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# Theories Used in Information Systems Research: Identifying Theory Networks in Leading IS Journals

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# THEORIES USED IN INFORMATION SYSTEMS RESEARCH: IDENTIFYING THEORY NETWORKS IN LEADING IS JOURNALS

*Research-in-Progress*

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## **Abstract**

*Though use of theory is critical in Information Systems (IS) research, the theoretical foundations of IS research have been understudied. Using Social Network Analysis, we analyze theory usage in IS research published in MIS Quarterly and Information Systems Research from 1998 to 2006. We find Technology Acceptance Model, Resource-Based View and Game Theory to be the three most frequently used theories. While strong dominance is found in research focusing on Information Technology (IT) for individuals, organizations and markets, no theoretical dominance is found in IT for groups and IS development. Psychology, Economics and Sociology are disciplines IS researchers most frequently leverage for theories. Psychology contributes several theories representing a large fraction of the long tail of theories. Our analysis suggests that IS consists of a few distinctive clusters of research instead of a single core. Our results provide insights on theoretical foundations of IS and suggest research opportunities for scholars.*

**Keywords:** IS theory, Social network analysis, originating disciplines, IS identity, IS Research issues, Structure of IS Discipline

## Introduction

The scope of Information Systems (IS) research has become focal in recent times (Agarwal and Lucas 2005). IS research was built upon the use of theories (Gregor 2006), many of which are drawn from other disciplines. IS researchers strive for strong theoretical contributions (Lee 2001) and top IS journals call for researchers to ground their work in theory. It is thus important to explore several theory related questions about IS research. While prior research has attempted to map our field using various criteria such as research streams (Banker and Kauffman 2004; Sidorova et al. 2008), co-citations (Culnan 1987) and executive perceptions (Claver et al 2000; Niederman et al. 1991), study of the use of theories in the field of IS, with a few notable exceptions (e.g. Gregor 2006, Lee et al. 2004), has been scant to our knowledge. This study aims to address this gap by using Social Network Analysis (SNA) to understand the theoretical foundations of IS research. We examine the following questions:

- RQ 1) Which have been the dominant theories in IS research?
- RQ 2) Which theories have been dominant within specific streams of IS research?
- RQ 3) How has the use of theories in IS research evolved over time?
- RQ 4) From which disciplines do IS researchers draw theory? How has this changed over time?

## Literature Review

Prior IS research analyzing the field's development has focused on a range of issues, including identification of the new field (Culnan 1987), development of conceptual frameworks (Nolan and Wetherbe 1980), and examination of the diversity of IS research (Benbasat and Weber 1996, Robey 1996). Regarding theory, Orlikowski and Iacono (2001) argued that IS research is under-theorized. These and other debates motivated study of how IS research could build on its strengths and learn from its weaknesses. Palvia et al. (1996) summarized previous meta-analyses to synthesize the research focus of and industry perception about IS. Claver et al. (2000) inferred that IS development studies were declining with focus shifting to IS management areas. Recently, Banker and Kauffman (2004) surveyed the evolution of IS research in *Management Science* over the last 50 years. Clark et al. (2007) examined IS research based on research institutes rather than research topics in the field. Sidorova et al. (2008) studied the intellectual core of the IS field from the viewpoint of organizational identities.

However, despite emphasis on theory usage in IS research, few studies have analyzed the theoretical foundations of IS research. Gregor (2006) examined the structural nature of theory in IS and proposed a taxonomy to classify theories. Markus and Robey (1988) suggested a meta-theoretical framework to structurally examine theories and promote their development. Polites and Watson (2009) investigated journals from IS and allied fields, finding that IS is still a net receiver of information from allied disciplines as opposed to a net provider. Lee et al. (2004) examined the scope of IS based on frameworks adopted by articles. Despite such studies, there is a knowledge deficiency regarding theories used in IS research. In this paper, we explore published research from two premier IS journals and use social network analysis (SNA) to analyze theoretical foundations and influential disciplines in IS research.

