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Information Systems Research Themes: A Seventeen-year Data-driven Temporal Analysis

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Abstract:

Extending the research on our discipline's identity, we examine how the major research themes have evolved in four top IS journals: *Management Information Systems Quarterly* (*MISQ*), *Information Systems Research* (*ISR*), *Journal of the Association for Information Systems* (*JAIS*), and *Journal of Management Information Systems* (*JMIS*). By doing so, we answer Palvia, Daneshvar Kakhki, Ghoshal, Uppala, and Wang's (2015) call to provide continuous updates to the research trends in IS due to the discipline's dynamism. Second, building on Sidorov, Evangelopoulos, Valacich, and Ramakrishnan (2008) we examine temporal trends in prominent research streams over the last 17 years. We show that, as IS research evolves over time, certain themes appear to endure the test of time, while others peak and trough. More importantly, our analysis identifies new emergent themes that have begun to gain prominence in IS research community. Further, we break down our findings by journal and show the type of content that they may desire most. Our findings also allow the IS research community to discern the specific contributions and roles of our premier journals in the evolution of research themes over time.

Keywords: IS Research Themes, Text Mining, Latent Semantic Analysis.

This manuscript underwent editorial review. It was received 05/10/2017 and was with the authors for 10 months for 2 revisions. Fred Niederman served as Associate Editor.

1 Introduction

IS research has a long-held tradition of providing periodic updates to the research trends in IS due to the discipline's dynamism (e.g., Palvia et al., 2015). In this paper, we build on Sidorova et al. (2008) and examine temporal trends in prominent research streams over the last 17 years. We contribute towards establishing our discipline's identity by examining major research themes in four premier IS journals: *Management Information Systems Quarterly* (*MISQ*), *Information Systems Research* (*ISR*), *Journal of the Association for Information Systems* (*JAIS*), and *Journal of Management Information Systems* (*JMIS*). Many have considered these four journals to represent the top four IS journals. Further, many top business journal lists include them, and they rank among the top business journals with the highest impact factors. Consequently, most business school scholars would look at these journals to form an impression of the identity of the IS discipline (despite the fact that one could debate whether these four journals alone represent the discipline's total identity).

As technology has continued to morph and mature, research themes and industry problems have evolved with it, altering the nature of IS research and, consequently, the IS journals that publish that research. We review these trends by broadly examining the content development over the last 17 years and examining major themes that these publications have formed and the linkages among them. While historical trends reveal new opportunities and directions for these journals, we examine these themes to reveal whether themes act as separate communities of knowledge or if they are linked with one another both in terms of topics of inquiry and authorship.

Over three decades ago, Keen (1980) challenged researchers to determine major themes that encompass IS as a discipline. Since then, several researchers have reviewed IS literature to understand the state of the IS literature (e.g., Lucas, Swanson, & Zmud, 2007; Sidorova et al., 2008; Oh, Choi, & Kim, 2005). As we present in more detail in Section 2, some of these researchers have adopted traditional methodologies (e.g., meta-analysis; see Palvia et al., 2015) while others have adopted objective methodologies (e.g., text mining; see Sidorova et al., 2008; Weigal, Rainer, Hazen, Cegielski, & Ford, 2013). Furthermore, some of these researchers have focused their analysis on specific research areas (e.g., technology adoption) of IS research, while others have focused on specific research trends (e.g., authorship networks). For example, Weigal et al. (2013) systematically screened the medical informatics literature to examine major research themes in the medical informatics discipline. Palvia et al. (2015), on the other hand, conducted a meta-analysis to determine research methodologies and research topics using data from seven IS journals. With this paper, we compliment this existing research in two ways. First, Okoli (2015) argues that, even though literature reviews represent the single most widely used methodology, few papers have professed the best practices for conducting them. Palvia et al. (2015) also contend that conducting a review with just 10 years of journal data could take thousands of labor hours. We address both these issues. Leveraging the advancements in business analytics and big data, we provide an exemplar of objectively analyzing trends in IS. Sidorova et al.'s (2008) work represents an important first step in this direction. We build on this existing work by examining prominent, yet specific, research streams and how they have evolved over the last 17 years. Second, Palvia et al. (2015) argue that, like every other discipline, the IS discipline changes rapidly and requires continuous updates to the research trends. We provide such an update.

In Section 2, we review key research studies that have examined the evolution of IS research. In Section 3, we describe our data sources and present the methodology. In Section 4, we present our results and, in Section 5, discuss them and present their implications. Finally, in Section 6, we conclude the paper.

2 Background

From their inception, *MISQ*, *ISR*, *JAIS,* and *JMIS* have made significant contributions to the academic community. Indeed, many seminal publications have had a profound impact on the IS discipline. Some of these publications have examined the abstract view of IS as a discipline, while others have set the foundation for answering several of the most important IS-related questions for academia. For example, Orlikowski and Baroudi (1991) explored the philosophical underpinnings of IS research and argued that one should not limit the nature of IS research to a single research philosophy or perspective. Mathieson (1991) and Taylor and Todd (1995), on the other hand, made significant contributions to address the so-called "productivity paradox" (see Devaraj & Kohli, 2003) by investigating behavior models that may explain whether a person will employ an IS or not. Despite these achievements and transitions, few studies have examined the cumulative contributions of these journals to the business literature in general and the IS literature in particular. Examining cumulative contributions of these journals would: 1) explain

how their content has developed; 2) reveal the pervading problems that the IS discipline has discussed and how IS researchers have approached them, and 3) provide guidance and prescriptions for future IS research.

We believe that there is value in examining how, in response to the changing IT and IS landscape, these journals have evolved in terms of their prominent themes. While researchers have conducted similar examinations for many reference disciplines—such as *Strategic Management Journal* (Phelan, Ferreira, & Salvador, 2002), *Management Science* (Banker & Kauffman 2004), *Supply Chain Management* (Carter & Ellram, 2003), and *Journal of Management* (Podsakoff, MacKenzie, Podsakoff, & Bachrach, 2008)—few researchers have conducted them for the IS discipline. As such, we analyze four journals (i.e., *MISQ*, *ISR*, *JAIS,* and *JMIS*) specifically and the overall IS discipline as those journals represent it. While, analyzing specific journals can assist potential authors (i.e., by revealing the type of content they desire), analyzing a discipline as a whole highlights potentially unexplored areas.

Exploring a journal's historical trends and themes tends to reveal new opportunities and directions for it that researchers have hitherto overlooked. Identifying trends at the premiere IS journals (i.e., *MISQ*, *ISR*, *JAIS*, and *JMIS*) would reveal the dominant themes in them and how they have evolved over time and would enable readers to determine how these journals have contributed to the IS discipline. Further, identifying these trends would reveal less researched or emergent areas that may warrant additional attention. Indeed, certain themes may have received ample attention in some of these premier journals but may not have garnered adequate attention in all of them, which could reveal potential areas that require more research.

2.1 Prior Review Studies in Information Systems

In general, the IS literature contains three streams of review studies. The first stream focuses on the overall IS discipline, the second stream focuses on just the core areas in IS research (e.g., knowledge management), and the third stream focuses on trends rather than research's content (trust, technology adoption, etc.). For example, this third stream of research has examined networks of authors, relationships among subdisciplines, and trends in reviewing and authorship tactics. We review these streams in more detail below.

The first stream investigates the core research areas in the overall IS discipline. The stream focuses on determining the foci of IS research (e.g., Banker & Kauffman 2004; Palvia et al., 2015; Sidorova et al., 2008) by distilling IS research papers into major themes/topics. Much of this research has focused on either assigning IS research into one of the core research themes (e.g., Palvia et al., 2015) or using objective data-mining approach to classify IS research into broad research themes (e.g., Sidorova et al., 2008). Palvia et al. (2015) manually assigned research published in seven IS journals (*MISQ*, *ISR*, *JAIS*, *JMIS*, *Decision Sciences Journal* (DS), *European Journal of Information Systems* (*EJIS*), and *Information and Management* (*IM*)) into 45 topics of IS research. Sidorova et al. (2008) used latent semantic analysis (LSA)—a data-mining methodology—to cluster research published in *MISQ*, *ISR*, and *JMIS* into five broad research areas. While Sidorova et al. (2008) used a more objective approach, their analysis did not reveal the specific IS themes but rather research areas. We build on these research studies and use an objective data-mining technique to identify specific research themes common to IS research.

The second research stream investigates the advancements that specific domains in IS research have made. For example, Weigel et al. (2013) examined advancements in healthcare IT, Alavi and Leidner (2001) in knowledge management, Kayworth and Leidner (2004) in the role of culture, Smith, Dinev, and Xu (2011) in information privacy, and King and He (2006) in the technology acceptance model. Domain-specific reviews help researchers understand domains' current state and determine the open questions that they could potentially answer. However, such examinations do not contribute towards the identity and relevance issues in IS research, which leave them open to criticism (see Benbasat & Zmud, 2003; Lyytinen & King, 2004). We not only examines the core research themes in IS but also compare how these themes have evolved in four top IS journals (i.e., *MISQ*, *ISR*, *JAIS*, and *JMIS*).

The third research stream exclusively investigates trends in IS research publications. For example, extracting data from *MISQ*, *ISR*, *JMIS*, and *Management Science* (MS), Oh, Choi, and Kim (2005) developed a "knowledge network" in which they created four distinct subdisciplines (i.e., behavioral science, organizational science, computer science, and economic science) in order to trace the relational and topical patterns across papers and, thus, to gauge the way in which researchers connect by topic area. In a similar vein, Gallivan and Ahuja (2015) analyzed five IS journals over a seven-year period to

determine authorship networks. Lowry et al. (2014) conducted bibliometric analysis to assess different IS journals. Roseman, Recker, and Vessey (2010) investigated the reviewing and publishing tactics in IS. Our research contributes to these trends as well. We examine the trends in different research themes in *MISQ*, *ISR*, *JMIS*, and *JAIS* since 2000 and, thus, show how the IS discipline has evolved in that time. We expected at the outset that some themes (e.g., technology acceptance) may have thrived consistently, that others (e.g., virtual world) may have not, and that others still (e.g., healthcare and security) may have only recently started to pique IS researchers' interest.

3 Method

Our data comprises all the papers in *ISR*, *MISQ*, *JAIS*, and *JMIS* from 2000 to the first issue of 2017 (a little over with 17 volumes from each journal). We limited our analysis to 17 years because *JAIS* began publishing only in 2000. In total, the four journals published 2,336 (624 from *ISR*, 635 from *MISQ*, 408 from *JAIS*, and 669 from *JMIS*). We excluded papers such as issues and opinions and editorials. We downloaded most of the papers from Business Source Premiere, though we manually downloaded some (around 5%)—mostly earlier ones—from their respective journal websites. Each paper formed one data entry and contained values for attributes such as journal (*ISR*, *MISQ*, *JAIS*, *or JMIS*), year, volume, issue, authors, keywords, and abstract. Thus, our dataset contained 2,336 entries. Table 1 contains an example of a typical data entry/paper that we used in the analysis.

