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Information Systems' Cumulative Research Tradition: A Review of Research Activities and Outputs Using Pro forma Abstracts

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ABSTRACT

This study mapped 947 articles published in top information systems (IS) journals over the period 1998-2002 into an updated version of March and Smith's taxonomy of IS research activities and outputs using Newman's method of pro forma abstracting. The results show that publishing in many of these journals is almost exclusively limited to the behavioral science paradigm of theorizing and justifying. Design science research, research that builds and evaluates systems, is negligible. These results suggest that an increase in design science research is needed to advance IS cumulative research because building and evaluating systems provides unique feedback that advances those ideas that are the most promising in practice.

Keywords

IS cumulative research tradition; IS research activities and outputs; research taxonomy; classification methodology.

INTRODUCTION

More than two decades ago, Keen (1980) challenged IS researchers to seek to move the field forward by developing a cumulative research tradition. Since then, several researchers have considered IS's progress toward this goal (Weber, 1987; Banville and Landry, 1989; Benbasat and Weber, 1996; Weber, 1999). Vessey, Ramesh and Glass (2002, pp. 166-67) suggest that a cumulative research tradition has not yet been achieved because of a lack of focus on <u>theory</u>, "[o]ur data leads us to the conclusion that IS research does not demonstrate reliance on a single theory, or a set of theories, even in what we may regard as well-defined subareas of the discipline." Also concluding that there is a lack of cumulative research tradition in IS, Benbasat and Zmud (2003), however, argued that this is a result of a failure to focus on the <u>artifact</u>.

In contrast, others have concluded that IS has made much progress in developing a research tradition. Baskerville and Myers (2002, p. 3) for example, state, "[i]t is our opinion that IS has been singularly successful in developing its own research perspective and its own tradition." Likewise, Culnan (1987, p. 341) states that IS has "made significant progress toward a cumulative research tradition."

The state of IS cumulative research remains unclear. One reason for this confusion may be a lack of balance between artifact design research, building and evaluating systems, and behavioral science research, theorizing and justifying systems. Others recognize the need for both types of research (Lee, 1991; March and Smith, 1995; Newman, 1994; Simon, 1996; Walls, Widmeyer, and El Sawy, 1992; Hevner, March, Park and Ram, 2004).

Appreciating where the field of IS is in its journey of developing a cumulative research tradition requires mapping the content of individual contributions onto a collective scheme. In this regard, March and Smith (1995) propose an integrative, comprehensive classification taxonomy for organizing IS research. To map publications into this taxonomy requires some instrument for making the classification assignment. Newman (1994) provides such an instrument. Pro forma abstracts are frames into which the results of specific research are "slotted" according to the research method utilized and research product generated.

Using Newman's method of pro forma abstracting, the research reported here mapped 947 articles published in top IS journals over the period 1998-2002 into an updated version of March and Smith's (1995) taxonomy. Specifically, each paper was read and its pro forma abstract was used to map the article onto the taxonomy. The results provide a view of cumulative research in IS over the five years studied. The publishing tendencies of IS journals and the need for a more balanced distribution of design science and behavioral science research are discussed.

BACKGROUND

Vessey et al. (2002) described the article by Alavi, Carlson, and Brooke (1989) as the main work that really sought to study cumulative research tradition in IS. In Alavi et al. (1989), two schemes were used to classify published IS articles: the Barki-Rivard-Talbot (1988) scheme and a binary classification based on the nature of the methodology: empirical and non-empirical. Consisting of nine top-level categories, each with several subcategories, the Barki-Rivard-Talbot scheme was used to classify IS publications into topic areas. Alavi et al. (1989) show that the three most popular research topic areas are: (1) IS management (including IS evaluation, planning and management); (2) Information Systems (including types of information systems, IS application areas and IS characteristics); and (3) IS development and operations (including IS life cycle activities, IS development strategies, and IS implementation). They also reported that about 46.5% of the articles published between 1968 and 1988 were empirical and concluded that "the field has taken major steps towards establishing a cumulative tradition of research necessary for providing scientific and valid guidelines for practice and research" (p.398).

