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EXPLANATION IN INFORMATION SYSTEMS

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Abstract

Explanation of observed phenomena is a major objective of both those who conduct and those who apply research in Information Systems (IS). Whereas explanation based on the statistical relationship between independent and dependent variables is a common outcome of explanatory IS research, philosophers of science disagree about whether statistical relationships are the sole basis for the explanation of phenomena. The purpose of this paper is to introduce an expanded concept of explanation into the realm of IS research. We present a framework based on the four principle explanation types defined in modern philosophy: covering-law explanation, statistical-relevance explanation, contrast-class explanation, and functional explanation. A well-established research stream, media richness, is used to illustrate how the different explanation types complement each other in increasing comprehension of the phenomenon. This framework underlies our argument that explanatory pluralism can be used to broaden research perspectives and increase scientific comprehension of IS phenomena above and beyond the methodological and ontological pluralism currently in use in IS research.

Keywords: explanation, ontology, research method, philosophy of science, information systems

1. INTRODUCTION

The explanation of observed phenomena is a major objective for both those who conduct research in Information Systems (IS) and those who apply the research results, yet the IS literature contains no discussion regarding what "explanation" entails. Although there is consensus that "a fundamental aim of science is to provide explanations of natural phenomena" (Salmon, 1989, p. 4), IS researchers persist in classifying research outcomes based on ontological approach and research method, rather than the explanatory content of their research. Such classification does not adequately inform us regarding the kind of knowledge research discovers. This research builds on Weber's (2004, p. xi) suggestion that there is a need for "deep understanding of the different sorts of knowledge we obtain using different research methods," but argues that knowledge claims are not the result of research methods themselves, but rather are intrinsically linked to different *types of explanation* produced by research. Furthermore, we argue that the type of statistical antecedent-consequent explanation of phenomena frequently produced by IS research is neither the only, nor the crucial type of explanation, and that a constellation of coexisting and complimentary explanation types, resulting from different questions, provide greater comprehension of phenomena. One aim of this research is to make different types of explanation distinct and recognizable by researchers. A second aim is to demonstrate how research can be extended with *explanatory pluralism*.

Philosophers have long been aware that a plurality of explanation types is necessary to identify and understand the underlying regularities of phenomena. Citing Aristotle (*Physics II*, Chapter 3), Ruben (1990, p. 78) writes:

Knowledge is the object of our inquiry, and men do not think they know until they have grasped the "why" of it... In one sense (1) that out of which a thing comes to be and which persists is called "explanation"...In another sense (2) the form or archetype... and its genera are called "explanations". Again (3) the primary source of the change or coming to rest...Again (4) in a sense of end or "that for the sake of which" a thing is done.... are all ways in which the term "explanation" is used.... As the word has several senses, it follows that there are several explanations of the same thing.

The four types of explanation identified are referred to as material, formal, efficient and final (functional) "causes" by Aristotle and pertain to different aspects of a given phenomenon. These concepts have been debated and have evolved within the philosophy of science literature and there is emerging agreement that there are multiple viable approaches to explanation (Salmon, 1989). Given this agreement, how can IS researchers best understand and pursue the explanatory pluralism underlying this view of knowledge?

Despite the philosophical debate on the nature of scientific explanation, there has been no discussion in IS of how explanation might apply to research or how the concept could be used to clarify what research outcomes actually mean. Researchers have pointed to the differences between the *natural sciences*, the *technological sciences*, and the *social sciences* as sources of these multiplicities (Bunge, 1984; Simon, 1969). Researchers have also recognized that sciences can benefit from multiple explanation types. For example, Simon (1969) suggests that the explanation of artificial environments, like Information Systems, is built on the combination of prescribed explanation types from both natural (physiological) and artificial (computer science) reference disciplines and that the two linked levels of explanation contribute to how Information Systems are explained. In this research we argue that the interdisciplinary field of Information Systems, built from both natural and social scientific disciplines, relies on the combination of different explanation types to understand research phenomena and shape research agendas. The existence of phenomena at the interface between human and technological systems presents a unique challenge and opportunity to clarify and to use the insights of different explanation types to advance our knowledge.