Table 1. Example of a Typical Data Entry/Paper used in the Analysis

Attribute name	Sample value
Journal	*MISQ*
Year	2014
Volume	38
Issue	3
Title	Expectation Confirmation in Information Systems Research: A Test of Six Competing Models
Authors	Brown, Susan A; Venkatesh, Viswanath; Goyal, Sandeep
Keywords	Expectations, disconfirmation, software use, polynomial modeling, response surface analysis
Abstract	Expectation confirmation research in general, and in information systems (IS) in particular, has produced conflicting results. In this paper, we discuss six different models of expectation confirmation: assimilation, contrast, generalized negativity, assimilation-contrast, experiences only, and expectations only. Relying on key constructs from the technology acceptance model (TAM), we test each of these six models that suggests different roles for expectations and experiences of the key predictor—here, perceived usefulness—and their impacts on key outcomes—here, behavioral intention, use, and satisfaction. Data were collected in a field study from 1,113 participants at two points in time. Using polynomial modeling and response surface analysis, we provide the analytical representations for each of the six models and empirically test them to demonstrate that the assimilation-contrast is the best existing model in terms of its ability to explain the relationships between expectations and experiences of perceived usefulness and important dependent variables—namely, behavioral intention, use, and satisfaction—in individual-level research on IS implementations.

We focused on uncovering the latent categories, or research themes, via analyzing the unstructured textual data in the abstracts. To do so objectively, we used an approach based on a method called latent semantics analysis (LSA). LSA as a method for extracting contextual-usage meaning has become an increasingly viable technique for processing unstructured text (Landauer, McNamara, Dennis, & Kintsch, 2007; Landauer & Dumais 1997). Classification is an area in which researchers have demonstrated LSA to produce objective results comparable to those by subjective humans (Landauer et al., 2014). Thus, researchers have unsurprisingly recommended LSA for converting textual data into numerical form as a precursor to subsequent analysis (Evangelopoulos, Zhang, & Prybutok, 2012). LSA represents an appropriate method for analyzing literature for several reasons. First, the volume of relevant literature has increased tremendously over the last few decades. An LSA-based method is more likely to offer a comprehensive analysis. As Palvia et al. (2015) accurately note, such an analysis, if done manually, could take hundreds of labor hours to conduct, which would make it difficult to update on a regular basis. Second, while traditional literature reviews by human experts are valuable, an LSA-based approach is more objective. Third, LSA uncovers latent structures in the textual corpus through patterns of co-

occurrence of terms. Thus, LSA can discover clusters of research missed in previous reviews. Fourth, an LSA-based approach allows one to analyze relationships among the identified clusters. For example, one can easily see what papers load into which multiple clusters, which can reveal interesting overlapping areas of research.

LSA rests on the idea that documents (or, in our case, abstracts that represent them) relate to each other through patterns of co-occurrence of terms and that extracting these patterns can uncover hidden structures or themes in the documents (Albright, 2004). Using LSA-based methods can contribute to our understanding of literature for several reasons. While humans excel at categorization and pattern matching, individual human perspectives can vary considerably (Larsen & Monarchi 2004). LSA offers the potential for a more data-driven analysis. In addition, an LSA-based approach necessarily features much more automation, which allows one to analyze a large body of literature in a reasonable amount of time.

Figure 1 describes the general process we used to analyze our data. In step one, we collected data as we describe above. In step two, we used natural language processing (NLP) techniques to reduce noise and data dimensionality in the data. In step three, we transformed the textual data into a structured form via using a term-by-document matrix and performed dimension reduction using singular value decomposition (SVD). In step four, we used a clustering algorithm to separate the abstracts into clusters with the principal components obtained through SVD. Finally, in step five, we analyzed the clusters that emerged to derive meaningful labels for them. These labeled clusters represent the research themes we identified. In addition to labeling the research clusters, we also found interesting trends about how these themes have evolved over time. We describe these steps in more detail in the rest of this section. We implemented most steps in SAS Enterprise Text Miner 14.

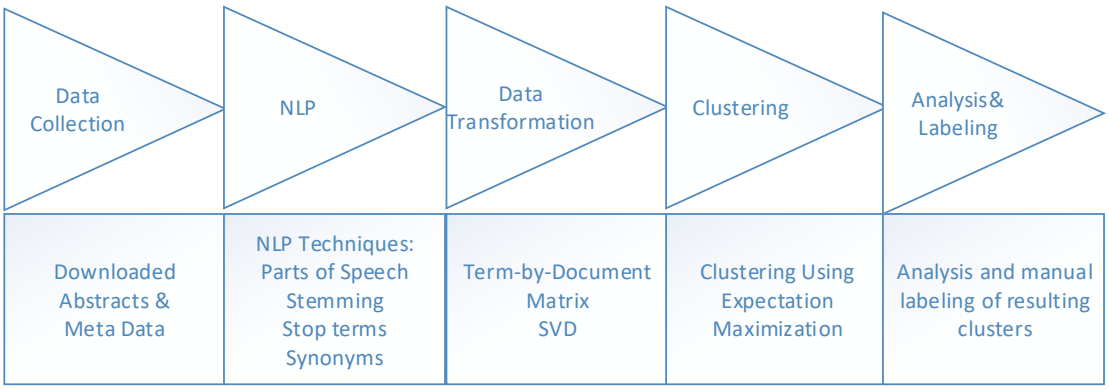

Figure 1. Main Steps in the Analysis

After we collected the data (step one), we used NLP techniques to reduce the noise in the data (step two). More specifically, we retained only certain parts of speech (POS) because tagging all parts of speech would create a much larger list of terms for analysis. Specifically, we retained the following POS: abbreviations, nouns, verbs, and verb adjectives. We performed stemming to map words into their root form. In addition, we excluded commonly used words or terms, called stop terms, since doing so constitutes common practice in text mining. We added additional stop terms after carefully examining the remaining terms. These custom stop terms included terms such as “paper” and “research” that contribute little meaning to the theme(s) represented in the research papers. Determining custom stop terms, a part of the text-mining process, is a manually intensive process that can significantly change the results (Albright, 2004; Chakraborty, Pagolu, & Garla, 2014). We also created a custom synonym list for terms that a research area commonly uses. For example, we used terms such as adopt, adopter, technology adoption as synonyms for the term adoption. The corpus originally had 20,003 total terms; after NLP preprocessing, we retained 3,554 terms. We somewhat expected this drastic reduction of terms because most terms were noise. Examples include prepositional phrases, such as instead of and along with, and terms that add little meaning, such as study and its various inflected forms (e.g., studying, studied, and studies).

The terms we obtained from step two served as the input to form the term-by-document matrix, which contained 2,366 documents (abstracts) and 3,554 distinct terms. We transformed the frequency counts in the term-by-document matrix via applying weight functions. After repeated trials, we found the combination of log and entropy weight functions produced the most consistent results (Chakraborty et al.,

2014).Dimension reduction through singular value decomposition is the next step, and the choice of the number of dimensions to retain is still an active area of research (Albright, 2004). We followed Evangelopoulos et al.'s (2012) recommendations and used a factor-analysis approach since we focused on understanding underlying research themes. We used the expectation-maximization clustering algorithm that Chakraborty et al. (2014) describe. Additionally, we used cluster analysis, as Evangelopoulos et al. (2012) define it, to determine how many clusters of papers occur in our dataset. We tested different numbers of factors (dimensions) and found that the 11-factor results produced the most understandable themes. Because cluster analysis does not specify how many clusters should exist, and the analysis objectively determines the number of clusters, this approach resembles unsupervised learning. In conducting repeated trials using the cluster-analysis approach, we found that about 11 clusters consistently emerged in these trials, which further confirmed our selecting them. We carefully examined the top loaded terms and abstracts of each of the resulting themes to determine an appropriate label for each theme. Finally, some abstracts did not meet the minimum criteria for any cluster. We set this minimum criteria as the mean of the weights of all the abstracts for that cluster plus 0.4 * standard deviation of the weights.

4 Results

In this section, we present the results of our analysis. Our dataset comprised 2,366 papers from *MISQ*, *ISR*, *JAIS*, and *JMIS* from 2000 to the first issue of 2017—a little over 17 years. These papers excluded papers such as issues and opinions and editorials. As we describe in Section 3, our analysis revealed 11 prominent clusters/factors that represent major themes in IS research. Table 2 shows these 11 research themes. Each research theme is defined by a set of terms that loaded into that theme. Table 2 also shows the top five loaded terms and the number of papers that loaded into each theme. For example, the adoption theme had 597 papers. Each paper could have loaded into zero, one, or more themes. For example, a paper relevant to the auctions literature might be equally relevant to both the e-commerce and trust literatures. Because one paper could load into one or more theme, the 2,366 papers had 3,863 total loadings.

Table 1. Predominant Research Themes as Revealed by LSA

Research theme	Top loading terms	Number of papers clustered
Knowledge management	knowledge management, firm performance, competitive advantage, transformation, interfirm, negotiation	719
Technology adoption	adoption, perceived usefulness, expectation, usefulness, continuance	597
E-commerce	e-commerce, electronic commerce, firm performance, agency, supply chain	483
Recommender systems	recommendation, expert, recommender system, advice, user preference	434
Security	security, threat, compliance, information security, attack	414
Virtual world	virtual world, collaborative work, creativity, co-creation, usability	284
Healthcare IT	health, patient, healthcare, physician, telemedicine	281
Trust	trust, e-commerce, virtual team, trust-build, trustworthiness	198
Outsourcing	outsourcing, outsource decisions, offshore, outsourcing relationship, outsourcing contracts	193
Auctions	auction, bid, combinatorial auction, online auction, auctioneer	167
Privacy	privacy, personal information, private information, privacy protection	93

Notes: each paper could have loaded into zero, one, or more themes. As such, the 2,366 papers had 3,863 total loadings.
We entered 2,336 papers into the analysis, but it used only 2,008.
Analysis classified about 86% of the data to develop 11 *prominent* themes.

We manually determined the label/name of each research theme after closely examining the top loaded terms and top loaded papers in each theme. Appendix A presents tables A1-A11 that list the top 10 loaded papers in each theme. We compared and contrasted these themes with themes identified in the prior research (e.g., Palvia et al., 2015; Sidorova et al. 2008). We discuss the similarities and differences between our findings and the findings from prior research in Section 5.

4.1 Research Trends

We used the papers classified into each research theme as data to further identify a series of research trends. Specifically, we examined two trends. First, we examined how the eleven research themes we identified have evolved over the last 17 years in each journal (i.e., *MISQ*, *ISR*, *JAIS*, and *JMIS*). Second, we examined how individual research themes were distributed across each journal.

Figures 2 to 6 present the results of this evolution: Figure 2 represents trends across all four journals, and Figures 3, 4, 5, and 6 represents trends across *MISQ*, *ISR*, *JAIS*, *and JMIS,* respectively. All four journals have consistently shown a high level of activity in knowledge management over time. With several researchers calling for IS research to explain the productivity gains accrued from IT investments, a large number of research papers have focused on how IT can improve firm performance and create capabilities that would result in a competitive advantage. Several other research themes show interesting trends. For example, for the e-commerce research theme, *ISR* has seen sustained activity, *MISQ* has seen inconsistent activity, and *JAIS* and *JMIS* have seen decreased activity over time. Similarly, Figure 2 shows that, even though some of the research themes (e.g., privacy) are in a nascent stage, they have seen an equal interest from most of the major IS journals. The IT security research theme's evolution represents another interesting observation. With the increasing number of data breaches (e.g., Target, Home Depot), practitioners and government agencies have allocated much resources towards improving information security. IS researchers have taken note of this trend. We found that the number of papers on information security increased significantly after 2008, almost immediately around the time when corporations witnessed an increase in their data breaches. Finally, our findings illustrate the short lifespan of some research themes. Interest in virtual worlds research, once considered one of the hottest topics of research, seems to have waned in three out of the four top IS research outlets. Figures 3 to 6 show that the interest in this area of research has dropped in *ISR*, *MISQ*, and *JAIS* (although it has significantly increased in *JMIS*).

