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INFORMATION TECHNOLOGY AND SYSTEMS - III RESEARCH PUBLICATIONS IN SYSTEMS DEVELOPMENT DURING 2000-2004

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ABSTRACT

Although systems development research is at the core of the Information Systems discipline, some scholars call attention to a teaching and research gap in this area of IS. In this study, we examine the state of systems development research in IS by analyzing the articles published in three leading journals between 2000 and 2004. We propose a classification framework based on the type of research paradigm (design vs. explanatory) and the nature of the IT-artifact (conceptualization vs. instantiation). Our results show that about 20% of the articles published in this five year period are focused on systems development. In two of the three journals, there are comparable proportions of studies in the design research and in the explanatory paradigm. However, in all three publications most of the articles are focused on conceptual IT-artifacts, as opposed to instantiations. These findings are important for system development researchers when they choose journals to which to send their papers.

Keywords: Systems development, empirical analysis, research paradigm, IT artifact

I. INTRODUCTION

The Special Interest Group of Systems Analysis and Design (SIGSAND) defines its field of interest as the study "of systems requirements, analysis, design and implementation tasks and technologies in business and organizational contexts" (SIGSAND website). As a field of inquiry, Systems Analysis and Design (SA&D) studies behavioral, technical and organizational issues related to the conception, design, development, and implementation of information systems. Although some scholars use the acronym SA&D to label this area for research and teaching purposes, broader terms such as 'systems development' cover more formally issues about the implementation and rollout of information systems, which are not technically included in the SA&D label.

In this paper, we use the term 'system development' to refer to all aspects of systems' production from specification, to development, to maintenance. System development encompasses not only the technology, but also the task and the people (users, managers, and developers) associated with their development. Our definition of systems development is more inclusive when compared to that used in other studies. For example, Vessey et al. [2002] use the ISRL classification scheme for their topic-based analysis. In this scheme, certain topics that we consider as part of systems development (for example, database management, process management, measurement/metrics for software/systems management) are classified under different categories such as system/software concepts, system/software management, and data/information management.

Overall, the objective of Systems Development (SD) research is to improve the development process, and create cost-effective systems that are reliable, modifiable and adaptable. From an Information Systems (IS) perspective, a fundamental component of the research questions and goals of SD research are the organizational factors such as processes, requirements and user attitudes that determine the creation of new systems or affect the maintenance of existing systems. Although in IS research these factors are examined at different levels of analyses (individual, group or organization) and using different research methodologies, the ultimate goal is to improve the systems development process [Morrison and George, 1995].

Since the objective of the Information Systems (IS) discipline is to study Information Systems and their characteristics and how such systems support human purposes [March and Smith, 1995], we believe that systems development should be at the core of the field. Furthermore, we believe that research about how to best develop information systems should be a natural area of general IS research. However, despite this logical connection, research on systems development topics is not always considered a legitimate part of IS research [Gregg et al., 2001, Morrison and George, 1995].

In the past, several articles called attention to the research and teaching gap in SD. Vessey et al.'s [2002] analysis of IS research concluded that top journals published little research on systems topics in the 1995-1999 period. More recently, Bajaj et al. [2005] show that there is also a teaching gap. About 22% of faculty in the ISWorld Directory list SA&D in their teaching interests, while only 3% indicate SA&D as a research area. The preference of IS mainstream journals for behavioral research, and the effects of the business school environment where technical research is not easily understood or appreciated, are two of the factors advanced by Bajaj et al. [2005] to explain this gap.

In the Spring of 2005, we were involved in developing and teaching a graduate systems development seminar for the Ph.D. program in IS offered by the business school at our institution. In the process of updating the curriculum and preparing our weekly discussions, we dealt first hand with many of the issues highlighted by Bajaj et al. [2005]. In particular, we debated the distinction between design and behavioral research paradigms, and how SD research was perceived in business schools and mainstream IS journals.

Three particular research questions emerged from this doctoral seminar. First, what kind of SD research gets published in top IS journals? Second, what is the proportion of SD research published in top IS journals in the last five years? Third, are there any differences in the number and type of SD research articles published in leading IS journals? Given the importance of SD in the IS discipline, we believe that it is necessary to generate a more updated and informed evaluation of the state of research in SD. To answer these research questions, we develop a classification framework based on two key research dimensions and use it to analyze SD publications in three major IS journals.

The paper proceeds as follows. In Section II, we discuss the two dominant research paradigms in Information Systems and the nature of the IT artifact that is the object of research in the field. Based on these two dimensions, we propose a classification framework (Section III). Then we present an empirical analysis of SD research articles recently published in three major IS journals and discuss the results (Section IV) . Finally, we summarize our efforts and present some concluding remarks about the current state and future of SD research (Section V).