The terms *explain* and *explanation* are widely found in IS literature but are rarely defined and are used with different meanings, even within the same paper. Table 1 illustrates a few of the inconsistent and disparate meanings of explanation found in published IS research.

Table 1.
Examples of different meanings of explanation in published Information Systems research

<i>Illustrative Quote</i>	<i>Basis of Explanation</i>
<p>"Therefore, only creativity theory would support the following <i>explanation</i>. The conservative organizational culture led to a lack of individual creativity, which reduced group members' abilities to take new perspectives and explore new cognitive pathways. Their natural inclination, then, was to develop image based on old ways of doing things" (Cooper, 2000, p. 266).</p>	Causal chain of relationships explains
<p>"Further, we posit that perceptions of information usefulness can be <i>explained</i> by theories of informational influence" (Sussman and Siegal, 2003, p. 51).</p>	Theory explains
<p>"Although there is no empirical evidence to <i>explain</i> what appears to be an over-concentration on a few roles, a preliminary <i>explanation</i> based on the Icarus paradox is offered:..." (Pinsonneault and Rivard, 1998, p. 350).</p>	Behavior explains
<p>"According to this model, researchers concern themselves with a theory to <i>explain</i> and predict a phenomenon, where their research activity generally consists of articulating or refining the theory so that it may more accurately explain and predict the phenomenon" (Lee, 2000, p. v).</p>	Theory explains and predicts
<p>"However, because our objective was to come up with a parsimonious set of variables that would <i>explain</i> the outcome of a study, our final model employed only the dummy variable for industry that displayed statistical significance" (Kohli and Devaraj, 2003, p. 133).</p>	Variables explain
<p>"The process-oriented approach attempts to <i>explain</i> the process through which IT investments improve intermediate operational performance, which in turn may affect higher levels of financial performance" (Barua, Kriebel and Mukhopadhyay, 1995, p. 277).</p>	Specific approach explains
<p>"Pure process theories <i>explain</i> that outcomes can happen only under a certain set of conditions and sequence of events, but the outcome may also fail to occur even when the conditions are present – outcomes are probabilistic" (Markus and Robey, 1988, p. 144).</p>	Theories explain
<p>"One plausible <i>explanation</i> for this finding rests in the essential difference in the functional activity supported by the Web sites examined here" (Agarwal and Prasad, 1999, p. 183).</p>	Function explains
<p>"It has also shown why consistent <i>explanations</i> were not found for media selection using trait theories since about 25% of the reasons given for media selection are not in a major trait theory" (Carlson and Davis, 1998, p. 352).</p>	Reasons explain
<p>"Qualitative research involves the use of qualitative data, such as interviews, documents, and participant observation, to understand and <i>explain</i> social phenomena" (Myers, 1997, p. 241).</p>	Data explains

"The technology frames concept helps *explain* why key stakeholders in IS selectively seek or filter contextual information consistent with existing frames" (Davidson, 2002, p. 352). Concept explains

"Structural equation model analyses indicate that metrics tested through each model provide a statistical significant *explanation* of the variation in the EC consumers' satisfaction and channel preference" (Devaraj, Ming Fan and Kohli, 2002, p. 316). Variable metrics explain

We see examples in which theories *explain* data (i.e. perceptions), an approach *explains* a process, and empirically derived relationships among variables *explain* variation in outcomes. In these examples theory, causal chains, variables, and functions are all used as the basis for explanation. These examples lead to the following questions: Are explanations based on these different concepts all of the same type? Are all types equally valid? Is an explanation grounded in theory based on the same reasoning as an explanation derived from empirical data? Does one explanation type take precedence over any other type? Is any explanation complete, or are explanations limited in scope? These questions underscore our argument that clarification of the content and meaning of *explanation* will aid researchers in evaluating research outcomes. We assert that by understanding explanation more precisely, we are provided with a powerful tool for deepening our comprehension of the outputs of research.