## Research Methodology

### *Selection of Articles and Identification of Theories*

We selected papers published in *Information Systems Research* (ISR) and *MIS Quarterly* (MISQ) from 1998 to 2006. These two journals are widely accepted as the top journals in the field and have published prior studies on theory in IS research (Gregor 2006, Sidorova et al. 2008). We considered the 9-year period to be comprehensive enough to serve as a representative sample of recent IS research and to capture variation in theory use. This period enabled us to map the articles to research streams identified by Sidorova et al. (2008), referred to hereafter as 'SEVR (2008)', thus allowing us to examine the theories dominant within specific streams of IS research (RQ2).

Each of three authors identified theories used in papers in both journals during three of the nine years. We excluded all research commentaries and editors' comments. First, an electronic search for preliminary identification of theoretical references in a paper was conducted to find the keyword 'theo'. Electronic search is used to minimize human error. Then, specific perusal of the theory sections of the paper was done to identify theoretical foundations. We then verified that the article used the theory for an argument and did not just mention it in passing or as part of a literature review. We did not consider any frameworks used by authors as theoretical bases. For example, we did not

consider 'Strategic Grid Framework' and 'Toulmin's model of argumentation' to be theories. This is in line with Cushing (1990), who distinguished frameworks from theory as separate steps in a program of scientific research. We also dropped theories which we deemed to be too broad or vague. For example, Resource Based View (RBV) is an unambiguous theory while Goal-Sharing Theory was deemed ambiguous and Organization Theory is too broad. As a validity check, the above steps were independently repeated by another author. Any discrepancies were settled through discussion among the authors. Table 1 summarizes our approach to identify the theories.

**Table 1: Theory Identification Methodology**

Step#	Activity	Description
1	Select	Select MISQ and ISR articles from 1998-2006
2	Filter	Drop Commentaries and Editorial Notes
3	Search	Electronic Search for words beginning with 'Theo'
4	Peruse	Peruse the article to ensure it used the theory. Do not consider theories too broad or too vague and exclude frameworks
5	Confirm	A different author repeats steps 3 and 4 for each article
6	Resolve	Differences resolved by discussion among the 3 authors

In addition, we conducted an exploratory analysis of inter-rater reliability with 10 doctoral students (raters) from areas including IS, Strategy, Marketing, Business Economics and Management & Organizations to judge the reliability of our process of theory identification. Inter-rater reliability was assessed using the Fleiss kappa statistic (Fleiss 1971) since our categories are nominal. The calculation of the Fleiss kappa Statistic requires that each paper be placed in a single category. We randomly selected 20 papers<sup>1</sup> from our sample (16 using 1 theory; 4 using no theory) and distributed them so that each rater assessed 6 papers. Thus each paper was analyzed by 3 different raters. The Fleiss Kappa statistic was 0.765 which falls in the range described as “substantial strength of agreement” (Landis and Koch 1977, pg. 165). In sum, though our identification of theories is imperfect, our methodology and inter-rater reliability analysis suggest that we can be confident in the validity and reliability of our results.

### *Identification of Originating Discipline of Theories*

IS research draws from various reference disciplines (Westin et al. 1994). One goal of this paper is to study how IS researchers draw theories from across disciplines (RQ4). This entails tracing theories used in IS research to their originating discipline. Since we did not find a formal guideline in the literature to identify originating discipline, we adopted the following approach. The textual content and the References section of each paper were used to identify the reference disciplines. A short list of possible reference disciplines for each paper was prepared when the foundations appeared to belong to more than one discipline. We then used multiple sources of scholarly information including Business Source Complete, Google Scholar, York University Website<sup>2</sup>, to trace the origins of each theory. All such sources were utilized until the list of potential disciplines was narrowed down. We conducted further analysis to deduce the origins of each theory by examining prior studies related to it. In the majority of the cases, the originating work could be unambiguously identified. For example, Theory of Self-efficacy (Bandura 1978) could be unambiguously traced to Psychology. A final check was conducted against the paper content to determine the originating discipline for each theory. All results were then validated by an author other than the initial evaluator. This improved the validity and authenticity of the data before further analysis. Some theories deemed to be originating from multiple disciplines were fitted into a discipline based on the context in the paper and a discussion among the authors. We acknowledge that tracing theories to their originating disciplines may be subjective in some cases. For example, it can be argued that RBV originated in the field of Strategic Management (Barney 1991) whereas, some may argue that RBV originated in Economics based on the concept of resources (Penrose 1959). Still, a very high proportion of theories in our dataset can be unambiguously traced to their originating discipline. We will work with other researchers to cross-validate the findings in future research.