II. BACKGROUND: PRIOR REVIEWS OF SYSTEMS DEVELOPMENT RESEARCH

Several previous papers analyze systems development research in MIS. For example, Morrison and George [1995] analyzed the SD papers published in *Communications of the ACM*, *Management Science* and *MIS Quarterly* between 1986 and 1991 and conclude that the majority (66%) of the SD research published in these journals is either descriptive or developmental[1].

Vessey et al. [2002] undertake an empirical study of the diversity of the IS discipline and its journals, by examining the articles published in the years 1995-1999 in five North American journals[2]. The study shows that the IS discipline is diverse in research approaches, levels of analysis, topics, reference disciplines and methods. With respect to the journals, JMIS and ISR published articles displaying the greatest diversity while *MIS Quarterly* and *Decision Sciences* published papers that focused on subsets of the field. Despite the diversity of the discipline, Vessey et al. [2002] report that research on system-related topics accounted for only 7% of the total research published in these journals[3].

Since previous evaluations of systems development research from the perspective of IS documenting its under-representation in highly ranked IS journals are based on publications from the late 1990's [Bajaj et al., 2005, Gregg et al., 2001, Morrison and George, 1995, Vessey et al., 2002], we need a more current assessment of the state of this type of research. It follows from this review of prior studies that to understand the nature of systems development research published in IS it is necessary not only to look at more recent publications but also to examine the characteristics of such research.

III. CLASSIFICATION FRAMEWORK

Information systems research focuses on gaining knowledge about the development and application of information technology at the organizational, societal, or individual level. It follows two distinctly different paradigms: design and explanatory research. Both these paradigms focus on the effective development and use of different kinds of IT artifacts. Past studies on the nature of research in IS highlight the importance of research paradigms [Hevner et al., 2004] and the nature of the IT artifact that is studied by IS research [Orlikowski and Iacono, 2001]. The significance of these two dimensions (research paradigm and IT artifact), especially in the segment of IS research focused on systems development is explained in detail in the following subsections.

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[1] Descriptive research focuses on developing theories or models and describing them to provide inputs for developing units of theory, its law of interaction, system states, and model boundaries. Developmental research involves generating knowledge for explaining or solving general problems.

[2] *Information Systems Research*, *Journal of Management Information Systems*, *MIS Quarterly*, *Management Science* and *Decision Sciences* were the journals examined. The authors only considered the Information Systems articles published in *Management Science* and *Decision Sciences*.

[3] Seven percent is the number [Vessey et al., 2002] reported for the systems/software management category. Other categories in their classification scheme will fit into our more inclusive definition of systems development (for example, systems/software concepts: 7.4% and data/information management: 3.1%). Hence, this proportion may be higher if we combine the three relevant areas. However, since these categories also include some topics that do not belong to our definition of systems development, adding these percentages may be an upper bound, at best.

RESEARCH PARADIGM: DESIGN AND EXPLANATORY RESEARCH

Explanatory research focuses on

> *developing and justifying theories that explain or predict organization or human phenomena surrounding the development and use of Information Systems*. [March and Smith, 1995]

It aims at understanding and explaining reality [March and Smith, 1995]. Design research focuses on

> *creating innovations that define practices and capabilities that enable effective development and use of information systems* [Hevner et al., 2004].

It includes two phases, (1) build and (2) evaluate, which encompass the activities of building purposeful artifacts that address unsolved problems and evaluating them for utility in solving those problems [Hevner et al., 2004]. With its roots in engineering and the sciences of the artificial [Simon, 1996], design research focuses on creating things that serve human purposes[4]. These two research paradigms differ in their research intent and approach.

Several discussions in the literature compare different research paradigms, (for example, design vs. natural science, design vs. behavioral science, and design vs. explanatory research). Though these comparisons share the same flavor, they are not exactly identical. We choose to focus on the contrast between design and explanatory research due to its more inclusive definition when compared to natural and behavioral science. While natural science implies the study of natural phenomena in domains such as physical, biological, or social, and behavioral research in IS involves the study of human interaction with systems, explanatory research is more general and focuses not only on explaining human interaction with systems but any phenomena including those that do not involve any human aspect.

Systems development, a sub-discipline of IS, depends heavily on engineering new system development methodologies and process guidelines through extensive research. It also depends on our understanding of organizational and human components surrounding their development and use. The cycle between developing new artifacts that support the system development process (design science) and the evaluation of these artifacts guided by various theoretical lenses (explanatory research) is essential for effective systems development research.

Though design research encompasses both build and evaluate phases, the evaluate phase is different in its goal from evaluations conducted in explanatory research. In design research, the primary goal of the ‘evaluate’ phase is to assess the usefulness/effectiveness of the new IT artifact produced in the build phase with limited consideration of other contextual factors that might impact its use. In contrast, evaluations undertaken in the explanatory research paradigm typically involve a careful consideration of theoretical aspects and contextual factors to explain the issue under investigation. The focus is usually not on assessing the usefulness of the IT artifact but on drawing theoretical conclusions and extensions related to its use. The objective of explanatory research is usually discovering new scientific claims and/or justifying the validity of these claims [March and Smith, 1995].