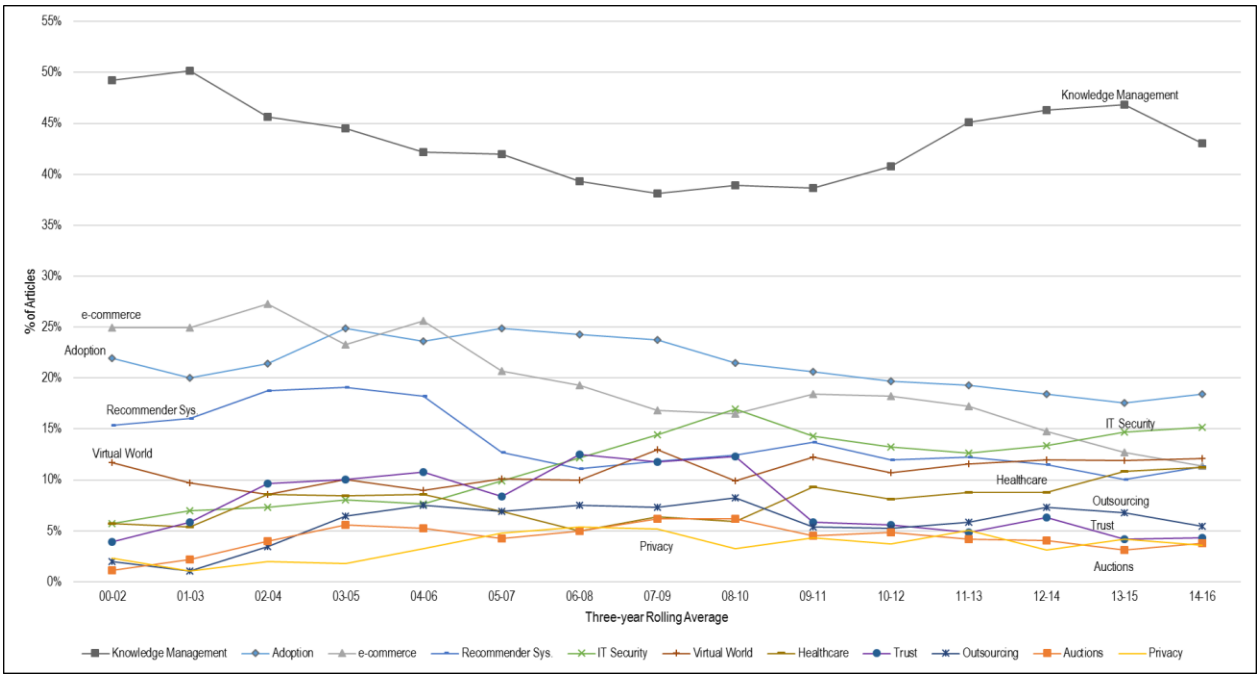

Figure 2. Evolution of the Eleven Prominent themes in IS Across all Four Examined Journals