2. A CASE FOR EXPLANATORY PLURALISM

Research in IS draws upon both the natural and the social sciences and encompasses a plurality of research paradigms and methods (Chen and Hirscheim, 2004). IS phenomena are often complex and have multiple aspects that can be researched. IS researchers have noted different aspects of phenomenon that strongly echo the distinctions made by Aristotle:

- the inner *material* environment of the IS artifact and the outer *functional* environment of the artifact (Simon, 1969) [emphasis added].
- theorizing the IT artifact as *material components* and *relationships*; theorizing about the *function* and *intention* of the artifact and users in a wide variety of communities; theorizing about the emergence

- and evolution of technosocial processes over time (Orlikowski and Iacono, 2001) [emphasis added].
- the *material*, social, and personal worlds (Mingers, 2001) [emphasis added].

Mingers argues for “critical pluralism” to extend scientific knowledge through the mixing of methods and triangulation. Within his description of research as a process he asks, “What is happening? Why is it happening? How could the situation or *explanation* be different? [emphasis added]” (p. 246). We assert that *explanatory pluralism* is necessary to explain different aspects of phenomena -- material composition, relationships among causal variables, processes of change, functions, and evolution. Different explanation types provide explanatory accounts of different aspects of a phenomenon. Types include: the general laws governing the phenomenon; representations of the mechanisms and interactions of material composition; comparison of relevant contrast-classes; and how functions of human-system interactions fulfill a purpose and evolve.

Explanatory research is not the only goal of research in Information Systems. Research that produces knowledge of artifact design, the interpretation and understanding of meaning, or identification of emancipatory values produce knowledge claims that are distinct from *explanation*. Descriptive research provides rich descriptions of phenomena without providing explanation or supporting theory. Interpretive research is intended to increase understanding of the meanings, categories, and symbols humans attach to actions, knowledge, and systems (for discussion of the explanation/understanding distinction see: Agazzi, 1992; Apel, 1984; von Wright, 1971). Critical Theory approaches address “ethical and moral questions, by seeking to be emancipatory and bring about improvements in the human condition” (Gregor, 2006, p 612). Design research is intended to “extend the boundaries of human and organizational capabilities by creating new and innovative artifacts” (Hevner, Ram, March and Park, 2004 p. abstract). Research frameworks integrate diverse or fragmented literature and models into a comprehensible framework that provides guidance for future investigations by identifying specific research questions, by presenting theoretical perspectives, and by suggesting variables of interest and identifying possible

methodologies. Finally, mathematical models “encapsulate some slice of the real world within the confines of the relationships constituting a formal mathematical system” (Casti, 1992 p.1). A model is thus the symbolic representation of some aspect of the modeler’s reality that allows exploration of that reality mirrored within a formal symbolic system. These modes of research address quite different problems and have different models, literature and terminology, methods, exemplars, and criteria of evaluation. This current study focuses specifically on the mode of research intended to provide explanation of phenomena.

The analysis of explanation types prompts researchers to ask, "How does this research explain the phenomenon, what are the limits of that explanation, and what types of explanation have not been provided?" Using a framework of explanation types, we present a lens through which the explanation produced by research can be evaluated and new research questions become apparent. We propose that research be guided by the pursuit of different explanation types that provide additional insight rather than simply pursuing different methods. As an example of how explanatory pluralism has benefited IS research, the mature research stream of media richness is examined below.

DIFFERENT EXPLANATIONS IN MEDIA RICHNESS RESEARCH

We introduce the varied and well-established media richness research stream as an example of how pluralistic explanation has deepened our knowledge of media selection based on media and information richness. The research has benefited from a large number of contributors and from different methodologies and ontological approaches. However, we suggest that it was the explanatory pluralism informed this research stream, not the methodological or ontological pluralism.