In contrast, the evaluate phase in design research seeks to investigate the usefulness of the specific artifact developed. The difference primarily lies in the expected contributions from these two types of evaluations. While explanatory research is expected to contribute by extending existing theory, the evaluate phase in design research is expected to contribute by validating the usefulness of the new IT artifacts developed in the build phase. However, it should be noted that both the evaluate phase in design research and evaluations in explanatory research typically use the same evaluation techniques.

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[4] For details about design science research, see Vaishnavi and Kuechler [2006].

Despite the differences in their intent, research in both paradigms can offer complementary perspectives in systems development. A design-explanatory research cycle can result in significant synergy in developing new IT artifacts and extending theory by testing the use of these artifacts under various contexts. Systems development research can benefit from the generation and examination of new IT-artifacts (consistent with the design research paradigm) and from its continuous and systematic evaluation (according to the explanatory paradigm). For such synergy to be exploited, research following both these paradigms should be prevalent and disseminated in journals that are commonly recognized by the community. This brings us to the questions: "How frequently do mainstream IS journals publish design research?" and "What kind of journals do design researchers in IS target?" These questions become even more important in the context of SD research because of the potential of both research paradigms to contribute to the advancement of this field.

IT ARTIFACT

The conceptualization of the IT artifact and its role in the Information Systems discipline was the subject of academic debates in recent years (See for example CAIS volume 12). We briefly review some alternative classifications of IT artifacts to identify a suitable distinction for our framework.

Orlikowski [2000] defines an IT artifact as the

> *bundle of material and symbol properties packaged in some socially recognizable form, e.g. hardware, software, techniques.*

Because an IT artifact is the product of human art and workmanship that is used in situated practices, Orlikowski argues that research often combines technology as an artifact and how people use the technology. Within this combined notion of technology as artifacts in use, she defines *conceptual artifacts* as "techniques or methodologies expressed in language" (p. 409), which are more likely to be associated with a wider range of uses than *software-based artifacts*. Although no specific definition is provided, it can be inferred that software-based artifacts are programs or application packages designed for particular purposes.

To analyze how information systems researchers approach the IT artifact, Orlikowski and Iacono [2001] present four broad conceptualizations[5]:

- *Tool*: technology as an engineered artifact with a specific purpose,
- *Proxy*: technology studied through particular characteristics that are used as a surrogate,
- *Computational*: technology as an algorithm or as a model with specific capabilities to represent, manipulate, store, retrieve and transmit information, and
- *Ensemble*: technology as immersed in a complex system of interactions, and set in a particular context.

The four views in which the artifact is present were developed to understand how researchers examine IT in their research. When these views are translated to the artifacts themselves, these categories intersect. For instance, according to our definition of SD research, an information

[5] Orlikowski and Iacono add a fifth category, called *nominal*, in which the technology is absent from the research because the IT artifact is neither described nor conceptualized. Based on the number of articles published in *Information Systems Research* from 1990 until 1999 and classified in the nominal view, Orlikowski and Iacono expressed concerns about the lack of centrality of the IT artifact in much of the information systems research conducted in the 1990's.

system may be viewed as a *tool* with particular information processing capabilities, or analyzed in terms of its *computational* properties, or studied in terms of its interaction with the environment and people, as in the *ensemble* view. Depending on the researchers' objectives, the same IT artifact may be approached from different perspectives, thus, exemplifying a particular view within systems development research.

Other classifications of IT artifacts surfaced in the literature to organize the nature of the artifacts themselves, rather than the perspectives of the researchers. For example, in their discussion of the design research paradigm, Hevner et al. [2004] distinguish four types of artifacts.

- *Constructs*: linguistic devices to define and communicate problems,
- *Models*: use constructs to abstract real-world situations and assist in problem understanding and solution development,
- *Methods*: define solution processes through formal algorithms or step-by-step procedures, and
- *Instantiations*: particular implementations of constructs, models or methods in a working system.

The first three categories correspond to Orlikowski's [2000] definition of *conceptual artifacts* because they are techniques, methodologies and other innovations expressed in language without complete implementations. However, the fourth type – instantiation – fits into Orlikowski's definition of *software-based artifact*.

Sometimes conceptual IT-artifacts evolve into software-based applications, encompassing a continuum that starts with an idea or abstraction and ends with a pragmatic solution to a specific problem (for example, the notion of analysis pattern reuse approach augmented with learning mechanisms that is implemented in a software tool [Purao, 2003]). This evolution is not always the case, however, as some conceptual IT-artifacts (such as the Technology Acceptance Model, for example) are mostly developed to provide better explanations or enhance our current understanding of a particular phenomenon.