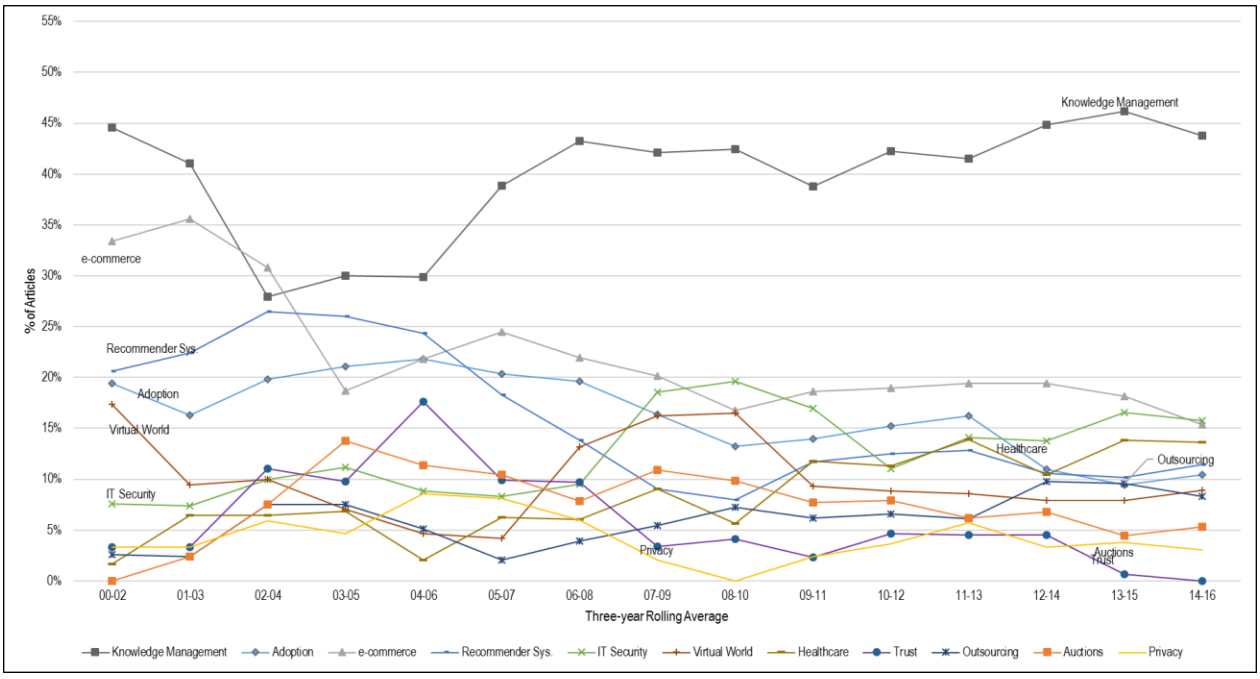

Figure 3. Evolution of the Eleven Prominent IS Themes in *ISR*

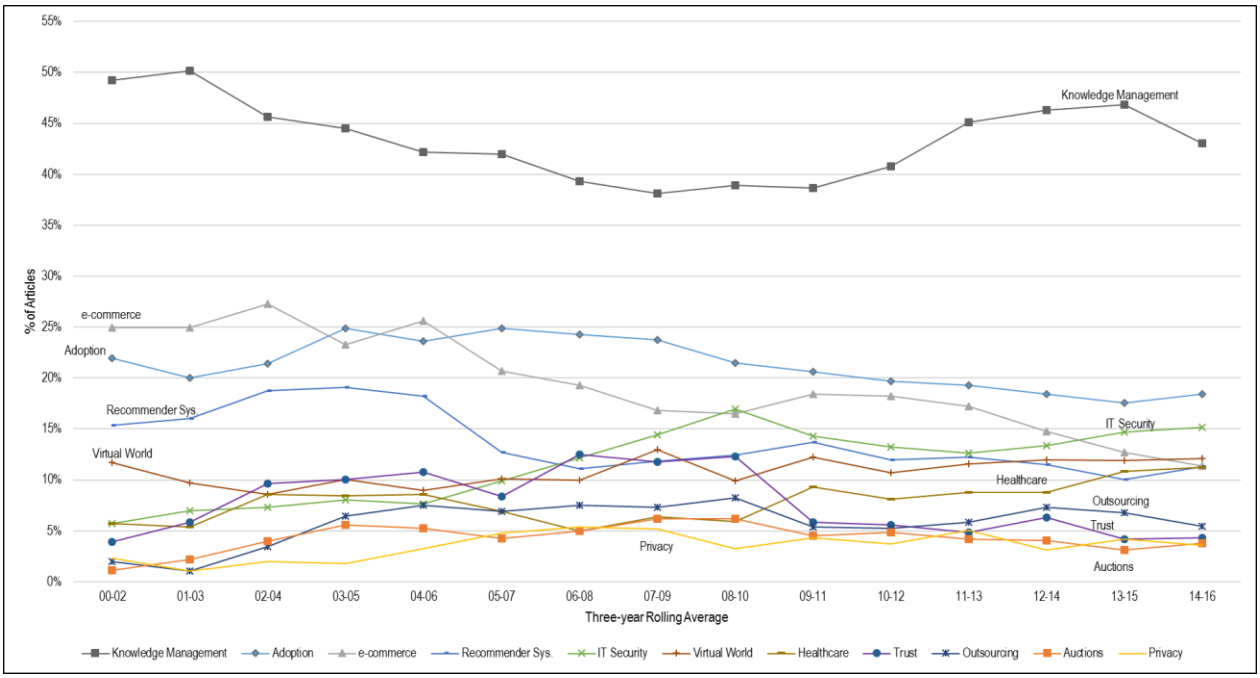

Figure 4. Evolution of the Eleven Prominent IS Themes in *MISQ*

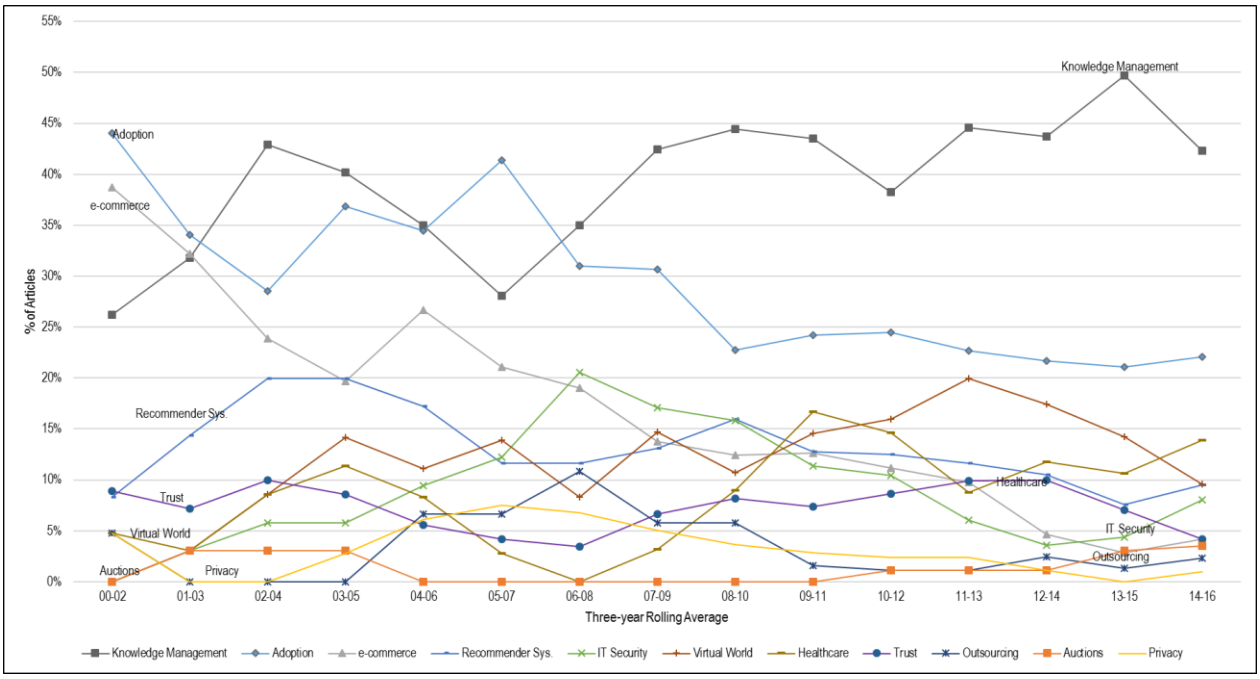

Figure 5. Evolution of the Eleven Prominent IS Themes in *JAIS*

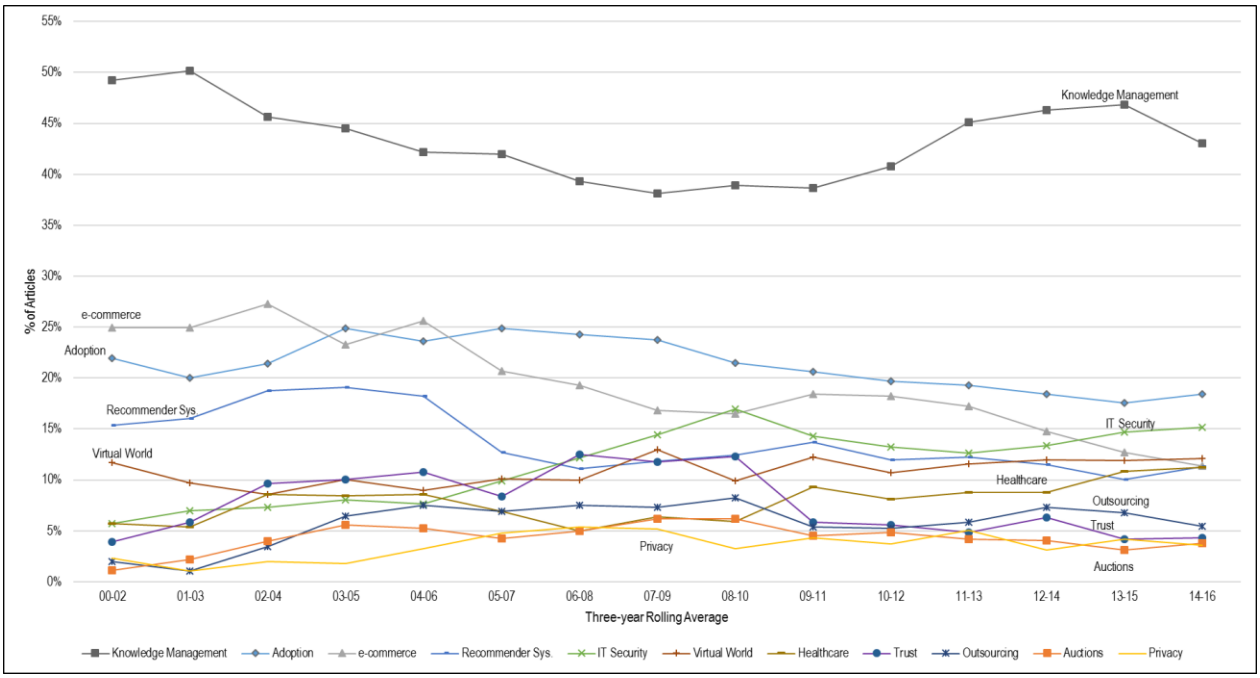

Figure 6. Evolution of the Eleven Prominent IS Themes in *JMIS*

Figure 7 presents an overall distribution of papers that we classified into eleven themes by journal. Figures B1 to B11 (Appendix B) present the publications trends of the individual research themes by specific journal. This examination shows some interesting trends. For example, many researchers (e.g., Benbasat & Barki, 2007) have noted technology adoption to be the most influential and the only well-recognized theory in IS. Our results confirm this assertion. Of all papers published in *MISQ*, *ISR*, *JAIS*, and *JMIS* since 2000, our analysis clustered 597 papers under technology adoption, which made it the second most dominant theme. Of these 597 papers, *ISR* published 20 percent, *MISQ* published 34 percent, *JAIS* published 23 percent, and *JMIS* published 24 percent, which indicates that technology

adoption research has appeared consistently across all four journals. Interestingly, even though some researchers (e.g., Venkatesh, Morris, Davis, & Davis, 2003) have contended that research models in this area of research are approaching practical limits of explaining individual acceptance variance, the area continues to see interest from the IS researchers. One of the many possible reasons for this interest in technology adoption research could be the infusion of theories from reference literature (e.g., marketing) to answer questions such as the "productivity paradox" (Devaraj & Kohli, 2003; Venkatesh & Goyal, 2010).

Another interesting finding is the delineation of online auctions from e-commerce. Many prior reviews of IS literature (e.g., Palvia et al. 2015) have subsumed auctions under e-commerce. Even though our analysis classified a low number of papers into auctions (i.e., 167), the analysis suggests that the body of research on auctions has advanced enough to represent its own dominant research theme alongside e-commerce. The numbers of auctions research papers skew heavily towards *ISR*. Specifically, of all the auctions research papers, *ISR* published 42 percent, *MISQ* published 23 percent, *JAIS* published six percent, and *JMIS* published 29 percent. This distribution suggests that some journals (e.g., *ISR*) are more amenable to auctions research than others (e.g., *JAIS*).

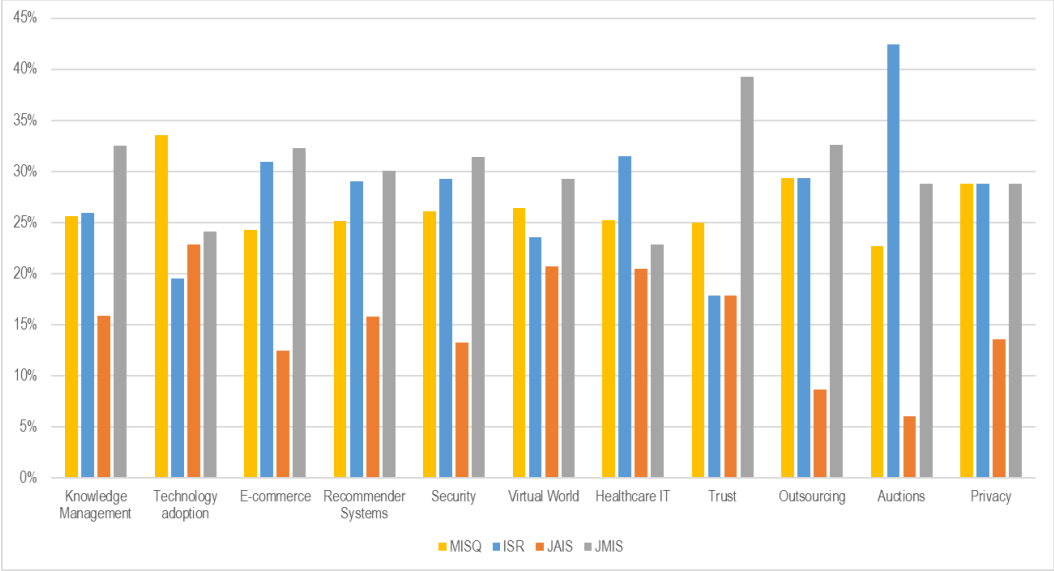

Figure 7. Paper Distribution of the Eleven Prominent IS Themes by Journal

Like technology adoption, the trust literature appears to be another recognized area of IS research. While we expected the trust research theme to have a larger number of papers, our analysis loaded only 198 research papers in this research theme (*ISR*: 18%; *MISQ*: 25%; *JAIS*: 18%, and *JMIS* 39%). Two reasons may explain this finding. First, researchers have conducted a large number of trust research studies in a variety of contexts or in conjunction with other research themes. As such, the papers may have involved more text about the context or the theme, which meant our analysis would not have classified such papers under trust. For example, a large number of studies we have in our dataset have examined trust in e-commerce. Manually examining the papers revealed that our analysis classified a number of them into e-commerce because they used a larger number of e-commerce and related terms in the abstract than trust because these studies contributed more to the e-commerce literature than the trust literature. Second unlike the technology adoption literature, the trust literature has seen a large drop-off in the major IS research outlets.

5 Discussion

In this study, we examine major research themes in four premiere IS journals—*MISQ*, *ISR*, *JAIS*, and *JMIS*—to better understand how these journals and, by association, the IS discipline has evolved over a 17-year period. Before we discuss our results, we note some key limitations of our work. First, we limited our research to four journals to generate a more parsimonious list of prominent themes in IS research. These four journals, however, only represent a small subset of work published in the IS literature. Future research should consider a much broader set of journals, such as the Senior Scholar's basket of eight journals. Doing so may further enhance the diversity of research themes and complement literatures from

reference disciplines. For instance, we found that IT security and privacy are upcoming themes. Considering the security challenges organizations have faced recently, such as the Equifax data beach (Puzzanghera & Raab, 2017), attention to such important topics in IS research would encourage attention from practitioners and researchers in reference disciplines. Future research should also look at how the evolution of these journals map with the different eras of IS research evolution (Hirschheim & Klein, 2012).

Using an objective text-mining approach, we identified eleven dominant research themes (i.e., knowledge management, technology adoption, auctions, e-commerce, information privacy, recommender systems, information security and trust, virtual world, healthcare IT, and IT outsourcing). We also found several other themes not dominant in the IS literature. These results have several similarities and differences with the research themes that other reviews have presented. For example, five out of ten research themes we present (i.e., knowledge management, technology adoption, e-commerce, healthcare IT, and IT outsourcing) map directly with Palvia et al. (2015), one of the most recent reviews. Of the remaining six, three (information privacy, recommender systems, information security) were closely related. Palvia et al. combine information privacy and information security into one single topic, but our analysis classified these two topics as distinct enough for them to emerge as their own theme. Palvia et al.'s decision support system and executive IS theme has several common strains with our research theme of recommender system. For example, Komiak and Benbasat's (2006) and Wang and Benbasat's (2007, 2009) work builds on the seminal work in decision support literature. Finally, our analysis revealed three themes—auctions, trust, virtual world— that Palvia et al. do not include. Some of these differences arise for two reasons. First, while Palvia et al. used traditional methodologies, we used a primarily objective method. Our objective analysis allowed the themes to emerge based on the occurrence patterns of key IS research terms, and, in some instances, the results of the analysis warranted themes such as information privacy and information security to stand as separate themes. Second, we focused on prominent, not all, themes. Our analysis used only a little over 86 percent of the available data. We believe that the themes that did not emerge from our analysis but that Palvia et al. identify are still relevant but that they have not received enough attention over the last 17 years.

This paper contributes towards the discussion of our discipline's identity by examining major research themes in four premier IS journals and extends the research on the historic tradition of the IS discipline (see Bryant, Black, Land, & Porra, 2013; Porra, Hirschheim, & Parks, 2014; Hirschheim & Klein, 2012). These themes provide insights into the nature of IS research and how the IS discipline has responded to changing trends in the economy, industries, and technologies. In doing so, this paper responds to the calls for researchers to periodically reflect on research trends and our actual output in each of these trends and themes (Love & Hirschheim, 2016). Second, building on Sidorova et al. (2008), we contribute methodologically by objectively analyzing the trends in IS research and how they have evolved over the last 17 years.

The findings we outline have several implications for future research. In recent years, a debate about the relevance of the IS research has gained momentum. Our work can help the discipline take stock of the thematic composition of our premier publications, and subsequently, allows the discipline to reflect on its future direction. While it is interesting to study historical trends, it is even more important for the editors and senior scholars of the IS research community to develop ways to provide guidance to the authors and our doctoral students on fruitful areas of research that allow the discipline to lead rather than follow the trends seen in practice. As a discipline, we must continue to strive for greater relevance and impact by balancing between examining current trends and other leading trends. In doing so, we must glance in the rearview mirror but only so that we can chart the road ahead.