<sup>1</sup> Future work will include a comprehensive test of inter-rater reliability with all the papers in our sample.

<sup>2</sup> Theories used in IS Research Wiki, York University, online, [http://www.fsc.yorku.ca/york/istheory/wiki/index.php/Main\\_Page](http://www.fsc.yorku.ca/york/istheory/wiki/index.php/Main_Page)

## ***Analysis Technique***

We used SNA to address our research questions. SNA is apt for our purpose as it enables us to observe and identify clusters of articles and theories based on their shared commonalities with other articles and theories. Such patterns are not identifiable using other methods, such as co-citation analysis and the Delphi method<sup>3</sup>. Additionally, to our best knowledge, no study has used SNA for the purpose of structuring the reference disciplines in the IS field.

A representation of the article and theory data would be a 'usage' network where edges representing usage of theories connect an article to a theory it uses<sup>4</sup>. This network can be projected to a network of articles as nodes (article network). Articles are connected if they have at least one theory in common. In other words, if two articles use the same theory, they are connected by a link. We examine important and commonly analyzed properties of social networks: a) scale-free structure, b) small-world properties, and c) community structures of the article network. First, a network exhibits a scale-free structure if a new edge from a new node attaches to existing nodes with the probability proportional to the degree of the existing nodes (i.e. a node with high degree has higher probability to get a new edge) as the network expands. Second, the 'small-world' phenomenon refers to the case when we can find a relatively short chain of acquaintances to reach a stranger. The small world is formally characterized by a relatively short "average shortest path" length between nodes and by a relatively high degree of clustering (Watts and Strogatz 1998). Shortest path length between two nodes is the minimum number of edges which a node has to pass to get to the other node. Clustering measures the likelihood for the neighbors of a node to be connected to each other (Watts and Strogatz 1998). The 'relatively short path length' and 'relatively high degree of clustering' are determined by comparing the real network to a random graph with the same number of nodes and edges. We used the most extensively used algorithm for generating random networks suggested by Edros and Renyi (1961). Finally, a community is a densely connected sub-network in a network. We used edge-betweenness algorithm (Newman and Girvan 2004), which is widely used in network analysis, to find community structures in the article network. iGraph packages in R and Guess were utilized for analysis and visualization respectively.

## **Sample Descriptives**

We identified 386 research articles (MISQ: 202, ISR: 184) from 1998 to 2006. Among them, 269 (70%) articles employed at least one theory (MISQ: 145, ISR 124). To address RQ2, we use the results of SEVR (2008) which used Latent Semantic Analysis to identify papers belonging to streams of IS research. Using a published classification ensures validity and objectivity in our analysis. According to the SEVR (2008) classification, 85 articles do not fall clearly within an IS stream; no theory could be identified for 28 of these articles. Regarding the other articles, 82 articles fall under the IT and Organization (ITO) stream out of which no theory could be identified for 22 articles; 52 articles fall under IS Development (ISD) stream out of which no theory could be identified for 33 articles; 74 articles fall under the IT and Individuals (ITI) stream out of which no theory could be identified for 16 articles; 54 articles fall under the IT and Markets (ITM) stream out of which no theory could be identified for 13 articles; 39 articles fall under the IT and Groups (ITG) stream out of which no theory could be identified for 5 articles. Except for ISD, 70% or more articles in each stream use at least one theory. One explanation of less use of identifiable theory in ISD would be that articles in this stream used frameworks, not theory. Rather than implying a lack of scientific rigor, it may indicate the development stage of the stream.

We identified 154 distinct theories by originating discipline employed in the journal articles. Among these, the top 10 widely used theories accounted for 90% of the total usage. 88 theories (57% of total) are used only once, thereby making the distribution of usage of theories exhibit a long tail, as displayed in Figure 1. Theories from Psychology and Sociology account for 32% and 17%, respectively, of the total. Economics and Organizational Science with 11% each also are prominent. Throughout this paper, we define usage of a discipline to be the number of theories from that discipline used in an article. For example, if an article uses RBV and Dynamic Capabilities (both from

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<sup>3</sup> Co-citation analysis or Delphi method have limitations in that co-citation restricts the range of the study and Delphi method relies on experts' opinions, not objective data. Moreover, these methodologies have been used previously to structure our discipline (Culnan 1987).