Baskerville and Myers (2002) point out that discussions regarding proper reference disciplines discourage IS from standing on its own merits. They argue that IS has progressed and matured to where it need not only look to other disciplines for reference, but has developed to where it can serve as a reference discipline for other fields.

Investigating the products of HCI research, Newman (1994 p. 279, parenthetic added) stated that the "primary value (of HCI research) lies in its contributions to the practice of interactive computer systems development ... of simplifying theory into practical models, which are the tools for designers to apply the theory." Looking to engineering as a successful model, Newman found that as much as 90 percent of the engineering literature reported enhancements to and evaluations of existing techniques, solutions, and tools, what he called "normal" science; the remaining 10 percent positing new theory and concepts. Newman called this 10 percent, "radical" science.

In terms of the efficacy of Newman's pro-forma abstracting methodology, he concluded that by differentiating research products, pro forma abstracts were invaluable for categorizing publications. "Pro forma abstracts are templates, written in the style of normal abstracts, into which the results of research can be 'slotted' according to the category of method followed and research product generated" (Newman 1994, p. 279). In the research reported here, a pro forma abstract template was developed for each cell in the updated March and Smith's taxonomy.

Shown as Figure 1, March and Smith's updated taxonomy consists of two dimensions: research activity and research output. The research output dimension encompasses research output defined as: construct, model, method or instantiation of an information system. The research activities dimension is split in March and Smith's original paper (1995) into design science activities and natural science activities. Later, Hevner, March, Park and Ram (2004) relabeled natural science to behavioral science. We use the term behavioral science in the remainder of this paper to include March and Smith's "natural" science and Newman's "normal science."

The behavioral science paradigm seeks to develop and verify theories that predict and explain human and organizational capabilities by creating new and innovative artifacts, whereas in design science knowledge and understanding are advanced in the building and application of the designed artifact (Hevner, et. al. 2004). "Rather than producing general theoretical knowledge, design scientists produce and apply knowledge of tasks or situations in order to create effective artifacts" (March and Smith 1995, p. 253). While behavioral scientists seek to use theory to explain a phenomenon, design scientists make instrumental use of theory to build efficient and effective systems (Lee, 2000). March and Smith argue that their framework provides an integrative and comprehensive classification scheme for IS publications.

		Research Activities			
		Design Science		**Behavioral Science**	
		Build	Evaluate	Theorize	Justify
Research Outputs	Constructs				
	Model				
	Method				
	Instantiation				

Figure 1. Framework for classifying IS research products (adapted from March and Smith 1995 and Hevner, et al. 2004)

Beginning the description of Figure 1 with Design Science activities, "Build refers to the construction of the artifact demonstrating that such an artifact can be constructed" (March and Smith 1995, p. 254). In Evaluate, metrics or criteria are developed and used to test the artifact for the purpose it was designed. In the Behavioral Science columns, Theorize involves explaining why and how the effects came about, i.e., why and how the constructs, models, methods, and instantiations work. Theorize attempts to unify the known data into viable theory, and may involve developing constructs with which to theorize about constructs, models, methods and instantiations (March and Smith 1995, p. 262). Justify involves theory proving or theory testing. The justification process uses evidence gathered to support or refute a claim posited in a theory. Justify performs empirical and/or theoretical research to test theory (March and Smith 1995, p. 262).

Turning to the Research Output categories, "[c]onstructs or concepts form the vocabulary of a domain. They constitute a conceptualization used to describe problems within the domain and specify solutions" (March and Smith 1995, p. 256). Model is a set of propositions or statements expressing relationships among constructs. Methods define a set of steps (an algorithm or guideline) used to perform a task. "Instantiation refers to the realization of an artifact in its environment" by operationalizing constructs, models, and methods (March and Smith 1995, p. 258).

RESEARCH METHODOLOGY

Some of the earliest reviews of IS literature used bibliographic assessment, in particular citation analysis (Culnan, 1986; Culnan and Swanson, 1986). Citation analysis can show the web of reference interconnects, but it cannot categorize a publication's contribution to a field's cumulative development. The limitations of citation analysis are well documented (Osareh, 1996).