Our findings show that some themes appear to be enduring but that others have peaked and troughed. Future research may need to examine what makes a theme enduring or not. One possible explanation could be that the enduring topics relate to the core phenomena of IS (e.g., adoption, IT value, etc.), while those that have a limited half-life relate to specific contexts (e.g., healthcare, auctions). It could also be that the research themes that exhibit shorter lifespans follow current challenges, practices, or the next big idea that become commonplace in a relatively short period of time. We call on the scholarly community in IS to conduct research that will lead the agenda for the practice. This and other plausible explanations of core versus fads warrant examination.

6 Conclusion

Researchers in IS and its reference disciplines have provided periodic updates on the trends in their respective disciplines. This research provides such an update for IS using a data-driven temporal analysis. We analyzed the research published in the top four IS journals (i.e., *MISQ*, *ISR*, *JAIS,* and *JMIS*) over a 17-year period to examine the temporal trends in prominent research streams. We found a diverse set of themes that have evolved over time. We also found new emergent themes, themes that have seen persistent interest from IS researchers, and themes that have peaked. While our work represents a useful contribution, we call on future scholars to broaden this conversation by including a broader set of journals.

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Appendix A: Top loaded 10 Papers in Each of the 11 Themes

Table A1. Top Loaded Terms and Papers for Research Theme: Knowledge Management

Top five loaded terms: knowledge management, firm performance, competitive advantage, transformation, interfirm, negotiation		
Top 10 loaded papers		
Journal	**Journal**	**Title**
MISQ	2005	Information Technology Relatedness, Knowledge Management Capability, and Performance of Multibusiness Firms
JAIS	2007	An Agent-Mediated Knowledge-in-Motion Model
ISR	2011	Knowledge Exploration and Exploitation: The Impacts of Psychological Climate and Knowledge Management System Access
ISR	2006	From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development
JMIS	2001	Situated Learning and the Situated Knowledge Web: Exploring the Ground Beneath Knowledge Management
MISQ	2001	Knowledge Management and Knowledge Management Systems: Conceptual Foundations and Research Issues
JAIS	2013	Infusing Ethical Considerations in Knowledge Management Scholarship: Toward a Research Agenda
JMIS	2005	Effect of Information Systems Resources and Capabilities on Firm Performance: A Resource-Based Perspective
ISR	2008	A Model of Conflict, Leadership, and Performance in Virtual Teams
JMIS	2004	Collaborative Business Engineering: A Decade of Lessons from the Field

Table A2. Top Loaded Terms and Papers for Research Theme Technology Adaption

Top five loaded terms: adoption, perceived usefulness, expectation, usefulness, continuance		
Top 10 loaded papers		
Journal	**Year**	**Title**
MISQ	2014	Expectation Confirmation in Information Systems Research: A Test of Six Competing Models
MISQ	2009	A Meta-Analysis of The Role of Environment-Based Voluntariness in Information Technology Acceptance
JAIS	2014	The Role of Signaling Identity in the Adoption of Personal Technologies
JAIS	2004	Web Site Delays: How Tolerant are Users?
ISR	2012	Expectation Confirmation in Technology Use
MISQ	2014	Reliability Generalization of Perceived Ease of Use, Perceived Usefulness, and Behavioral Intentions
JAIS	2009	Sequential Adoption Theory: A Theory for Understanding Herding Behavior in Early Adoption of Novel Technologies
MISQ	2006	Reconceptualizing Compatibility Beliefs in Technology Acceptance Research
MISQ	2010	An Alternative To Methodological Individualism: A Non-Reductionist Approach to Studying Technology Adoption by Groups
MISQ	2004	User Acceptance Of Hedonic Information Systems

Table A3. Top Loaded Terms and Papers for Research Theme: E-Commerce

Top five loaded terms: e-commerce, electronic commerce, firm performance, agency, supply chain		
Top 10 loaded papers		
Journal	**Year**	**Title**
ISR	2002	e-Commerce Metrics for Net-Enhanced Organizations: Assessing the Value of e-Commerce to Firm Performance in the Manufacturing Sector
JMIS	2004	The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of Their Business Value
JMIS	2004	Reexamining the Value Relevance of E-Commerce Initiatives
MISQ	2014	Swift Guanxi in Online Marketplaces: The Role of Computer-Mediated Communication Technologies
JAIS	2001	Assurance Services for Business-to- Business Electronic Commerce: A Framework and Implications
JMIS	2005	The Relationship of E-Commerce Competence to Customer Value and Firm Performance: An Empirical Investigation
ISR	2001	The Impact of E-Commerce Announcements on the Market Value of Firms
JAIS	2010	Sellers' Trust and Continued Use of Online Marketplaces*
ISR	2012	The Boundaries of Trust and Risk: The Quadratic Moderating Role of Institutional Structures
ISR	2002	Antecedents of B2C Channel Satisfaction and Preference: Validating e-Commerce Metrics

Table A4. Top Loaded Terms and Papers for Research Theme: Recommender Systems

Top five loaded terms: recommendation, expert, recommender system, advice, user preference		
Top 10 loaded papers		
Journal	**Year**	**Title**
ISR	2011	A Query Language for Customizing Recommendations
JMIS	2015	Impact of Recommender System on Competition Between Personalizing and Non-Personalizing Firms
JMIS	2010	Empirical Analysis of the Impact of Recommender Systems on Sales
JAIS	2014	Generating Effective Recommendations Using Viewing-Time Weighted Preferences for Attributes
ISR	2013	Do Recommender Systems Manipulate Consumer Preferences? A Study of Anchoring Effects
ISR	2015	Recommendations Using Information from Multiple Association Rules: A Probabilistic Approach
MISQ	2012	A Hidden Markov Model for Collaborative Filtering
JMIS	2011	Effects of Automated and Participative Decision Support in Computer-Aided Credibility Assessment
ISR	2016	In CARSs We Trust: How Context-Aware Recommendations Affect Customers' Trust and Other Business Performance Measures of Recommender Systems
JAIS	201	A Theory-Driven Design Framework for Social Recommender Systems

Table A5. Top Loaded Terms and Papers for Research Theme: Security

Top five loaded terms: security, threat, compliance, information security, attack		
Top 10 loaded papers		
Journal	**Year**	**Title**
JMIS	2008	Information Risk of Inadvertent Disclosure: An Analysis of File-Sharing Risk in the Financial Supply Chain
ISR	2016	Mandatory Standards and Organizational Information Security
JMIS	2009	Information Security: Facilitating User Precautions Vis-à-Vis Enforcement Against Attackers
ISR	2013	The Association Between the Disclosure and the Realization of Information Security Risk Factors
ISR	2008	Let the Pirates Patch? An Economic Analysis of Software Security Patch Restrictions
MISQ	2015	An Enhanced Fear Appeal Rhetorical Framework: Leveraging Threats to the Human Asset Through Sanctioning Rhetoric
ISR	2009	Choice and Chance: A Conceptual Model of Paths to Information Security Compromise
MISQ	2010	Fear Appeals And Information Security Behaviors: An Empirical Study
MISQ	2010	Market Value Of Voluntary Disclosures Concerning Information Security
JMIS	2008	Investments in Information Security: A Real Options Perspective with Bayesian Postaudit

Table A6. Top Loaded Terms and Papers for Research Theme: Virtual World

Top five loaded terms: virtual world, collaborative work, creativity, co-creation, usability		
Top 10 loaded papers		
Journal	**Year**	**Title**
MISQ	2011	What If Your Avatar Looks Like You? Dual-Congruity Perspectives For Avatar Use
JMIS	2011	Usability Design and Psychological Ownership of a Virtual World
JAIS	2012	Team Collaboration in Virtual Worlds: Editorial to the Special Issue
JAIS	2009	Avatars, People, and Virtual Worlds: Foundations for Research in Metaverses *
ISR	2012	Using Real Options to Investigate the Market Value of Virtual World Businesses
MISQ	2011	Virtual Space And Place: Theory And Test
JAIS	2012	A Structured Approach for Designing Collaboration Experiences for Virtual Worlds
MISQ	2011	Co-Creation In Virtual Worlds: The Design Of The User Experience
JAIS	2012	Valuing Virtual Worlds: The Role of Categorization in Technology Assessment
MISQ	2011	Enhancing Brand Equity Through Flow and Telepresence: A Comparison Of 2d and 3d Virtual Worlds

Table A7. Top Loaded Terms and Papers for Research Theme: Healthcare

Top five loaded terms: health, patient, healthcare, physician, telemedicine		
Top 10 loaded papers		
Journal	**Year**	**Title**
ISR	2014	Feeling Blue? Go Online: An Empirical Study of Social Support Among Patients
ISR	2011	An Analysis of the Adoption of Digital Health Records Under Switching Costs
MISQ	2007	Telemedicine in the Upper Amazon: Interplay with Local Health Care Practices
JAIS	2011	Dynamic Capabilities in Home Health: IT-Enabled Transformation of Post-Acute Care
ISR	2011	Managing Emerging Infectious Diseases with Information Systems: Reconceptualizing Outbreak Management Through the Lens of Loose Coupling
ISR	2015	Network Dynamics: How Can We Find Patients Like Us?
JAIS	2011	The Clinical Impact of eHealth on the Self-Management of Diabetes: A Double Adoption Perspective
JAIS	2011	The Dynamics of Information Collaboration: A Case Study of Blended IT Value Propositions for Health Information Exchange in Disability Determination
JMIS	2017	The Consensus Effect in Online Health-Care Communities
MISQ	2007	Developing Health Information Systems in Developing Countries: The Flexible Standards Strategy

Table A8. Top Loaded Terms and Papers for Research Theme: Trust

Top five loaded terms: trust, e-commerce, virtual team, trust-build, trustworthiness		
Top 10 loaded papers		
Journal	**Year**	**Title**
JMIS	2008	Examining Trust in Information Technology Artifacts: The Effects of System Quality and Culture
MISQ	2010	What Does The Brain Tell Us About Trust and Distrust? Evidence From A Functional Neuroimaging Study
ISR	2004	Toward Contextualized Theories of Trust: The Role of Trust in Global Virtual Teams
JMIS	2003	The Role of System Trust in Business-to-Consumer Transactions
JMIS	2004	What Makes an ERP Implementation Relationship Worthwhile: Linking Trust Mechanisms and ERP Usefulness
ISR	2012	The Boundaries of Trust and Risk: The Quadratic Moderating Role of Institutional Structures
MISQ	2006	The Effects of Personalization and Familiarity on Trust and Adoption of Recommendation Agents
JMIS	2009	Individual Swift Trust and Knowledge-Based Trust in Face-to-Face and Virtual Team Members
MISQ	2014	Trust, Satisfaction, and Online Repurchase Intention: The Moderating Role of Perceived Effectiveness of E-Commerce Institutional Mechanisms
JAIS	2010	Sellers' Trust and Continued Use of Online Marketplaces