<sup>4</sup> This usage network is a type of bipartite network in graph theory; this network has two types of vertices - articles and theories. In network research, a bipartite network is projected to one-mode network for analysis in many cases.

Strategy), we categorized the article as using 2 theories from Strategy.

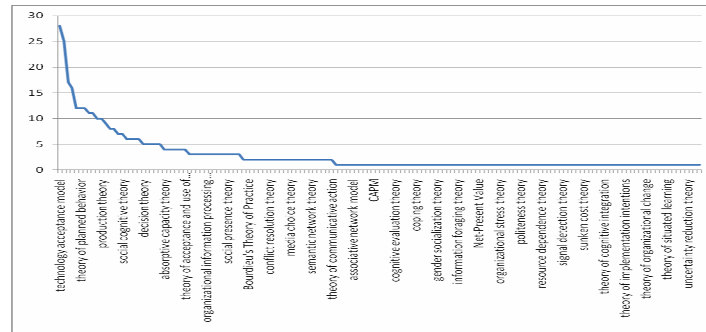


Figure 1: Number of Articles using Theory – Long-Tail Phenomenon

## Analysis and Results

### Analyzing Theories/Disciplines over Time (RQ1, RQ3, RQ4)

Figure 2 displays the 10 most dominant theories in IS research aggregated over the study period 1998-2006. The depiction segregated the analysis into three 3-year time periods to show the progression of usage of these theories over time and to understand the usage at a more granular level. It can be seen that Game Theory and RBV gained prominence over time. Technology Acceptance Model (TAM) (Davis et al. 1989) appears as the most frequently used theory in IS in 2 periods ('98-00 and '01-03).

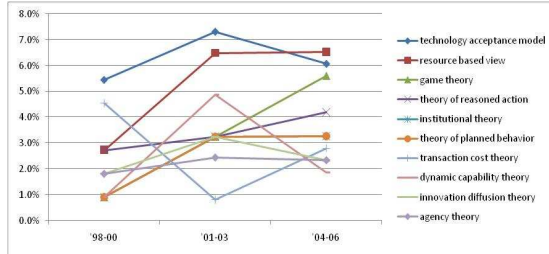


Figure 2: Usage of Theories over Time

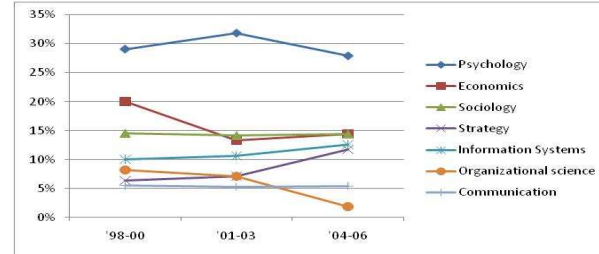


Figure 3: Influential Originating Disciplines over Time

As seen in Figure 3, Psychology theories clearly dominate IS research while Sociology and Economics come a close second and third respectively. Psychology and Sociology together account for about 45% of theory use during 1998-2000 and 2001-2003. The share of the disciplines remains fairly constant over time except for Economics and Organizational Science dropping in 2001-03 and 2004-06 respectively. IS constitutes 10-15% of theory use throughout. Interestingly, while Psychology dominates the usage of theories as a discipline (Figure 3), none of the Psychology theories are among the 5 most used theories aggregated over the period of the study (Figure 2).