Media richness theory was originally based on the formation of generalizable laws regarding media and information. The original theory defined the relationship between media channels and equivocal tasks in a law-like manner (Daft and Lengel, 1984; Daft, Lengel and Trevino, 1987; Trevino, Lengel and

Daft, 1987). The theory was extended to predict how organizational design can support the information needs of equivocality, based on social structures or contextual settings in which an individual or group is embedded.

Discrepancies of media richness classifications resulted in a large set of research producing new explanation through statistical analyses of the variables and the composition of media type (El-Shinnawy and Markus, 1992; Dennis and Kinney, 1998). A different type of explanation was provided by contrasting theories of social construction of technology with prior deterministic law-like arguments to explain task, media relationships, and media use using media richness theory as a foundation (Lee, 1994; Markus, 1994). The stream of studies explained differences in media selection by (1) ascribing general laws, (2) providing statistical relevance between independent and dependent variables, and (3) by contrasting choices of media types. The more recent explanations largely do not refute or negate earlier explanations but rather add to a more comprehensive knowledge of the phenomenon. We suggest that it was the evolving diversity of explanation that provided greater comprehension of media selection, not methodological or ontological pluralism. We look at this stream in more detail later in the paper.

In the next section, we illuminate the differences, scope, and relationships between the different types of explanation and argue that we are able to understand streams of research more clearly through explanatory pluralism.

3. EXPLANATION TYPES

The search for scientific knowledge can be traced back to early Greek philosophers who recognized a distinction between descriptive knowledge *that* something occurred and explanatory knowledge *why* something occurred. We define description as, "consisting of knowledge that a phenomenon occurs with presentation of objective, factual statements about a phenomenon with no explicit consideration, reflection, or accounting given to how or why the phenomenon occurs" (after Orlikowski and Baroudi, 1991). As an example, descriptive knowledge would result from a study that observes and reports the

benefits and effects of a technology initiative without the measurement of specific constructs or reference to theories.

The Philosophy of Science literature provides formal accounts and requirements of the relationships entailed by different types of explanation. Recent overviews of explanation (Salmon, 1989) and the philosophy of marketing science (Hunt, 1991) provide guidance to the seminal expositions of what constitutes a scientific explanation. These discussions have produced a complex set of theories and models of explanation from which we derived four major types of explanation: covering-law, statistical-relevance, contrast-class, and functional explanation. These explanation types differ in kind as well as form.

To enable comparison and to illuminate differences among explanation types, we provide the following definitions (Table 2), based on the original explanation work of Hempel and Oppenheim (1948), Salmon (1971), Wright (1976), and van Fraassen (1980). The four explanation types presented in this study represent major conceptual classes that may have variants. In these cases we selected the most inclusive definition for the explanation type. Variants and alternatives to these four primary explanation types are briefly discussed in Appendix A.

Table 2. Definitions of Explanation Types

<i>Explanation Type</i>	<i>Definition</i>
Covering-law (Deductive-nomological) Explanation	Consists of a deductive argument whose conclusion about observations to be made pertaining to a phenomenon is the logical outcome of applying a general or statistical law to the statements describing the conditions initially observed about the phenomenon in a given setting; whenever phenomenon X is observed to occur in the setting of conditions C, Y will be observed.
Statistical-Relevance Explanation	Consists of the identification of, and statistical relationship between, the assemblage of factors which contribute a difference in the probability of a phenomenon occurring; based on empirical data, factors A, B and C contribute to the probability of Y by amount X.
Contrast-class Explanation	Consists of a context-dependent answer to a “why-question” that selects from a set of alternatives (contrast-class) based upon the relevance to the questioner. Different questions about the same phenomenon will result in different explanations; in this context and given my purpose, why did X (rather than X* , X** ...etc) occur?