Table A9. Top Loaded Terms and Papers for Research Theme: Outsourcing

Table A9. Top Loaded Terms and Papers for Research Theme: Outsourcing

Top five loaded terms: outsourcing, outsource decisions, offshore, outsourcing relationship, outsourcing contracts		
Top 10 loaded papers		
Journal	**Year**	**Title**
JAIS	2012	Systemic Determinants of the Information Systems Outsourcing Decision: A Comparative Study of German and United States Firms
JMIS	2009	A Learning Model of Information Technology Outsourcing: Normative Implications
ISR	2011	Returns to Information Technology Outsourcing
JAIS	2000	Structuring IS Outsourcing Contracts for Mutual Gain: An Approach to Analyzing Performance Incentive Schemes
ISR	2013	Outsourcing Contracts and Equity Prices
JMIS	2007	Proximity and Information Technology Outsourcing: How Local Are IT Services Markets?
MISQ	2013	Information Technology Outsourcing and Non-IT Operating Costs: An Empirical Investigation
ISR	2012	IT Outsourcing Contracts and Performance Measurement
JMIS	2015	The Impact of Firm Learning on Value Creation in Strategic Outsourcing Relationships
JMIS	2011	Influence of Industry Characteristics on Information Technology Outsourcing

Table A10. Top Loaded Terms and Papers for Research Theme: Auctions

Top five loaded terms: auction, bid, combinatorial auction, online auction, auctioneer		
Top 10 loaded papers		
Journal	**Year**	**Title**
MISQ	2012	Bidding Behavior Evolution in Sequential Auctions: Characterization and Analysis
ISR	2005	Toward Comprehensive Real-Time Bidder Support in Iterative Combinatorial Auctions
JMIS	2014	The Impact of Buy-Now Features in Pay-per-Bid Auctions
ISR	2010	Understanding Willingness-to-Pay Formation of Repeat Bidders in Sequential Online Auctions
JMIS	2010	Bidding Patterns, Experience, and Avoiding the Winner's Curse in Online Auctions
ISR	2009	Designing Intelligent Software Agents for Auctions with Limited Information Feedback
ISR	2016	Characteristics and Economic Consequences of Jump Bids in Combinatorial Auctions
MISQ	2013	Impact of Information Feedback in Continuous Combinatorial Auctions: An Experimental Study of Economic Performance
ISR	2009	A Computational Analysis of Linear Price Iterative Combinatorial Auction Formats
ISR	2011	An Experimental Comparison of Linear and Nonlinear Price Combinatorial Auctions

Table A11. Top Loaded Terms and Papers for Research Theme: Privacy

Top five loaded terms: privacy, personal information, private information, privacy protection		
Top 10 loaded papers		
Journal	**Year**	**Title**
MISQ	2011	State Of The Information Privacy Literature: Where Are We Now and Where Should We Go?
MISQ	2011	Privacy In The Digital Age: A Review of Information Privacy Research In Information Systems
ISR	2012	Effects of Individual Self-Protection, Industry Self-Regulation, and Government Regulation on Privacy Concerns: A Study of Location-Based Services
JAIS	2011	Information Privacy Concerns: Linking Individual Perceptions with Institutional Privacy Assurances
JAIS	2005	Theoretical Explanations for Firms - Information Privacy
ISR	2004	Internet Users' Information Privacy Concerns (IUIPC): The Construct, the Scale, and a Causal Model
MISQ	2011	Managing Consumer Privacy Concerns In Personalization: A Strategic Analysis Of Privacy Protection
ISR	2006	An Extended Privacy Calculus Model for E-Commerce Transactions
MISQ	2011	Information Privacy Research: An Interdisciplinary Review
ISR	2011	The Effect of Online Privacy Information on Purchasing Behavior: An Experimental Study