### Analyzing Theories/Disciplines by Streams (RQ2)

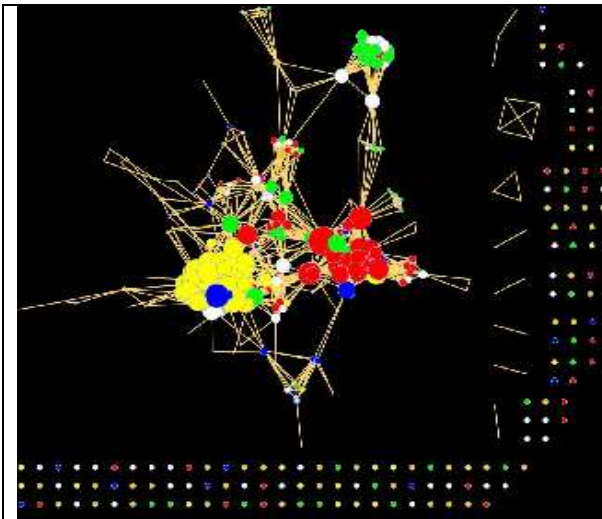
We next examine the use of theories in different streams of IS research (RQ2). For our analysis, we use the streams identified by SEVR (2008) to map each article to its stream. We observe that these findings are on expected lines and the theories used in each stream are diverse. For example, we find high usage of RBV in ITO stream. Also ITO and ITI have clear theory dominants. We see no dominant theories in two streams i.e. ISD and ITG. It can also be seen that usage of theories is thin in these two groups. Similarly, mapping originating disciplines against streams provided interesting insights, though not unexpected. Psychology, which is more pertinent to individuals and groups,

also ranks higher in the corresponding research stream (ITG). The theories from IS find a comparatively higher place in the ISD Stream. Table 2 below shows the top 5 theories that dominate each research stream.

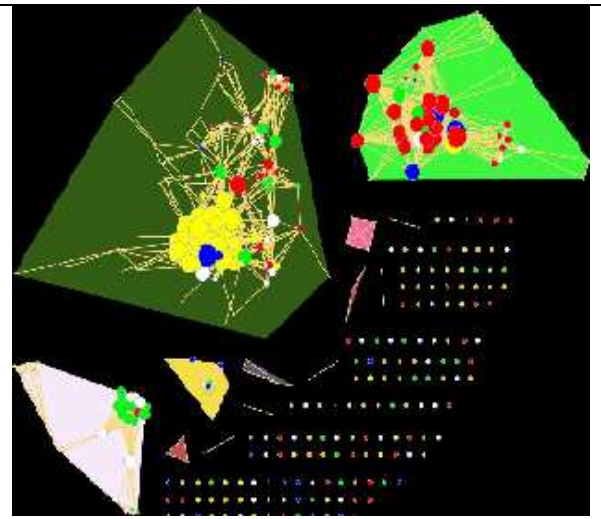
**Table 2: Five most frequently used theories in each IT stream**

ITO	#	%	ISD	#	%	ITI	#	%	ITM	#	%	ITG	#	%
Resource Based View	17	17	Cognitive Fit	3	13	Technology Acceptance Model	25	20	Game Theory	10	17	Media Richness Theory	5	8
Dynamic Capabilities	7	7	Decision Theory	3	13	Theory of Reasoned Action	11	9	Transaction Cost Theory	5	9	Resource Based View	3	5
Org. Learning Theory	7	7	Activity Theory	1	4	Innovation Diffusion Theory	9	7	Theory of Network Externalities	4	7	Social Presence Theory	3	5
Transaction Cost Theory	5	5	Agency Theory	1	4	Theory of Planned Behavior	9	7	Options Theory	4	7	Channel Expansion Theory	2	3
Absorptive Capacity	4	4	Theory of Practice	1	4	Social Cognitive Theory	6	5	Production Theory	4	7	Media Choice Theory	2	3
Others	58	58	Others	15	63	Others	63	51	Others	31	53	Others	49	77

### Analyzing Article Networks<sup>5</sup>



**Figure 4: Visualization of Article Network**



**Figure 5: Community Structure in Article Network**

*Note: The classification is based on SEVR (2008): Red - 'ITO'; Orange- 'ISD'; Yellow - 'ITI'; Green - 'ITM'; Blue - 'ITG'; White - Not categorized*

The article network (in Figure 4) contains 386 nodes (articles) and 1590 edges that indicate use of the same theory by two articles. The size of each node is proportional to the number of connected edges and the width of each edge indicates the number of papers that two articles share. A large node thus indicates that it uses popular theories. For papers loading on multiple factors in SEVR (2008) classification, we considered (for simplicity) only the highest loading. The color scheme, representing the streams defined by SEVR (2008), enables analysis of variation in theory usage in different streams. Most articles are connected via one or more theories, forming a giant component which contains 215 articles (53% of total nodes). In cases where theories are shared by two articles, 95% of them share only one theory. We identified six articles which shared three theories. The large ITO and ITI nodes indicate the popularity of theories used, implying that researchers in these streams share a set of theories and use them heavily. The size of most nodes in ITG, ITM, and ISD is small, indicating a fragmented use of theories in these streams.