This study used Newman's pro forma abstract method to assign journal articles into March and Smith's taxonomy. One of the authors developed a pro forma abstract template for each cell of March and Smith's Taxonomy. Each of the 947 articles was then read. A through review and comparison of the content of the article to the pro forma abstracts assigned the article to one of the 16 cells in the taxonomy. Figure 2 is an example of a pro forma abstract for the Theorize/Model cell in the taxonomy. Detailed pro forma abstract templates for all cells of March and Smith's framework are presented in Appendix 1.

<New> theoretical <model> for <explaining> the <factors> that influence <the assimilation of web technologies> has been <developed>. The paper <shows> that <this model> effectively <explains assimilation of web technologies> <in the eCommerce environment> [Chatterjee et al., MISQ, 2002.]

Figure 2. Example of a Theorize Model Pro Forma Abstract

Journal Selection

Publications from six journals were selected for this research: Communications of the ACM (CACM), Decision Sciences (DS), Journal of Management Information Systems (JMIS), Information Systems Research (ISR), Management Science (MS) and MIS Quarterly (MISQ). These journals were selected because (1) all six journals are well recognized as among the top journals in the field (Larson and Neely, 2000; Vessey et al., 2002); (2) they have been used in earlier studies (Alavi et al., 1989); (3) despite their collective interests in computing, their core audiences and perspectives differ; and (4) both within and without the IS academic community, these journals are pointed to as leading outlets for quality IS research and publishing. No claim is made that publications in these journals represent the whole field of IS research and writing; however, these journals have historically been included in analyses of IS publications, and for many both within and without IS, articles in these journals serve as bellwethers of IS research and writing.

Data Collection

All IS articles for the period 1998-2002 were collected from each journal. A 5 year window was selected because it is consistent with earlier reviews of the IS literature and because it provided a large enough longitudinal timeframe to minimize aberrations in the types of research published by each journal.

All articles were collected from JMIS, ISR, and MISQ; whereas only the IS articles were gathered from CACM, DS and MS. All IS and IT articles in DS and MS were included in the sample. CACM articles were included if the IT artifact reported in the article was discussed within the context of an organizational system or organizational aspects of IS. Next, one of the authors read each article and matched it to a pro forma abstract template from the pool of 16 pro forma abstract templates discussed above. Because each pro forma abstract is distinct from the others, the researcher had little difficulty recognizing the appropriate pro forma abstract for each article. Once the article was categorized, the research activity - research output cell of the taxonomy was recorded as well as the name of the journal publishing the article, year of publication, and first author's surname.

To consider rater reliability, a second researcher independently classified articles using the same pro forma abstracts methodology. This second reader classified 5% of the sample (47 of the 947 articles). Inter-rater reliability was computed using Cohen's kappa (Cohen, 1960), which adjusts the raw agreement to account for the possibility of agreement occurring by chance. The raw agreement was 89% (42 out of the 47), resulting in a kappa calculation of 0.84. According to Landis and Koch (1977), kappa values equal to or greater than 0.81 are regarded as "almost perfect." When disagreements occurred between raters, the papers almost always included multiple research outputs and activities. For example, a paper may have included both theorizing a model and justifying a model. When this occurred, the two raters met and assigned the article to the classification coinciding with the primary focus of the paper.

RESULTS

Table 1 shows the pro forma results for the 947 articles reviewed in this study within the updated March and Smith taxonomy pooled across the journals. Raw counts and their corresponding percents, given in parentheses, are presented in each cell.

It is clear that a preponderance of IS research activity is in Behavioral Science. The data in Table 1 show that the Behavioral Science research activity of Theorize constituted 72.2 percent of all IS research activity published in the journals included in this study over the period 1998-2002, and only 2.2 percent of publishing was categorized as Justify Behavioral Science research. Table 1 also shows that Build Design Science research activity accounted for 19.8 percent of all IS research activity, and 5.8 percent of publications were Evaluate Design Science research activity.