Table 2. Definitions of Explanation Types

<i>Explanation Type</i>	<i>Definition</i>
Functional Explanation	Consists of identification of a relationship between ends or goals and the preceding conditions such that the effect ensures that the phenomenon of interest continues to exist; Identification of the mechanism by which desirable goal A ensures the continued existence of the phenomenon.

These explanation types are fundamentally different from each other and account for different levels or aspects of the phenomenon being explained. Details of these major explanation types are discussed in the next sections.

COVERING-LAW (DEDUCTIVE-NOMOLOGICAL) EXPLANATION

Hempel (1948) argues that an explanation consists of the logical relationship between the *explanandum* (the event to be explained) and the *explanans* (the premise, including at least one general law). The fundamental assumption is that an explanation is based on a formal logical relationship - the phenomenon is to be expected given the premise and the general law. An IS example of a covering-law explanation is the use of a general law of media characteristics to explain communication uncertainty. The media characteristics would be determinant and highly predictive of communication equivocality in all contexts.

STATISTICAL-RELEVANCE EXPLANATION

A statistical-relevance (S-R) explanation consists of the identification of factors that have a causative relationship with the phenomenon such that its occurrence depends on the presence of the factors (Hall, 2004; Salmon, 1989). S-R explanations were developed in response to criticism of covering-law models, which relied on logical relationships entailed by universal laws. Many phenomena, especially in the social sciences, are influenced by a wide and variable set of factors that operate differently under different conditions or in different combinations. Statistical-relevance explanation accounts for the variation and interaction of factors regardless of the degree of influence on the phenomenon. The influence of a large number of causal factors leads to the use

of statistical hypothesis testing and probabilistic explanations. This overcomes the objection to covering-law models of explanation in which the phenomenon to be explained must have a high probability of occurrence (Kitcher, 1989).

An example of a statistical-relevance explanation is the relative contribution and directionality of relevant factors of website usability that rely on quantitative data and use statistical analytic techniques to explain how the factors influence usability or are grouped into dimensions. Statistical-relevance explanations may include relationships and interactions among factors, the directionality and strength of effects, and/or differences between groups.

CONTRAST-CLASS EXPLANATION

The third type, contrast-class explanation (van Fraassen, 1980), is defined as an answer to a “why-question” that involves not just the relationship between theory and fact, but also the context (Salmon, 1989). Sometimes referred to as “pragmatic” explanation, this view incorporates the concept of contrast classes, so that a question “Why X?” becomes “Why X rather than X*, X**...?” The suitability of an explanation is dependent on both the context of the question and the purpose of the questioner. Explanation can be thought of as audience-variant, “therefore what counts as an explanation differs as a function of differences in interest” (Ruben, 1990, p. 21). In van Fraassen's (1980) example of the explanation of the height of a tower, the architect's explanation would result in a description of the plans, whereas the builder's explanation might rely on the nature of the construction materials and the stability of the tower. But the answer to a specific contrast question, “Why is the height h rather than h^* ?” reveals that the length of the shadow cast by the building was important to the owner. This provides the relevant explanation for the question of the tower's height (Kitcher, 1989). The relevant explanation depends on who is asking the question and is specific to that particular question (Kitcher, 1989). A contrast-class explanation may create several new questions involving other contrast classes, each of which may have a different explanation.

In IS, research resulting in contrast-class explanation is exemplified by studies comparing contrasting theoretical perspectives in analyzing variables that influence an IS phenomenon, or studies contrasting differences in group behavior (e.g., “Why did the group adopt *this* technology instead of *that* technology?”). The study may rely on description or statistical analysis but contains an explanation of the contrast class in addition to showing group differences.