We explore the article network for two properties which are extensively examined in network research: scale-free

<sup>5</sup> We have also analyzed the theory networks. Inferences complied with that from the article networks and results are available upon request

and small-world. Our analysis reveals that the network exhibits a scale-free structure, suggesting that a well-used theory becomes even more used as the field develops. This is consistent with our expectation, because new articles build on prior work. New articles enter the article network with a tendency to be connected to already well-connected articles (by theories), creating clusters with few hubs. Next, a comparison between the article network and a random network fails to reveal evidence of a small world. Though the clustering coefficient is substantially high (0.72 compared to 0.02 of the random network), the average shortest path length of the real network is 3.08, which is similar to 3.03 of the random network. The high clustering coefficient and long average shortest path suggest that though there are cohesive research sub-groups within which researchers apply a similar set of theories, few researchers adopt theories across groups. This fails to shorten the distance between the groups. Due to this lack of connection across groups, the article network is not a small world and might be seen as disconnected, raising concerns of a lack of distinctive intellectual core in IS (Benbasat and Zmud 2003). Our finding suggests that IS field consists of a few distinctive clusters of research instead of a single core, a view consistent with SEVR (2008).

To examine the cluster structures in depth and compare them to the SEVR (2008) classification, we used edge-betweenness algorithm on the article network. The communities were first identified independent of SEVR (2008) classification and then colored based on SEVR (2008) classification. Figure 5 shows the identified community structure in the article network. We identified 3 communities, which are dominated by yellow (ITI), red (ITO), and green (ITM) nodes, respectively. First, the result of community formation matches closely with the SEVR (2008) classification and is a validity check for our work. We find relatively large (more than 4 papers sharing a common theory) clusters for 3 out of the 5 streams identified by SEVR (2008). This suggests that IS researchers in these 3 streams draw from dominant theories in these streams. Second, ITG and ISD (unlike ITO, ITI, and ITM) are not identified as having their own communities, which might indicate that a strong theoretical base has not yet evolved in these streams. The isolated nodes are predominantly blue (ITG) and orange (ISD), suggesting the diversity of theories in these fields. We infer that research in ITG, for example, draws from a variety of Psychology theories. This is in contrast to papers in the other 3 streams which tend to locate close to other clusters or clusters dominated by papers in their own streams. Third, in three communities, we find articles which may be exceptions. We find that they used theories common in other streams. For example, Nicolaou and McKnight (2006) is the large blue node in the yellow community. This study uses TAM and Theory of Reasoned Action, two of the most popular theories in the ITI stream. This article loaded on two factors in SEVR (2008). Though it appears to be an anomaly in the community, it reflects that the article could not be unambiguously classified into a single stream by SEVR (2008).

## **Discussion and Implications**

First, the consistent and not insignificant use of IS theories may indicate that IS does have and employ its own theories. The dominance of Psychology theories is consistent with the increasing emphasis on the social context of IS (SEVR 2008). But disciplines like Strategy and Economics are prominent with theories such as RBV and Game Theory widely used in IS. We unequivocally find a 'long tail' of theory usage. Second, ITO and ITI suggest the presence of a strong theoretical core forming dense cohorts of research. One may argue that cohorts make usage of new theories in these streams rarer or theory usage in these streams is maturing. Third, we find an apparent lack of use of theories in ISD. It may be because ISD is less popular in recent IS research (SEVR 2008) or that the maturity of theory use in this stream is evolving. Alternatively, ISD research might be getting published in other journals. Still, the relatively lower use of theories in the ISD stream is consistent with the argument that computing disciplines have a different philosophical approach to the use of theory as it is more technically oriented than conventional IS research and focuses more on developing artifacts (Glass et al. 2004, Lee et al. 2004). This suggests that reviewers and journal editors be aware of these differences when assessing the scientific validity of design science articles, as suggested by others (Gregor 2006). Fourth, the small-world implies that despite having some research communities, IS research may be disconnected in theory usage (due to lower commonality across groups). Finally, our findings of theory usage map closely with prior research (SEVR 2008) that used a different approach to map the field.