The IT artifacts at the center of systems development research may be innovations expressed through linguistic devices (such as constructs, models or process improvement guidelines) or innovative solutions to specific problems presented in the form of new systems or algorithms. Therefore, for the purposes of classifying and evaluating SD research it is important to categorize the IT-artifacts that constitute the primary contribution of this research in terms of its level of abstraction (or pragmatism) into two groups:

1. Conceptualizations (such as models, frameworks, constructs) and
2. Instantiations (such as concrete algorithms, software tools, application programs).

Figure 1 presents a framework with the two dimensions identified as relevant for examining system development research. This framework captures two of the most recent debates in the IS literature: the nature of the IT artifact as an object of IS research [Lyytinen and King, 2004, Orlikowski and Iacono, 2001, Weber, 2003] and the importance of design research as an alternative and legitimate paradigm in IS [Hevner et al., 2004, March and Smith, 1995]. By analyzing the systems development literature in terms of this framework, we will be able to provide evidence and inform both discussions.

		Research Paradigm	
		Explanatory Research	**Design Research**
IT ARTIFACT	**Conceptualization**		
	Instantiation		

Figure 1. Classification Framework

IV. RESEARCH METHODOLOGY

Empirical evaluations of the state of the research in a particular field of inquiry typically follow a classification or a citation approach [Vessey et al., 2002]. The classification method consists of developing a set of categories and coding the keywords and/or the content of the articles accordingly [Gallivan and Benbunan-Fich, 2005, Prasad and Tata, Forthcoming]. In contrast, the citation method seeks to establish the relevance of a particular set of authors or papers based on the number of times they appear referenced or co-referenced in other articles [Culnan and Swanson, 1986, Sircar et al., 2001]. Because citation methods are time sensitive, they are not recommended for recent periods of study, when not enough time has elapsed for the articles to be cited in other papers.

Since we are interested in a current analysis of SD research, we decided to use a classification approach in order to understand the types of articles published in mainstream IS journals. We selected the same set of dedicated IS journals as Vessey et al. [2002], namely: *Information Systems Research* (ISR), *Journal of Management Information Systems* (JMIS), and *MIS Quarterly* (MISQ). Our time period, however, is more recent and encompasses the five years 2000-2004. Another important distinction between this study and prior reviews is that we perform a more in-depth analysis of SD research articles, by classifying them according to our framework.

To identify SD research articles of interest, we examined all the papers that appeared in these three leading IS journals from 2000 to 2004. The total number of research papers published in these journals in this period is 386 (111 in ISR, 174 in JMIS and 101 in MISQ). This number excludes editorial notes, opinions and comments and introduction to special issues.

Consistent with our definition of the field, we classified articles that addressed any aspect of the system development process with the objective of improving such process as SD research. In addition to the typical requirements gathering and design issues, other examples of topics in this category include (but are not limited to): producing error free software, developing systems documentation, improving portability, improving modularity and software architecture, reducing development and maintenance costs, improving speed of development and increasing the robustness of the system [Ba et al., 2001].

The two authors working independently examined each paper to determine whether it belonged to the category of "systems development." Initially, we tried to extract these papers based on keywords. However, the wide variety of potential terms that could describe a systems development paper, along with the inconsistencies in the usage of such terms, rendered the keyword approach ineffective.[6] Our independent classification of each paper in terms of SD (or

[6] Other authors (e.g. [LaBrie and St. Louis, 2003]) also pointed out the limitations of keywords to extract and classify articles.

not SD) found a small set of coding discrepancies (inter-coder reliability = 0.91%). These differences were adjudicated through a discussion process.

The selection process yielded a total of 81 systems development articles, which represents 21% of the total number of papers examined. The sample is approximately equally divided among the three journals (30% from ISR, 37% from JMIS and 33% from MISQ) with a slightly higher proportion for JMIS. JMIS published more articles in the 5-year period (174) than ISR (111) or MISQ (101). The chronological distribution of the sample is also balanced, with approximately 20% of the articles in each year of the period of study. Table 1 lists the number of SD studies, organized by publication and by year.

Table 1. Description of the Sample

	2000	2001	2002	2003	2004	Totals (%)
ISR	6	5	3	5	5	24 (30%)
JMIS	4	7	8	6	5	30 (37%)
MISQ	9	4	5	4	5	27 (33%)
Totals (%)	19 (22%)	16 (20%)	16 (20%)	15 (19%)	15 (19%)	81 (100%)

For each of the 81 selected articles, we coded the type of IT-artifact and the type of research paradigm. For this coding, the two authors also worked independently, following the same procedure as for the article selection. In this case, however, instead of coding with 0s and 1s, we used labels. For research paradigm, we used the words: Explanatory or Design, depending on whether the research objective was to explain a phenomenon or to develop an innovative solution to change the status quo. In the IT-artifact dimension, we classified the artifact whose development or description is the primary contribution of the article. To classify a paper in this category, we tried to keep the same labels used by the authors to describe their work (e.g. framework, model, system, algorithm, approach, or technique). These labels were then classified as either conceptualizations or instantiations.