FUNCTIONAL EXPLANATION

The fourth explanation type, functional explanation, accounts for cases where legitimate explanations are provided by the end state or goals of a phenomenon (Elster, 1996a; Kinkaid, 1994; Markus, 2004) First-person descriptions of behavior are frequently couched in these terms, e.g., “Why did I ride my bike to the store? To buy spaghetti.” The future goal explains the event, based upon belief that the event will fulfill the goal. The explanation is correct even if the store has no spaghetti. From a variable study perspective, the desire causes the action. But from a functional perspective, we can observe that riding the bike also fulfills the function of getting exercise, being outdoors, and relaxing all of which may contribute to the behavior. Functional explanation seeks to identify the classes of functions that “go together” and fill a niche in the user's goals and leads to insights into what people are actually doing (Hovorka, 2005).

Wright (1976) predicates functional explanations on the consequences of a feature. The explanation of a feature's presence is due to the fact that when it was present in the past, it had certain positive results or consequences and its presence is reinforced. Whitehead (1967) proclaimed that *what something is* cannot be differentiated from *what it does*. Since humans are constantly anticipating changes and reacting to feedback from their environment, they make adjustments to those changes to fulfill their needs or goals. Actions that produce negative feedback are avoided, whereas positive feedback reinforces behaviors. Asking questions from this perspective is not about identifying causes, but rather about analysis of what functions the activity fulfills. An example of research producing a functional explanation is a study that explains success of an

organization in a competitive environment, based upon its adoption of an information technology. Success is explained by the strategic advantage gained through changes resulting from the implementation of the technology. The use of the technology will persist as long as it provides a competitive advantage, since mechanisms in the environment select for organizations with traits that positively affect survival (Kinkaid, 1996).

SCOPE AND LIMITATIONS OF EXPLANATION

Many research papers describe the limitations of the study, based on the composition or size of the sample, the number or type of cases examined, and other limiting characteristics. In addition to these identified limitations, each type of explanation has a specific meaning and scope of *what is actually explained*. Explanation types are also limited in *how* they explain, e.g. by invoking a general law, by identifying factors, by comparing contrast-classes, or by defining functional relationships. The limitations and inadequacies of each explanation type have been summarized (Table 3) and illuminate the scope and the advantages of each type.

Table 3. Scope and Limitations of Explanation Types

<i>Explanation Type</i>	<i>Limitation</i>
Covering-law (Deductive-nomological) Explanation	Covering-law explanation has been heavily criticized on syntactic and linguistic bases, the asymmetry of explanation and prediction ¹ , and the arbitrariness of statistical occurrence ² (Salmon, 1989). Additional inadequacies arise due to the complexity of human action (Fay, 1996; Hayek, 1996). It is difficult to determine law-like relationships to the rapidly changing environments of socio-technical IS phenomenon.
Statistical-Relevance Explanation	S-R explanation are subject to the limitations and requirements of quantitative data collection and statistical analysis (Pervan and Klass, 1991) and identification of relevance (Salmon, 1989; Salmon et al., 1971). There are major questions regarding identification of causal

¹ For example, a falling barometer allows inference that there has been a drop in air pressure, but the drop cannot be explained by referring to the barometer. Rain will explain why a driveway is wet, but a wet driveway doesn't explain why it rained.

² For example, in an experiment with two outcomes, X and Y, with $p < .05$ and $p > .05$, respectively, enough trials will produce some instances of Y. Therefore, we have a statistical explanation of X but have not explanation why Y occurred.

Table 3. Scope and Limitations of Explanation Types

<i>Explanation Type</i>	<i>Limitation</i>
	relationships in human behavior and the importance of context (Dreyfus, 1986; Rosenberg, 1988) due to the multiplicity and diversity of influences in complex systems and the incompleteness of our knowledge of causal relationships (Fay, 1996).
Contrast-class Explanation	Contrast-class explanation lacks criteria ruling out potential alternative answers to why-questions. In addition, the case-specific nature of contrast classes makes prediction and generalization difficult and the specialized characteristics of information systems makes determination of equivalent contrasts problematic.
Functional Explanation	Functional explanation is controversial in both social science and philosophy. Critics deny that functional claims have adequate evidence, that even confirmed claims are truly explanatory, and that functionalism's biological analogies are not applicable to the social realm (Rosenberg, 1988). Practically, it is often difficult to identify specific functions in systems that have multiple functions in different contexts.