		Research Activities			
		Design Science		**Behavioral Science**	
		Build	Evaluate	Theorize	Justify
Research Outputs	Constructs	4 (0.4)	1 (0.1)	39 (4.1)	4 (0.4)
	Model	26 (2.7)	3 (0.3)	591 (62.4)	15 (1.6)
	Method	122 (12.9)	42 (4.4)	52 (5.5)	2 (0.2)
	Instantiation	35 (3.7)	9 (1.0)	2 (0.2)	0 (0.0)
	Totals	187 (19.8)	55 (5.8)	684 (72.2)	21 (2.2)

Table 1. Classification of Articles into March and Smith's and Hevner, et al. Taxonomy Across Journals

Of particular interest is the 3.7 percent of articles classified as Build Instantiation. Concern has been expressed that these novel instantiations, "radical solutions" according to Newman, may not contribute to development of a cumulative research tradition.

> [T]here is little argument that novel constructs, models, and methods are viable research results, there is less enthusiasm in the information technology literature for novel instantiations. Novel instantiations, it is argued, are simply extensions of novel constructs, models, or, methods. Hence, we should value the constructs, models, and methods, but not the instantiations…instantiations that apply known constructs, models, or methods to novel tasks may be of little significance (March and Smith 1995, p. 260).

Further examination of Table 1 reveals that no paper was found to exhibit Justify/Instantiation characteristics. One plausible reason for this is that IS instantiations are themselves no different from existing IS artifacts. As these artifacts are already built and in use, there is no motivation for justifying these specific artifacts per se in a journal article. Instead of justifying an instantiation, authors are more inclined to justify models, which would lead ultimately to justifying instantiations.

Reviewing results within each journal, Table 2 presents the research outputs nested in research activities for each journal. A review of this data shows dramatic differences across journals in the distribution of articles across classifications. Publication of Design Science research ranges from 1.1 percent in MISQ to 38.4 percent in CACM. In fact, these results show that only 1 Design Science article appeared in MISQ from 1998-2002. At the other end of the table, CACM published 196 articles categorized as Design Science. Conversely, an examination of the Behavioral Science activities shows that 90 percent of the publications in MISQ theorized a construct, model, method or instantiation. However, 77 of these 81 articles fell into 2 categories: Construct and Model theorizing. At the other extreme, only 2 Theorize/Instantiation articles were published in these IS journals between 1998 and 2002 and they both appeared in MISQ. Likewise, MISQ published the only 2 Justify/Method articles during the period. Not surprisingly, of the IS publications in CACM, only 61.4 percent were Theorize Construct, Model, Method or Instantiation papers. Across all six journals, 72.2 percent or 684 articles were categorized as Behavioral Science Theorize pieces. The two categories with the fewest number of publications were Evaluate and Justify.

	Journal						
	MISQ	**ISR**	**JMIS**	**DS**	**MS**	**CACM**	**Total**
Build/Construct	-	-	-	-	-	4(0.8)	4(0.4)
Build/Model	-	6(5.8)	5(2.9)	-	2(9.1)	13(2.5)	26(2.7)
Build/Method	1(1.1)	4(3.9)	12(7.1)	-	5(22.7)	100(19.5)	122(12.9)
Build/Instantiation	-	-	3(1.8)	2(4.1)	-	30(5.8)	35(3.7)
All Build	1(1.1)	10(9.7)	20(11.8)	2(4.1)	7(31.8)	147(28.7)	187(19.8)
Evaluate/Construct	-	-	-	1(2.0)	-	-	1(0.1)
Evaluate Model	-	-	-	1(2.0)	-	2(0.4)	3(0.3)
Evaluate/Method	-	1(1.0)	1(0.6)	2(4.1)	-	38(7.4)	42(4.4)
Evaluate/Instantiation	-	-	-	-	-	9(1.8)	9(1.0)
All Evaluate	-	1(1.0)	1(0.6)	4(8.2)	-	49(9.5)	55(5.8)
Total Design Science	1(1.1)	11(10.7)	21(12.4)	6(12.2)	7(31.8)	196(38.2)	242(25.6)
Theorize/Construct	17(18.9)	4(3.9)	9(5.3)	2(4.1)	1(4.5)	6(1.2)	39(4.1)
Theorize/Model	60(66.7)	76(73.8)	126(74.1)	28(57.1)	11(50.0)	290(56.5)	591(62.4)
Theorize/Method	2(2.2)	6(5.8)	14(8.2)	8(16.3)	3(13.6)	19(3.7)	52(5.5)
Theorize/Instantiation	2(2.2)	-	-	-	-	-	2(0.2)
All Theorize	81(90.0)	86(83.5)	149(87.6)	38(77.5)	15(68.2)	315(61.4)	684(72.2)
Justify/Construct	-	2(1.9)	-	1(2.0)	-	1(0.2)	4(0.4)
Justify/Model	6(6.7)	4(3.9)	-	4(8.2)	-	1(0.2)	15(1.6)
Justify/Method	2(2.2)	-	-	-	-	-	2(0.2)
Justify/Instantiation	-	-	-	-	-	-	-
All Justify	8(8.9)	6(5.8)	-	5(10.2)	-	2(0.4)	21(2.2)
Total Behavioral Science	89(98.9)	92(89.3)	149(87.6)	43(87.8)	15(68.2)	317(61.8)	705(74.4)
Total	90	103	170	49	22	513	947