High levels of agreement were reached in the research paradigm dimension (inter-coder reliability = 0.95), while the level of agreement in the IT-artifact dimension was slightly lower (0.83). These coding differences were discussed individually until consensus was achieved. One source of differences in the research paradigm classification was how to treat research articles that did not present a detailed account of the building of the artifact, but only its evaluation. We agreed to classify these articles as design research. For example, Nissen [2000] only presents the evaluation of a new knowledge-based process redesign system (KOPer-lite) but he provides references to his prior publication where he describes the development of the system ("build" phase) [Nissen, 1999].

In the IT-artifact classification, most of the discrepancies occurred when papers described their IT-artifact from its conceptual origination until its implementation (e.g. approach and algorithm), and thus it was coded in different ways by the two authors.

To understand the final criteria used for classification, Table 2 on the next page shows examples for each of the four categories.

Table 2 . Examples of the Classification Framework

		Research Paradigm	
		Explanatory Research	**Design Research**
IT artifact	**Concept-ualization**	Kim et al. [2000] "apply a diagrammatic reasoning framework to assess the usability of multiple diagrams as an integral part of a system development methodology." Since their focus is explaining the process of understanding a system using multiple diagrams and not designing any new and innovative solution, we categorize this article as explanatory. The artifact under consideration here is the approach used in understanding systems that use multiple diagrams and their associated design guidelines, and not any software-based artifact. Hence, we place this paper in the conceptual artifact category. Keil et al. [2000] explain the factors that affect the escalation of commitment behavior in software projects. Since their purpose is the explanation of a phenomena rather than design, this paper is classified as explanatory. The artifact under consideration is a model that explains commitment behavior in software projects, and hence a conceptualization.	Krishnan et al. [2004] *'develop'* a stochastic decision model for the maintenance of information systems. Since their focus is the *'development'* of a new *'model'*, we classify it as 'design' and since the artifact is a modeling framework (and not a software-based artifact), we classify it as 'conceptual'. Chen et al. [2002] develop a flexible database system approach to achieve gains in query processing times. Since the focus is the *'development'* of a new *'approach'*, we classify this article into the 'design/conceptual' cell in our framework.
	Instantiation	McMurtrey et al. [2002] *'explain'* the impact of CASE tool sophistication on the relationship between career orientation and job satisfaction. Since the focus is explanation rather than design, we classify it as 'explanatory'. The important artifact under consideration is a CASE tool environment and hence an 'instantiation'. Cooper et al. [2000] *'explain'* the transformation of an organization through the use of a data warehouse system called Vision. Here, the object under consideration is a software-based artifact, and hence classified as an 'instantiation'.	Krishnan et al. [2001] *'develop'* a cognitively guided approach for database retrieval. Their approach includes algorithms, mathematical model, and is implemented in a software tool. Since the focus is the *'development'* of *'algorithms and a system'*, we classify this article into the 'design/instantiation' cell in our framework. Here, it should be noted that even though the primary IT artifact developed is an approach, this approach is instantiated in more concrete artifacts like algorithms and a system. Purao et al. [2003] develop an intelligent assistant to a designer that incorporates learning mechanisms to improve analysis pattern reuse in conceptual modeling. Since the focus here is the *'development'* of a *'system'*, this article is classified as 'design/instantiation' in our framework.

V. DATA ANALYSIS AND RESULTS

Table 3 shows the 81 systems development articles, classified separately in each dimension: Research Paradigm and IT-Artifact. The proportion of papers under the explanatory paradigm is significantly greater than in the design research category (64% vs. 36%), and this difference is statistically significant at $p<0.001$ ($Z=4.26$). In addition, there is a marked concentration of conceptual IT-artifacts such as models, frameworks, approaches and methods, when compared to instantiations (84% vs. 16%). This difference between proportions is also significant at $p<0.001$ ($Z=20.4$).