Confusion can arise if researchers overreach and claim one explanation type from data supporting a different explanation type. Recognizing the scope of each explanation type, how it explains, and why that type of explanation is warranted from the data, will help researchers understand the limitations of the explanatory knowledge furnished by research. By asking, "What type of explanation does this study furnish?" researchers are better equipped to avoid confusing different types of explanation, and will be better able to identify opportunities to advance and strengthen streams of research.

As stated, the goal of this research is to present explanation as a lens through which IS research can be improved. An exhaustive framework of explanation types is not required to demonstrate that a pluralistic approach to scientific explanation provides different aspects of knowledge about the phenomenon being examined. Further research may demonstrate the scientific value or necessity of additional explanation types, but the four types we examine support our argument.

4. EXPLANATION AS A LENS FOR RESEARCH

In this section we review two applications of explanation types as a tool for study. In the first case, we revisit the earlier discussion of media richness and illustrate how explanatory pluralism provides supports evolution of thinking within this research stream. Next, we examine the types of explanation present in the IS field and the emergent relationships between explanation, ontological approach and research method.

EXPLANATION IN MEDIA RICHNESS RESEARCH

Selected research focused on media richness (Table 4) provides an example of how varying explanations have produced a fuller understanding of the original observations and the subsequent production of new theory.

Table 4. Selected Studies on Media Richness theory

<i>Study</i>	<i>Research Question and Method</i>	<i>Explanation Type</i>
Daft and Lengel (1984)	Relationship between task and media characteristics (content analysis)	Covering-law
Daft et al. (1987)	Managers' selection of communication media (field study)	Contrast-class
Trevino et al. (1987)	Description of media selection and its relation to media characteristics (field study)	Contrast-class
Schmitz and Fulk (1991)	To predict perceptions, assessments, and use of media (field study)	Contrast-class
Rice (1992)	Determine the effect of task on media choice and performance (field study)	Statistical relevance
El-Shinnawy and Markus (1992)	Determine differences in preference for media type (field study)	Statistical relevance
Markus (1994)	Explain and predict media use (field study)	Contrast-class
Lee (Lee, 1994)	Illustrate richness as an emergent characteristic (field study)	Contrast-class
Ngwenyama and Lee (1997)	Review of field study from Markus (1994)	Contrast-class
Dennis and Kinney (Dennis and Kinney, 1998)	Determine the effects of media richness on decision making (experiment)	Statistical relevance

Early work on media richness theory was based on the formulation of generalizable laws (covering law explanation) that suggested its predictive value. The original law-like generalization prescribed relationships between media channels and equivocal tasks (Daft and Lengel, 1984) based on the structural characteristics of media. Field studies were initially used to determine its validity in an organizational setting (Daft and Lengel, 1984; Trevino et al., 1987). Later field studies of media richness theory investigated the relevance of social influence and organizational context in defining media richness (Schmitz and Fulk, 1991; Markus, 1994; Lee, 1994) and found that apparently simple information requests were actually messages rich with information and subtle meaning. These instances of information richness through low density channels were explained by providing different contrast-classes of environments. The theory was also explored experimentally (Dennis and Kinney, 1998) and through surveys (Rice, 1992; El-Shinnawy and Markus, 1992). These studies operationalized media characteristics and developed statistical relevance explanations of the relationship of media richness to performance and media preference. Over all, covering law, contrast-class, and statistical relevance explanations provided mixed support of the original media richness theory.

Ngwenyama and Lee (1997) produced a contrast-class explanation by directly contrasting different theoretical approaches with the work of Markus (1994) from a critical-theory perspective. They explained how social influences guide individuals in their actions and described individuals as socially and contextually constructed actors on their environment. This contrast-class explanation provided a foundation of a more socially aware theory of media richness that provides opportunity for new application of the explanation types.