Appendix B: Publications Trends of Individual Research Theme by Specific Journal

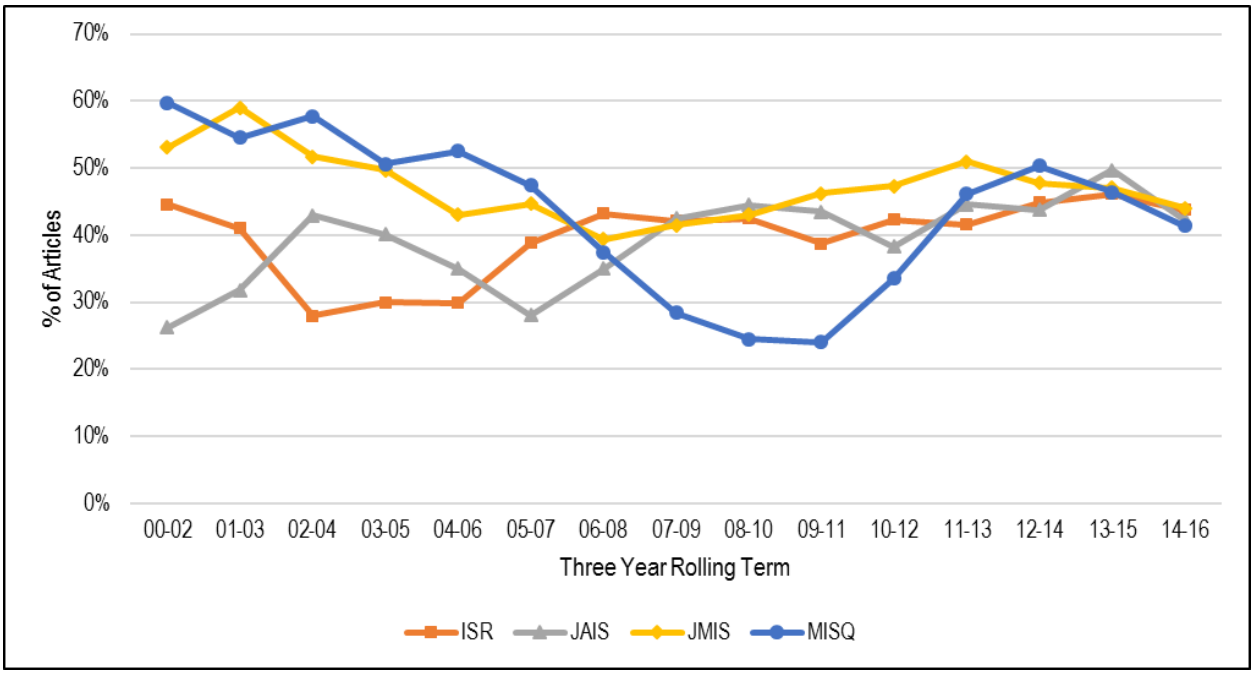

Figure B1. Three Year Rolling Averages of Publications on Knowledge Management

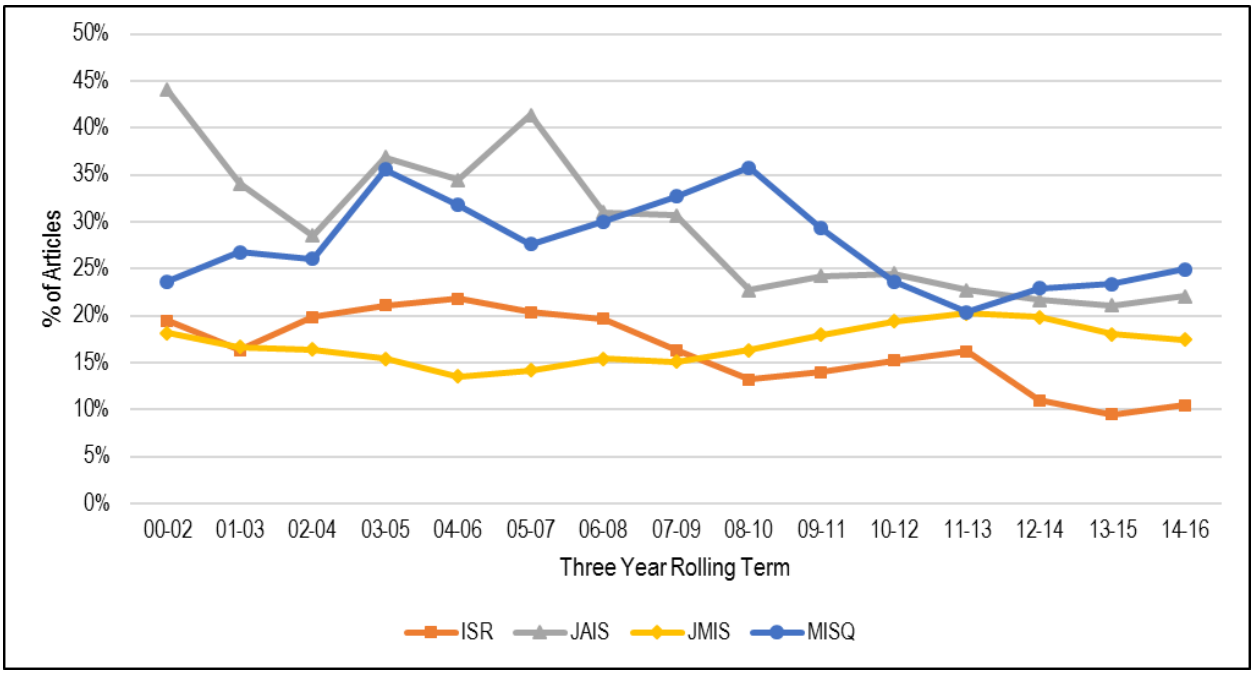

Figure B2. Three Year Rolling Averages of Publications on Technology Adoption

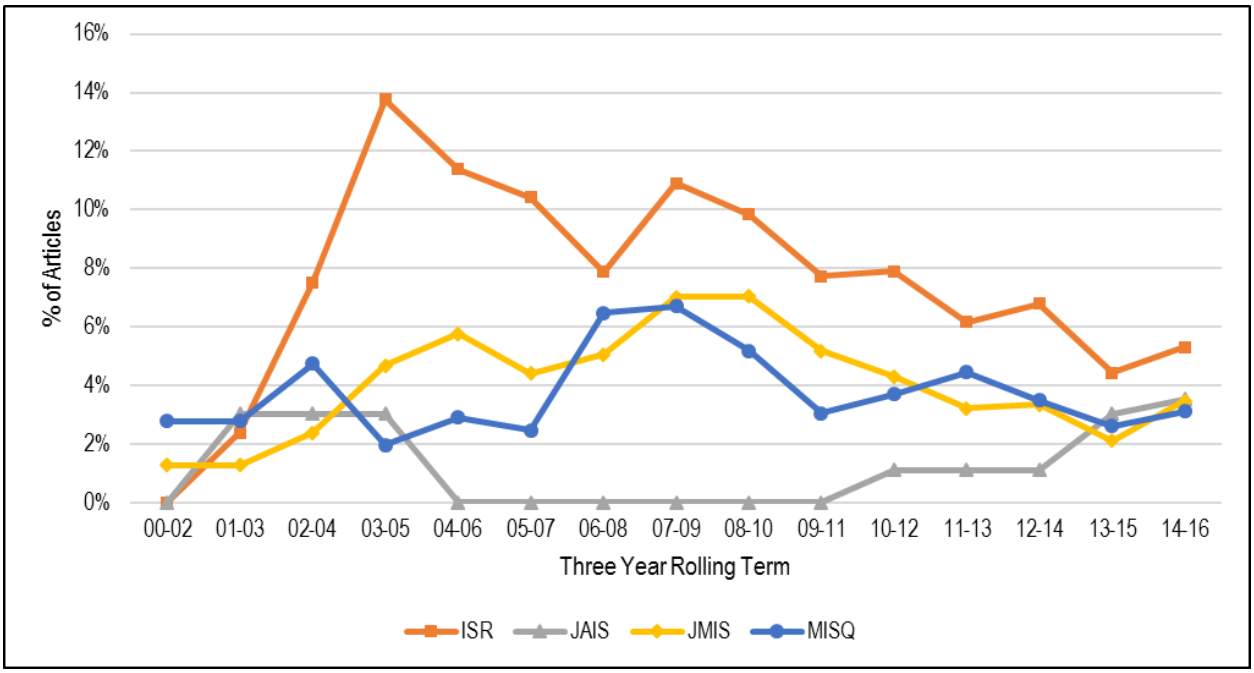

Figure B3. Three Year Rolling Averages of Publications on Auctions

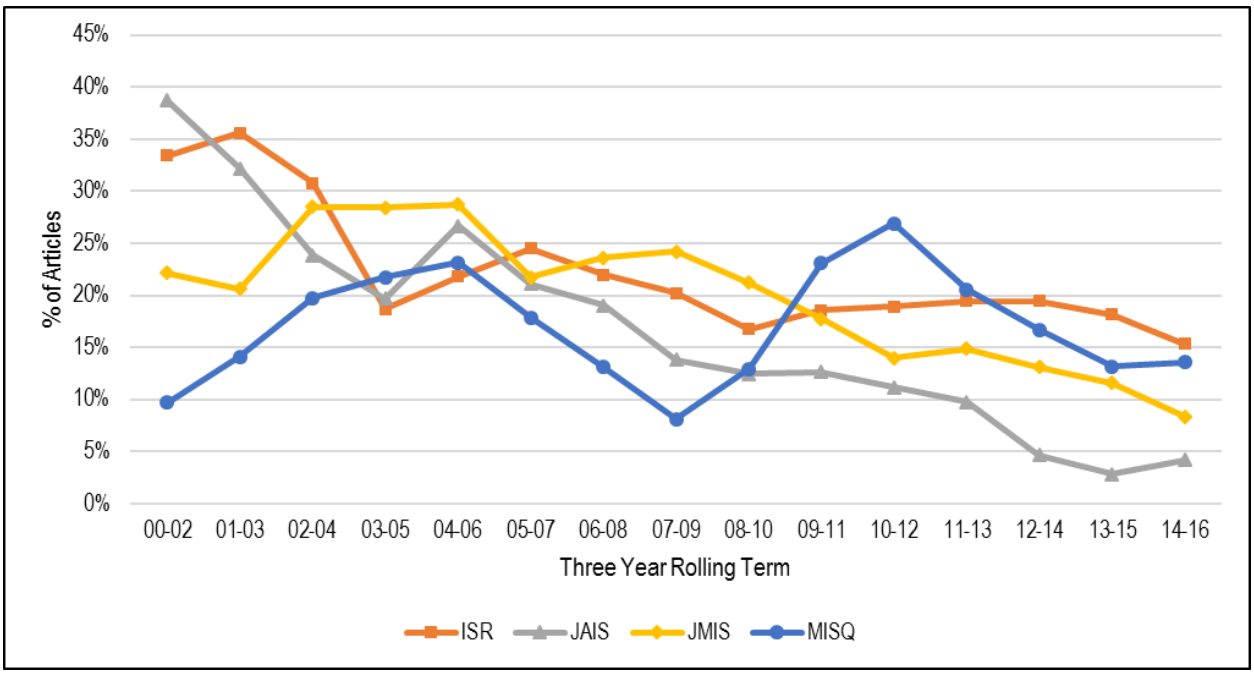

Figure B4. Three Year Rolling Averages of Publications on E-Commerce

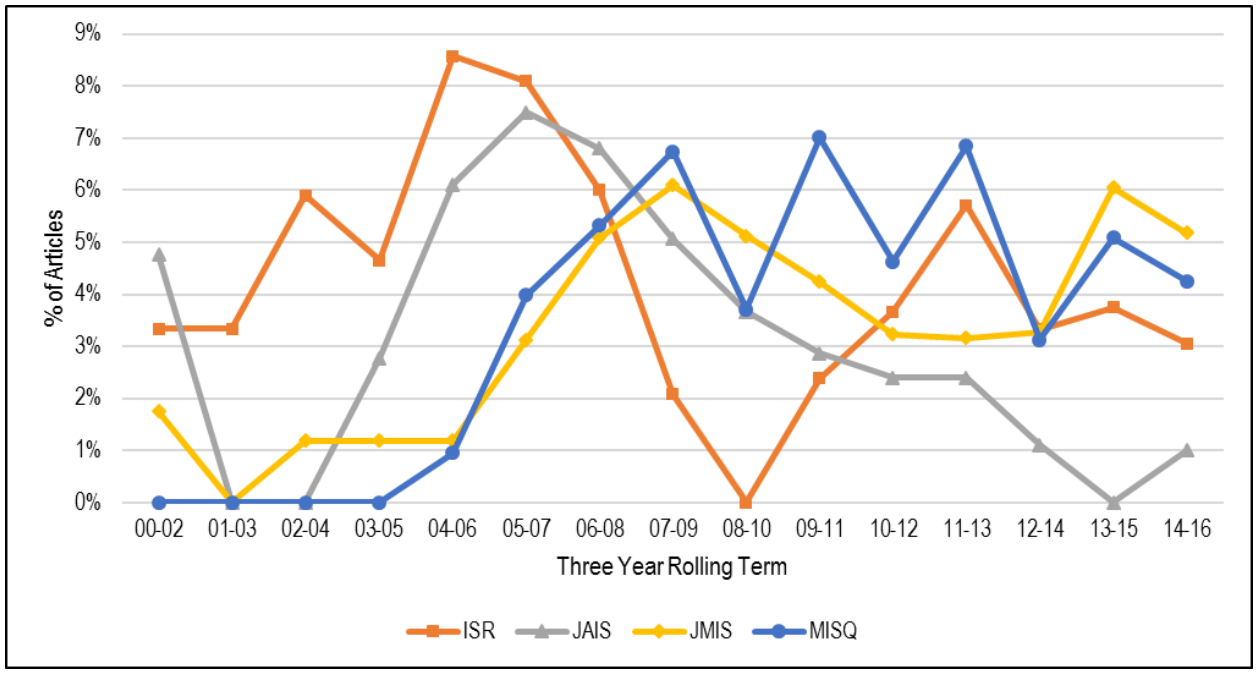

Figure B5. Three Year Rolling Averages of Publications on Privacy

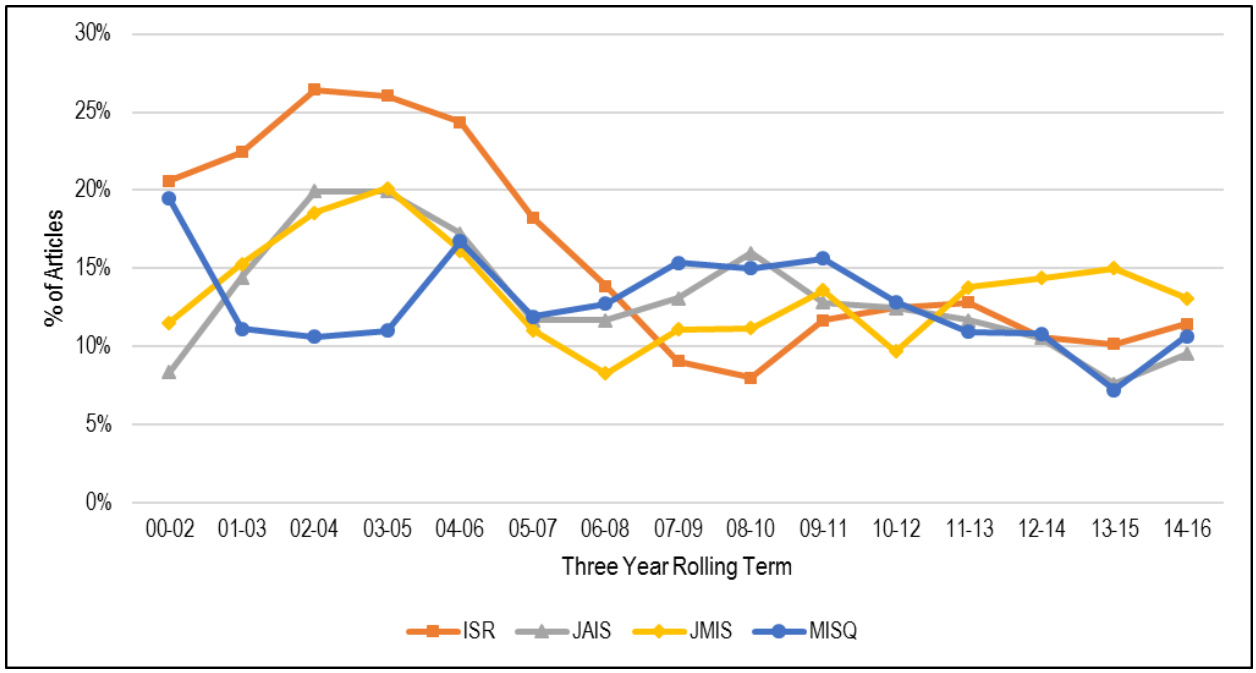