We next discuss the main contributions of this research. First, this study provides insight into trends of theory usage in IS and should be valuable to new and experienced researchers alike. Second, it highlights theories used in specific IS streams and can be useful to researchers seeking to identify a theoretical basis for their arguments. Third, we identify areas in IS which are theoretical 'holes', for example, ITG and ISD. The long tail of theory usage is an opportunity for researchers to identify theories which are sparsely used but still valuable. Researchers may observe the theories adopted in their IS area and may evaluate how their own work differs from other scholars. Journal editors may use our paper to help identify theory in submissions. Fourth, our analysis identified cross-disciplinary



foundations of IS research. This may facilitate crossovers between IS and other areas and enable experts in other areas to identify sources of cross-pollination of ideas between IS and their own. Finally, our analysis may help point out when a theory has reached saturation or is waning as a subject of study. In sum, as stronger theory can result from combining different theories (Gregor 2006), researchers can explore combining their own theory with others.

Studying theoretical foundations enables IS scholars to appreciate the diversity in the field, understand the current landscape and how they want it to evolve including an opportunity to position one's own research. A comparative look into the theoretical foundations can also help track IS research evolution in the future against the emerging theories in other areas to see opportunities for cross-pollination. Finally, research into the foundations of a field can work as a screen or magnet for future research (Nag et al. 2007). Based on the current diversity, future work can use our research as a filter to check if it aligns with the theoretical nature of the IS field or a magnet to attract interest and theories from other disciplines to change the shape of the field. Nag et al. (2007, pg. 951) suggest that one of the "distinctive competences of the field might be its ability to broker, reconcile and integrate the works of other fields".

## Limitations and Future Research

Despite our attention to detail in identifying theory and analyzing the resulting article and theory data, our work is not without limitations. First, there may be concerns over the classification and identification of theories and reference disciplines. We tried to minimize subjectivity by adopting a consistent procedure and by employing cross-checks among the authors. Our findings concerning the top 5 disciplines in each stream provided face validity to our classification of theories to disciplines. The pilot study on inter-rater reliability further enhanced the validity of our findings, though a complete inter-rater reliability study of our entire sample is a subject of future work. Second, we dropped theories which could not be clearly or unanimously classified into disciplines. Though this might result in some bias, we believe it does not significantly influence our results. Third, our approach to consider papers which used frameworks to be using 'No theory' (in line with the Cushing 1990) may be considered a limitation.

Future research can include more journals to see commonalities and differences in IS research or to see how results emerge across an extended set. We broadly classified the sub-disciplines under one umbrella. For example, social psychology and cognitive psychology were classified as 'Psychology'. This could be a reason we found TAM to be the most frequently used theory in Psychology. Future research may consider more granular classification. Though we used popular hierarchical clustering and edge-betweenness algorithms to detect communities, removing nodes of highest betweenness instead of edges could be more effective. In future, customized algorithms can be developed. Our study can be replicated in other academic fields to find if IS is different from other fields in using theories from outside disciplines. It also provokes a question: "Will our long tail observation hold in other disciplines?" Future researchers can also use other techniques like the Delphi technique to identify patterns in theory usage. For example, causal patterns governing theory usage may be indicative of a discipline-based culture (Nicolaisen 2007).

## Conclusion

Our work adds support to past evidence of diversity (Robey 1996) in IS research. It also yields evidence about dominance of robust IS theories like TAM. While diversity may foster creativity and attract researchers from other disciplines, it also highlights an important fact that IS research is not conducted in isolation but is widely connected with the broader world. The multi-dimensional relationships in our network analysis show the relatedness, focal areas and influential contributions in IS research. Our paper maps the IS research topology and can help researchers as a primer about foundations and relationships within and beyond the field and where to position their own research. In sum, our analysis informs insiders and outsiders regarding the theoretical foundations of IS research.

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