Table 3. Tests of Differences between Proportions

Research Dimension	**N**	**Explanatory**	**Design**	**Z**
- Full Sample	81	52 (64%)	29 (36%)	4.26***
By Journal				
- ISR	24	13 (54%)	11 (46%)	0.30
- JMIS	30	17 (57%)	13 (43%)	0.84
- MISQ	27	22 (81%)	5 (19%)	9.21***
IT-Artifact Dimension	**N**	**Conceptualization**	**Instantiation**	**Z**
- Full Sample	81	68 (84%)	13 (16%)	20.4***
By Journal				
- ISR	24	19 (79%)	5 (21%)	7.16***
- JMIS	30	24 (80%)	6 (20%)	8.68***
- MISQ	27	25 (93%)	2 (7%)	29.7***

Significance: *** $p<0.001$

When the proportions are divided by journal, we find that both ISR and JMIS published similar proportions of articles in the research paradigm dimension (slightly over 50% of explanatory papers, vs. 40% of design research). No significant differences between proportions are found for these two journals ($Z=0.30$ and $Z=0.84$, for ISR and JMIS respectively). However, MISQ published a noticeably higher percentage of explanatory papers compared to design research (81% vs. 19%), and this difference is significant at $p<0.001$ ($Z=9.21$).

The results in the IT-artifact dimension are also consistent for ISR and JMIS, with both publishing about 80% of SD articles focused on conceptual artifacts, against 20% of papers focused on instantiations (algorithms or software-based tools). The proportion for MISQ is similar in direction but with an even stronger emphasis on abstract artifacts when compared to pragmatic ones (93% vs. 7%). All three journals publish more research devoted to conceptualizations than to instantiations. The differences between proportions are significant at $p<0.001$ for each journal ($Z=7.16$ for ISR, $Z=8.68$ for JMIS and $Z=29.7$ for MISQ).

Table 4. Cross-Tabulation of Articles

	Research Paradigm		
IT-Artifact	**Explanatory**	**Design**	*Total*
Conceptualization	50	18	68 (84%)
Instantiation	2	11	13 (16%)
Total	52 (64%)	29 (36%)	
Fisher's Exact Test	0.0001296***		

Two-sided Pr <=p. Significance: *** $p<0.001$

We also cross-tabulated these results in terms of our framework and analyzed the significance of the association between the two dimensions. The full sample cross-tabulation is presented in Table 4.

We conducted Fisher's exact tests to calculate the statistical significance of these differences. The Fisher's exact test is recommended when one (or more) of the cross-tabulation cell counts has an expected frequency of five or less and Chi-Square statistics are not accurate. In this case, the explanatory/instantiation quadrant contains only two articles and therefore, the total expected count is less than five. The results of the Fisher's exact test show that the differences among the number of articles classified in each cell are significant. The highest proportion of articles is found in the explanatory/conceptualization quadrant and the lowest in the explanatory/instantiation cell. We advance some possible explanations for the latter result in Section IV.

If we analyze separately the percentage of articles in each IT-artifact category, we find that 96% (50 out of 52) of the explanatory research papers, and 62% (18 out of 29) of the design research studies are focused on conceptualizations. Studies from both research paradigms tend to address conceptual artifacts when compared to concrete systems or applications (instantiations), which appeared to receive less research attention, in studies reported in the three journals investigated.

Another objective of this research (see Section I) is to determine whether there are distinct patterns among the three journals selected for this study. It is conceivable that particular editorial policies and preferences resulted in differences in the number and type of SD articles published in each journal during the period of the study. Table 5 presents the proportions by journal.

Table 5. Cross Tabulations and Significance Tests by Journal

	Explanatory/ Conceptual	Design/ Conceptual	Explanatory/ Instantiation	Design/ Instantiation	Fisher's exact test
Full Sample	50	18	2	11	0.0001296***
By Journal					
- ISR	13	6	0	5	0.0109**
- JMIS	16	8	1	5	0.0606*
- MISQ	21	4	1	1	0.3419

Two-sided Pr <=p. Significance Levels: * p<0.1; ** p<0.05; *** p<0.001

The results of the Fisher's exact tests for each journal show significant associations between the two dimensions. In ISR, the explanatory papers are exclusively focused on conceptualizations, while the design articles are equally distributed between the two categories of artifacts. The relation between the two dimensions is significant at p<5%. A similar pattern is found in JMIS, although the association is only significant at p<10%. In contrast, the association is not significant at MISQ, given the small proportion of articles focused on instantiations.

VI. DISCUSSION OF RESULTS

After analyzing all the papers published in three North American IS journals (ISR, JMIS and MISQ) in 2000-2004, we find that approximately 1 in 5 articles (81 out of 386) is an SD research paper. The distribution of SD articles across journals and across years is similar.[7] This balanced sample demonstrates a consistent publication rate of SD articles in the three journals between 2001 and 2004 despite the emergence of topical trends ("hot topics") and the implementation of particular editorial policies that may favor some topics over others.

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[7] No significant differences are found in the cross-tabulation of the sample by journals and years.

When we classified the sample of 81 SD articles in terms of the research paradigm and the type of IT-artifact, we found significant associations between these two dimensions. In particular, almost two thirds of the sample is representative of the explanatory research paradigm, while only one-third can be considered exemplary of design research. The proportion of design research we find in our sample (36%) is considerably lower than the 66% ratio of descriptive and developmental articles reported by Morrison and George [1995]. We attribute this variation to the differences in the journals selected. The Morrison and George sample included CACM, the journal in which they published their results and which publishes more computer science papers. We achieve remarkably consistent results with Morrison and George [1995] in the only journal we have in common – MISQ. In our study and in theirs, the proportion of SD articles published in this journal is 27%, despite the differences in the sample period.