Figure B6. Three Year Rolling Averages of Publications on Recommender Systems

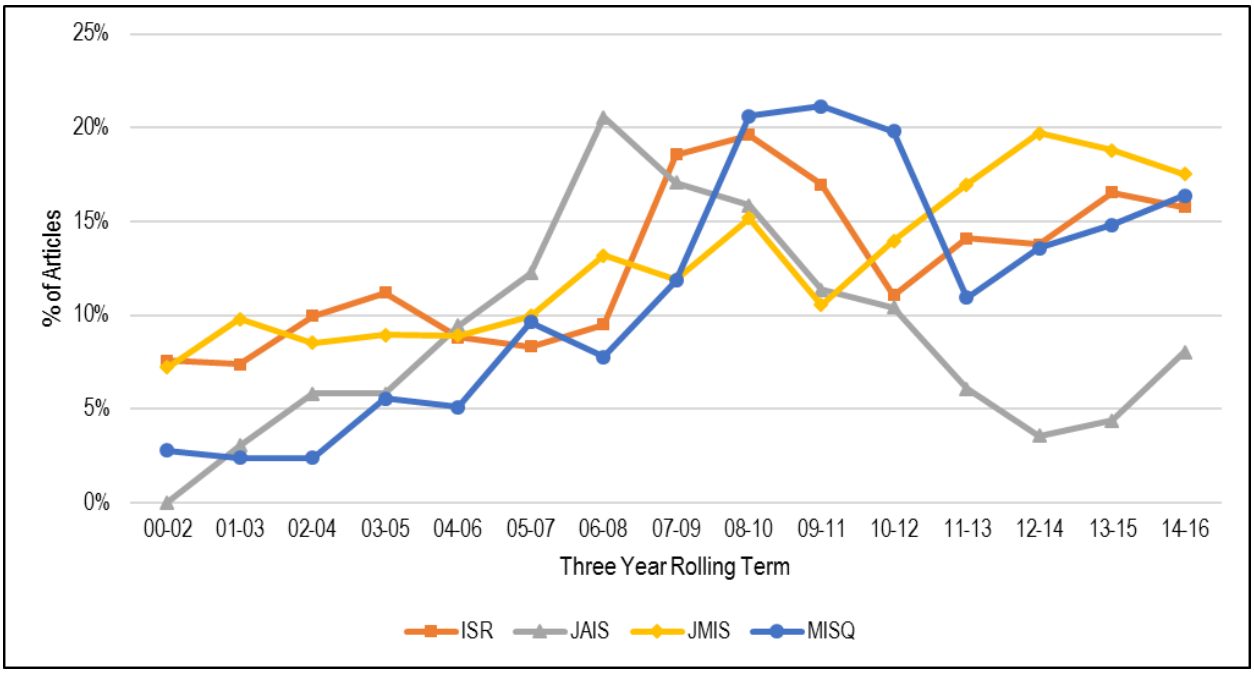

Figure B7. Three Year Rolling Averages of Publications on IT Security

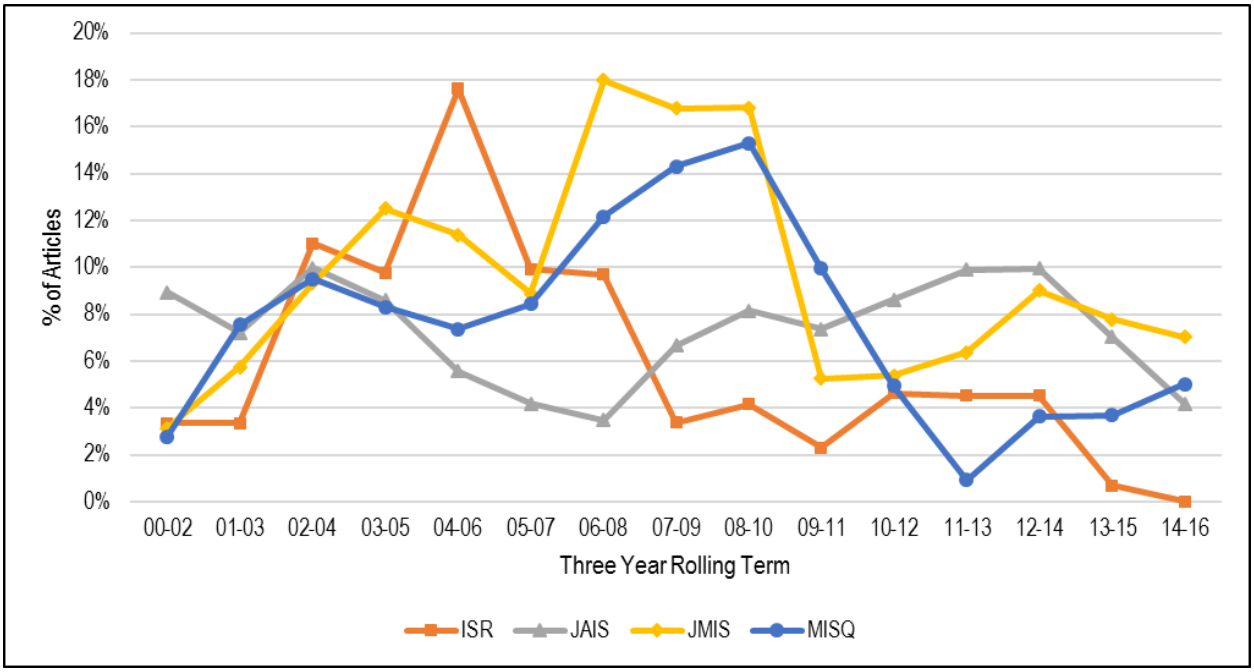

Figure B8. Three Year Rolling Averages of Publications on Trust

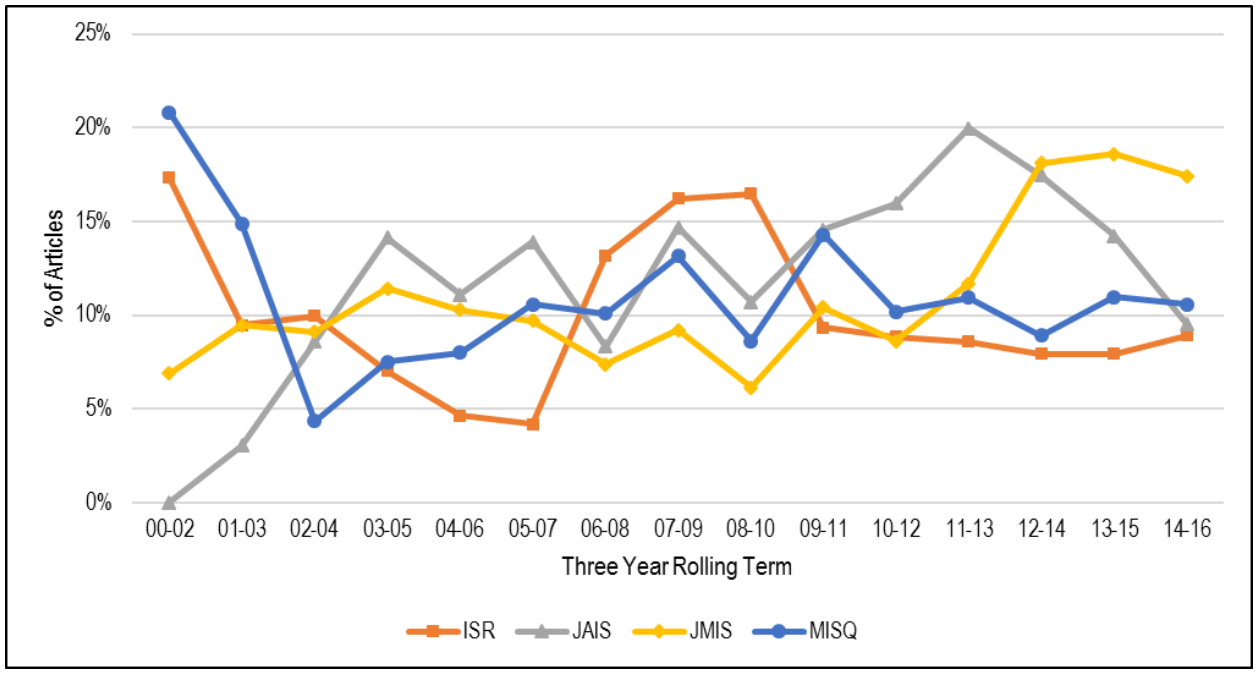

Figure B9. Three Year Rolling Averages of Publications on Virtual World

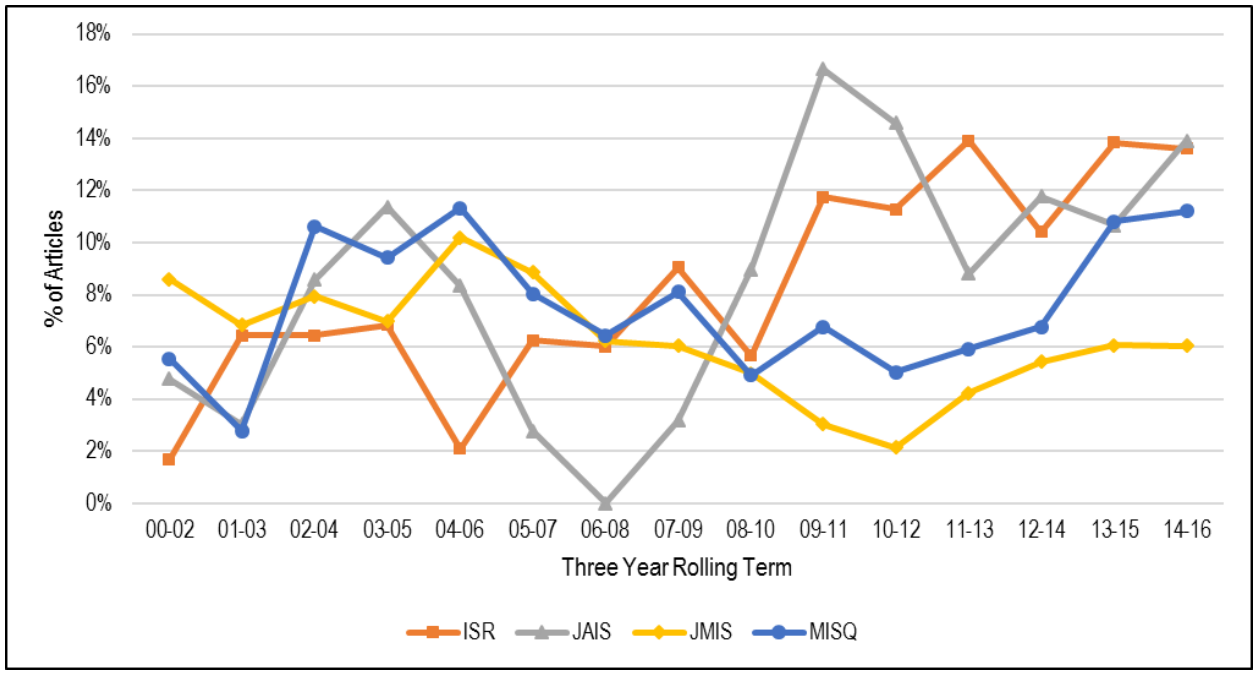

Figure 20. Three Year Rolling Averages of Publications on Healthcare IT

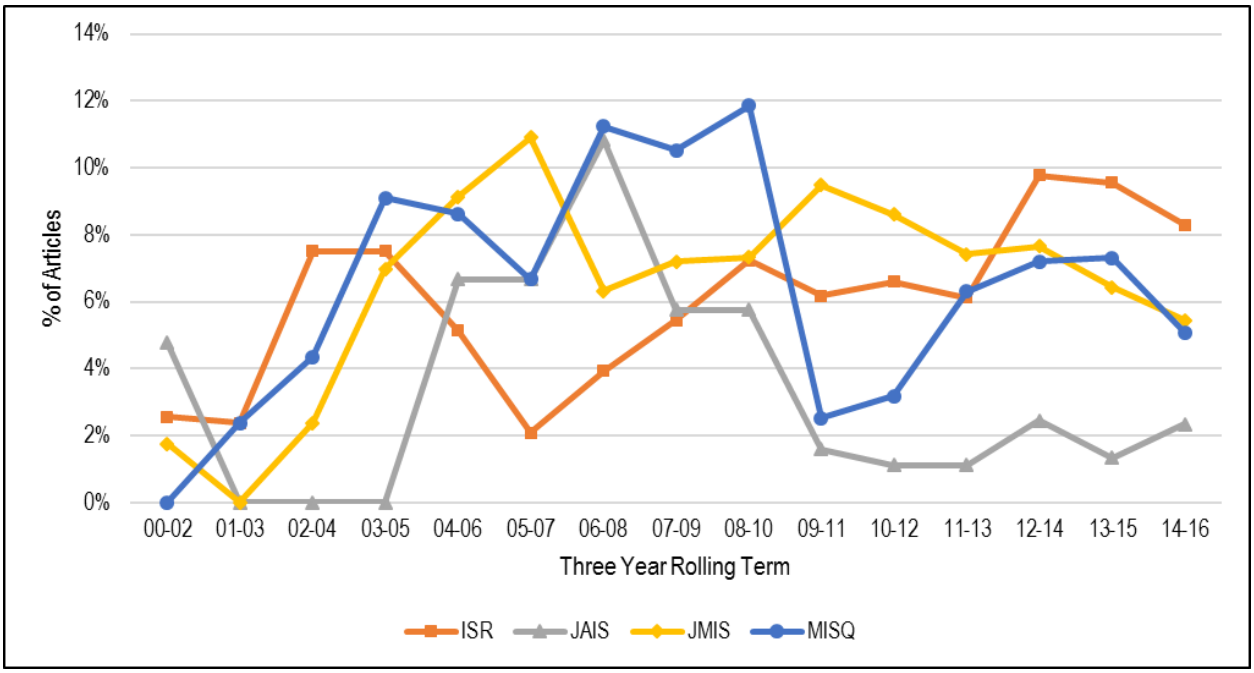

Figure 31. Three Year Rolling Averages of Publications on IT Outsourcing

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