	Klein, H. K. & Myers, M. D.	J	8	19	5	10	3	39
"Bridging the digital divide: new route to development or new form of dependency?" <i>Global Governance</i>	Wade, R.W.	J	8	19	3	30	5	18
"Evaluating the developmental impact of e-governance initiatives," <i>Electronic Journal of IS in Developing Countries</i>	Madon, S.	J	7	21	2	n/a	5	18
Human Development Report	UN Development Program	R	7	21	3	30	4	28
"ICT4D 2.0: The Next Phase of Applying ICT for International Development," <i>IEEE Computer</i>	Heeks, R.	J	7	21	0	n/a	7	7
<i>ICT4D: Information &amp; Comm Technology for Development</i>	Unwin, T. & Unwin, P. T.	B	7	21	0	n/a	7	7
<i>Institutions and Organizations: Ideas and Interests</i>	Scott, W. R.	B	7	21	0	n/a	7	7
"Scaling of Health IS In India: Challenges and Approaches," IFIP 9.4 paper; re-published in <i>Information Technology for Development</i>	Sahay, S. & Walsham, G.	C, J	7	21	5	10	2	n/a
<i>Some Elements of a Sociology of Translation: Domestication of the Scallops and Fishermen of St Brieuc Bay</i>	Callon, M.	B	7	21	2	n/a	5	18
"Using Technology and Constituting Structures: A Practice Lens for Studying IT in Organizations," <i>Org. Science</i>	Orlikowski, W.	J	7	21	5	10	2	n/a
<i>Design and Implementation of Health IS</i>	Lippeveld, T., Sauerborn, R., & Bodart, C.	B	6	30	1	n/a	5	18
"IS in developing countries: A critical research review," <i>Journal of Information Technology</i>	Avgerou, C.	J	6	30	0	n/a	6	12
"IT and Social Transformation: GIS for Forestry Management in India," <i>Information Society</i>	Barrett, M.; Sahay, S. & Walsham, G.	J	6	30	4	18	2	n/a
"Negotiating multiple rationalities in the process of integrating the IS of disease specific health programmes," <i>Electronic Journal of IS in Developing Countries</i>	Chilundo, B., & Aanestad, M.	J	6	30	2	n/a	4	28
"Telemedicine in the Upper Amazon: interplay with local health care practices," <i>MIS Quarterly</i>	Miscione, G.	J	6	30	3	30	3	39



### APPENDIX A: Summary of Co-citation Papers

Paper (article) Cocitation Analysis							
Article Information				Data collection			Short Summary
Surnames	Paper Title	Journal	Year	Research Area	Time Period	source documents	
Pilkington & Meredith	The evolution of the intellectual structure of operations management -- 1980-2006: A citation/co-citation analysis	Journal of Operations Management	2009	OM research	1980-2006	3 journals: <i>JOM</i> , <i>POM</i> , <i>IJOPM</i>	Identified 12 top knowledge groups in the OM field and how they change over the decades
Hsiao & Yang	The intellectual development of the technology acceptance model: A co-citation analysis	International J. Information Management	2011	Technology acceptance model (TAM)	1989-2006	72 articles	Presented a visual mapping of intellectual structure and identified the subfields of TAM
Gregoire, Noel, & Bechar	Is there Conceptual Convergence in Entrepreneurship research? A co-citation analysis of frontiers of Entrepreneurship Research, 1981-2004	ET&P	2006	<i>Frontiers of Entrepreneurship Research</i>	Four periods: 1981-1986, 1987-1992, 1993-1998, 1999-2004	960 full-length articles in the <i>Frontiers of Entrepreneurship Research</i>	Provided evidence for the varying level of convergence and the evolution of the conceptual themes
Uysal	Business Ethics Research with an Accounting Focus: A Bibliometric Analysis from 1988 to 2007	Journal of Business Ethics	2010	Business ethics	1988-2007	40 documents with at least 10 citations	Identified the core articles in accounting research with focus; analyzed the scholarly citation patterns using SNA tools to profile centrality of the co-
Ramos-Rodríguez & Navarro	Changes in the intellectual structure of strategic management research: a bibliometric study of the Strategic Management Journal, 1980-2000	Strategic Management Journal	2004	Strategic Management Research	Three periods: 1980-1986, 1987-1993, 1994-2000	100 most cited documents	identified the works that have had the greatest impact on strategic management research and analyzed the changes that have taken place in the intellectual structure of this discipline.
Charvet, Cooper & Gardner	The Intellectual Structure of Supply Chain Management: A Bibliometric Approach	Journal of Business Logistics	2008	Supply Chain Management	1995-2004	33 articles from 915 articles with > 10 citations each in BSC database	Identified intellectual structure in supply chain management

**Figure 1A: Social Network Diagram of Frequently-Cited Sources (2002-2007)**



**Figure 1B: Social Network Diagram of Frequently-Cited Sources (2009-2013)**