In our sample, the majority of the articles (84%) are concerned with conceptual IT-artifacts and only a few deal with instantiations (algorithms, systems or software-based tools), in both research paradigms. The difference between the nature of IT artifact in the explanatory/instantiation cell and the design/instantiation cell should be noted. While the latter refers to an innovative IT artifact that embodies prescriptions and theory, the former refers to artifacts that are already used in organizations. The purpose of the IT artifact in the explanatory/instantiation category is to enhance the current understanding of a particular phenomenon, while the purpose of the IT artifact in the design/instantiation quadrant is to offer a novel solution to a problem.

In particular, we found a very small number (2 out of 81) of articles in the explanatory/instantiation cell. This finding could have been the result of our consensus decision to classify as "design" even those studies presenting only the evaluation portion of the research (with the "build" phase published elsewhere). As a result, some of the articles that could have been placed in the explanatory/instantiation cell, ended up in the design/instantiation cell. We believe, however, that classifying an article by the scope of the study is more accurate than classifying it by the focus of the published paper.

Another possible explanation for the low numbers of articles in the explanatory/instantiation cell is that research articles that only describe uses or impacts of instantiated artifacts are not rigorous enough to meet the publication threshold at these highly ranked IS journals. To be accepted, this kind of article must advance the knowledge in the field significantly. To do so, researchers need to develop new constructs or propose new theoretically driven frameworks to increase the rigor of their explanations. As a result, the IT-artifact that is the central contribution of the study shifts from an instantiation to a conceptualization and these studies end up in the explanatory/conceptualization cell of our framework, rather than in the explanatory/instantiation. This argument is further elaborated by Tichy [1998], who emphasizes the need for validations in the field of computer science, and the importance of experimentation. The most likely causes for the lack of experimentation include the cost of experimenting, the pace at which such research progresses, the time to publishing the results of these study, the dynamic nature of technology being evaluated, the difficulty in controlling the environment, and the usefulness of the results gained from overly controlled experimental environments. Zelkowitz and Wallace [1998] argue in the same vein for the need of experimentation in software engineering. They raise critical questions about industry adopting new tools and techniques without validating their usefulness experimentally. Their arguments are relevant to the nature of explanatory work on instantiations discussed in this paper because their causes explain the lack of incentives for conducting research in the explanatory/instantiation cell.

Researchers in the IS field are uniquely positioned to fill the lack of experimentation highlighted by Tichy and by Zelkowitz and Wallace. However, most of the current explanatory and evaluative studies published in the three IS journals studied are more focused on extending theory when evaluating IT artifacts than just validating the utility of the artifact. The emphasis is on applying and extending existing theory to explain why an IT artifact may be useful rather than just evaluating the IT artifact for its usefulness or effectiveness. Hence, such research tends to be classified as explanatory/conceptualization rather than as explanatory/instantiation.

Our results show that the type of SD research that appears more frequently in the three IS journals we studied is explanatory/conceptual. Other combinations of research paradigms and IT-artifacts are also published, but to a lesser extent. It may be argued that studies in the explanatory/conceptualization category are the most favored by researchers, and the publications are only a reflection of this preference. Our data only allows us to conclude that a majority of articles are published in this category, but not the source of this prevalence. The issue of whether the preponderance of articles in the explanatory/conceptual cell is due to researcher' preferences or journal editorial policies deserves further investigation.

The findings by journal are consistent with the results reported by Vessey et al. [2002] in their general analysis of the IS discipline. ISR and JMIS publish the same proportions of explanatory and design research, thus showing a greater diversity of research in the field; while MISQ appears to be mainly focused on a subset of articles (explanatory/conceptualizations).

We examined current editorial policies of the three journals under consideration to gain insights into why certain types and number of SD research articles are published in each journal.

- *ISR's* editorial statement [Sambamurthy, 2006] cites Benbasat and Zmud's [2003] nomological network as a valuable view in defining the core of the IS discipline. SD research clearly falls under the realm of the nomological network, which encompasses research that focuses on understanding the construction of IT artifacts from conception to use. Though the editorial policy does not specifically identify each research area that it considers as the core to IS, its definition of general academic knowledge creation and dissemination modes is inclusive of SD research as well. In addition, the editorial statement does not specifically acknowledge the need for both explanatory and design, but it appears to be inclusive of both.