Table 2. Classification of Articles into March and Smith's updated Taxonomy By Journal

CONCLUSION

This study mapped 947 articles published in top IS journals over the period 1998-2002 into an updated version of March and Smith's taxonomy of IS research activities using Newman's method of pro forma abstracting. The results show that publication in these IS journals is almost exclusively behavioral science; design science activities, research that builds and evaluates systems, is negligible. The proportion of design science to behavioral science publications ranges from a low of 1/90 or 1.1 percent for MISQ to a high of 196/513 or 38.2 percent for CACM. Some of these differences may be attributed to differences in intended audiences. For example, "institutional issues have had, and continue to have, an important impact on the IS field's evolution. In other words, the field's evolution depends on various institutional stakeholders, not just intrinsic characteristics of IS as a scientific or applied field" (Alter 2003, p.620).

The institutional arrangements in business schools that determine promotion, tenure and rewards have a part to play to increase the amount of design science research and publication in IS. As sponsored research makes greater inroads into the culture of business schools, greater emphasis will be placed on design science research. As in engineering, this is likely to result in more publication of design science research activities and outputs. Similarly, few, if any, IS doctoral programs consider design science. Obviously, if design science is to become a methodology known to researchers and properly used in the IS research community, nascent scientists must be introduced to the methodology. IS Ph.D. students must be introduced to design science in much the same way that most doctoral programs now include qualitative research methods. Development of design science research and methodology is beyond the scope of this paper. However, the reader interested in knowing more about design sciences should review Vaishnavi and Kuechler (2004) and Hevner, et al. 2004.

Based on these results, we join the increasing number of IS researchers calling for an increase in design science research and publication to advance IS cumulative research. Building and evaluating systems provides unique feedback that advances those ideas that are the most promising in practice. March and Smith (1995) and Hevner, et al. (2004) also conclude that IS research must include a proper mix of both design science and behavioral science research activities and outputs. "Progress is achieved … when existing technologies are replaced by more effective ones" (which could only be done if existing technologies [are] part of the cumulative tradition)" and are subjected to scientifically rigorous procedures and methods (March and Smith 1995, p. 254, parenthetic in original). In other words, IS cumulative tradition is diminished as opposed to strengthened by a disproportionate, in this case almost exclusive, focus on behavioral science in relation to design science research. An increase in design science research and publication will enhance rather than diminish both IS practice and scholarship.

As is the case in all scholarly endeavors, IS researchers recognize theory development and theory testing as critical parts of their discipline. However, IS researchers must also be involved in building and evaluating artifacts that instantiate theory. This integrative, proof-of-concept process is critical, especially in professional disciplines such as IS (Brooks, 1996; Iivari, Hirscheim, and Klein, 1998; Lee, 1991; March and Smith, 1995; Simon, 1996; Hevner, et al. 2004).

We feel compelled to echo Hevner, et al. 2004 by emphasizing that it would be counterproductive to embark on design science research program without a proper appreciation for rigor. Because design science is practice-oriented, it is relevant by definition. It is the rigor of design science that often must be defended. This can be a challenge because for many IS artifacts their "proof" is confirmed within environments that are heavily influenced by factors that raise very compelling competing hypotheses questions, making it almost impossible to differentiate cause and effect relations.

The obvious limitation of this work is the sample of IS journals. Other IS journals may publish much more design science research. However, even if this is the case, it does not diminish the conclusion that many of the most prestigious and most recognized IS journals publish very little design sciences research, and that it would add to the visibility and credibility of design science to have more quality design science papers published in theses recognized IS journals.

Lastly, this study integrated and applied a classification and coding scheme based on pro forma abstracts rather than using key words, abstracts or citations. This methodology provides a level of detail in assessing cumulative research tradition heretofore not seen in IS research.

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APPENDIX 1

Classification	**Pro Forma Abstract Template**
Build Construct	New/Existing construct (s) in/for <IT artifact type> has/have been proposed/developed/enhanced.
Build Model	New/Existing model for/in <IT artifact-type> has been proposed/developed/enhanced.
Build Method	New/Existing method/algorithm/technique/approach for building <IT artifact-type> has been proposed/developed/enhanced.
Build Instantiation	New <IT artifact-type> has been developed. This <IT artifact-type> presents a solution to/for <environment-type> and/or <user-type.>
Evaluate Construct	The <IT construct-type> for building <IT artifact-type> has been evaluated using <performance measuring metrics>. The paper shows/fails to show that the <IT construct-type> has better/favorable <performance-type> than/to existing constructs.
Evaluate Model	New/Existing model (s) for/in <IT artifact type> has/have been evaluated using <performance measuring metrics>. The paper shows/fails to show that the model provides a more comprehensive representation and captures more of the <IT tasks> than existing models.
Evaluate Method	<Method-type> for building <IT artifact-type> has/have been evaluated using <performance measuring metrics>. The paper shows/fails to show that this method is effective and/efficient. In addition this method presents a complete and or/consistent/and or/easy to use/and or high quality features when applied in <environment-type.>
Evaluate Instantiation	<IT artifact-type> has been evaluated using <performance measuring metrics>. The paper shows/fails to show that the <IT artifact-type> presents a better/comparable solution than/to and or in <user-type> and or <environment-type.>
Theorize Construct	New/Existing construct (s) has /have been developed/enhanced to explain/study/measure <IT phenomena>. The paper shows/fails to show that this/these construct (s) is/are valid and reliable.
Theorize Model	New/Existing theoretical framework/model for studying/explaining the relationship between <constructs>/ factors that influence <IT phenomena> has been developed/enhanced. The paper shows/fails to show that model/framework effectively represents/explains <IT phenomena> <in an environment.>
Theorize Method	New/Existing method/approach for <IT phenomena> doing <IT task> has been developed/enhanced. The paper shows/fails to shows using <IT-artifact> or <participants> that this framework/method/approach is effective <in/or> <environment/situation.>
Theorize Instantiation	New/Existing theory for explaining <information technology type> has been developed/enhanced. The paper shows/fails to show that this theory effectively explains how/why the <IT artifact-type> works <in environment-type.>
Justify Construct	A/An empirical and or theoretical research has been performed to validate <IT construct-type>. The paper shows/fails to show that this/these construct (s) underlies/underlie <IT theory>, /is/are <useful/critical/influence> <for studying> <IT phenomena> <and that the construct (s) is/are valid, reliable and useful/ not valid and reliable.>
Justify Model	A/An empirical and theoretical research has been performed to validate <IT model-type>. The paper shows/fails to show that this theoretical <model-type> effectively represents the <IT phenomena> or explains how/why the <IT phenomena> works.>
Justify Method	A/An empirical and or theoretical research has been performed to validate <IT method-type> for doing <IT task>. The paper shows/fails to show that that the <IT method type> is effective This method is effective and/efficient in doing <IT task.].
Justify Instantiation	A/An Empirical And Theoretical Research Has Been Done For Studying <It Artifact-Type> /Explaining How/Why <It Artifact-Type> Works. The Paper Shows/Fails To Show That This Theory Effectively Explains How/Why <It Artifact-Type> Works. The <It Artifact-Type> Presents A Better/Comparable Solution To/And Or In <User-Type>/And Or <Environment-Type.>