- *MIS Quarterly* updated its editorial policy statement in its March 2006 issue [MISQ, 2006] to say that it publishes "... high-quality research about the development of information-technology based services, the management of information technology resources and the economics and use of information technology with managerial and organizational implications." This statement replaced the previous one which stated that MISQ published research "concerning both the management of information technology and the use of information technology for managerial and organizational purposes." The new statement indicates that MISQ is broadening its range of interests.

- The editorial statement of *Journal of Management Information Systems* [Zwass, 2006] specifically recognizes systems development as one of the core areas of IS.

Aside from the explicit recognition of SD research by JMIS, the stated editorial policies of the three journals are not starkly distinct from one another to explain any differences in the nature of research published in these journals.

VII. LIMITATIONS

Before discussing the implications of our findings, we acknowledge the limitations of this study. The two main sources of limitations are the selection of journals and the particular characteristics of our framework. Although the three journals we selected are consistently ranked among the top journals in the IS field, our findings only reflect what has been published in these journals in 2000 through 2004. Expanding the set of journals to include other publications, and/or more specialized publications may not necessarily produce the same results. Neither do we expect the same results if this analysis were to be performed again in the future for a different time period.

Our results also depend on the dimensions of our 2 x 2 framework and the categories in each dimension. We chose to analyze the SD literature using two overlapping lenses (research paradigms and IT-artifacts), and operationalized these dimensions with categorical indicators. Other variations and extensions of this framework are possible. For example, the design research paradigm may be subdivided according to the scope of the studies into: build, evaluate and build-and-evaluate, depending on the aspects covered by the articles. Likewise, other categorizations in the IT-artifact dimension may yield more detailed results. However, since we intended to perform statistical analyses, we decided against using micro-level classifications to avoid a multitude of categories with a few articles in each.

VIII. IMPLICATIONS

EMPIRICAL EVIDENCE ON EXPLORATORY VS. DESIGN RESEARCH

The criteria used to define articles as being exploratory or design research affects the empirical results reported for the number of articles in each category. Although different criteria would change the numbers in the two categories, we believe that the present preponderance of explanatory research articles would still be true.

SYSTEMS DEVELOPMENT PRACTICE AND RESEARCH

Systems development practice can benefit from increased studies following the design research paradigm. Such studies could suggest novel processes and techniques for systems development that may improve SD practice. However, given the preference of leading IS journals for explanatory/conceptual articles, systems development and design researchers should also concentrate on promoting high quality design science journals (e.g., IEEE and ACM Transactions). These efforts, however, require acceptance of design science journals for promotion and tenure consideration in academic fields such as business where many IS design researchers teach.

THE IT ARTIFACT

We provide empirical evidence that, in three leading journals we studied, less research is reported on developing concrete IT artifacts than on developing conceptualizations. Does this disparity imply the increased need for research on developing and evaluating instantiations of conceptual artifacts? Or is this disparity a byproduct of the implementation of the editorial policies by different editors at top IS journals? These are issues that deserve further investigation.

CHOICE OF JOURNAL FOR SUBMITTING ARTICLES

In the early years of 21st century, the proportion of SD articles in the three journals studied was about 20%. When compared to the proportions reported by Vessey et al. [2002], this ratio is a promising sign of more research being conducted in the field along with a welcoming attitude from the part of these IS journals. Although the proportions in the full sample are significantly higher for explanatory research, it is encouraging to find evidence of an almost equivalent distribution of studies in the design research and explanatory paradigms for two of the three journals examined in this study.

RESEARCH AGENDA FOR SD RESEARCH

Our results indicate areas where to focus new research efforts. For example, building or evaluating more pragmatic IT-artifacts receives less attention than developing conceptual models or constructs, yet it appears to be a significant area in which IS researchers can make relevant contributions to practice. One of the practical implications of developing concrete artifacts is that it provides compelling proof-of-concept and spurs the use of novel approaches in industry. Industry use, in turn, can facilitate increased field evaluations of new approaches.

IX. CONCLUSIONS

In this study, we examined the state of systems development research in the context of Information Systems research in general. After analyzing recent publications in three top IS journals in the 2000-2004 period, we find that about 20% of the articles are classified as systems development research. This result suggests that the teaching and research gap identified by Bajaj et al. [2005] may be closing, as the proportion of SD research published in top IS journals is comparable to the percentage of faculty members indicating a preference for teaching the subject.

A closer examination of the articles related to systems development indicates that both the design and explanatory research paradigms are equally represented in two of the three journals. In spite of this equitable distribution in terms of research paradigms, there is a noticeable preference for conceptual IT-artifacts when compared to instantiations (algorithms and software-based tools). Future research endeavors should seek to understand whether the lack of IS research on concrete artifacts is a result of researchers' choices or journals' preferences.

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EDITOR'S NOTE: The following reference list contains the address of World Wide Web pages. Readers who have the ability to access the Web directly from their computer or are reading the paper on the Web, can gain direct access to these references. Readers are warned, however, that

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