These studies formed a collective research stream through which the comprehension of media richness evolved through development of different explanation types. Studies in varied contexts resulted in three different explanation types and ultimately led to formulation new theory. No one of these explanations supersedes another. Explanation types coexist, and each type adds to our overall comprehension of the phenomenon.

EXPLANATION IN INFORMATION SYSTEMS

The elucidation of explanation provided in this paper can be used to identify gaps in IS research beyond the current classification by ontology and methodology. To further illustrate the value of explanation as an independent tool to identify research opportunities, it is necessary to demonstrate that research from multiple perspectives and/or using multiple methods would not necessarily produce explanatory pluralism.

More importantly, in examining prior literature we strengthen our argument that comprehension of, and explicit use of explanation should hold a place in IS research. At this point in the paper, our reasoning to support this argument has been that using different explanation types strengthen IS research. In examining IS literature for published explanation types, we illustrate that multiple explanation types are, in fact, already present in IS research. This finding, in combination with the earlier reasoning for explanatory pluralism, tells us that researchers need to recognize and expand the explanatory pluralism they already have so as to strengthen IS research.

Our approach was to code a subset of published IS research for explanation type produced, ontological approach, and method used. An exhaustive review of the literature was not necessary because our goal was to discover whether explanation type was determined by ontology or by research method. Examples in which different methods or ontologies produced the same type of explanation would indicate that simple multi-method approaches do not necessarily produce the explanatory pluralism that enriches research streams such as media richness.

To examine explanation in IS, and specifically its relationship to ontology and methodology, we reviewed published research literature in two IS Journals in the years 1990-91 and 2000-01. The two blocks of time in Information Systems research were chosen to represent our evolving field and the types of research and the associated methods and ontologies that have evolved and emerged with it. Target journals were *Information Systems Research* (ISR) and *Management Information Systems Quarterly* (MISQ). These journals provided a suitable venue

for focusing attention and reflection on the differences among explanation types in Information Systems research. In addition, these journals provided our desired 10-year span of review to identify trends that have occurred within the same journal. Additional journals were not included to (1) restrict the study to a reasonable sample size, and (2) to provide longitudinal depth across time and not cross-sectional breadth across journals. The total number of articles reviewed (167) is consistent with previous literature describing characteristics of IS research (e.g. DeLone and McLean, 1992; Orlikowski and Iacono, 2001). Of the 167 articles examined, 76 provided explanation types described in Table 2. The remaining articles (91) presented descriptions of IT -related outcomes (42 papers), research frameworks (30 papers), artifact designs (8 papers), and mathematical models (11 papers). These research outcomes do not fit into the explanatory framework developed here.

The primary classification of articles was based on the types of explanation discussed in Section 3. The ontological perspectives and the research method for each study were also coded. Ontologies include interpretive and positivistic (no examples of critical theory were found so the classification was not included in the results table). The research methods, from Orlikowski and Baroudi (1991), include experimental, case study, survey, field study, mixed method, instrument development, and action research. The category of “other” includes event studies and process traces.

Although assignment of explanation types to individual papers was usually clear, ambiguous studies required interpretation due to the difficulty in specifying exact classification boundaries and the presence of multiple explanatory elements. For example, some research presenting contrast-class explanation relied on statistical analysis. In these cases we interpreted the primary purpose of the research (e.g., whether the paper was presenting a model with a description of the problem, or whether the research was testing a model and presenting statistical evidence).

Following DeLone and McLean’s (1992) approach, coding was performed by three coders. Because coding of the articles required evaluation and

interpretation of the definitions, inter-rater reliability (Miles and Huberman, 1994) was a concern. Therefore, two primary coders were each responsible for coding the entire data set, and a “coding moderator” resolved differences between the primary coders. Two of the coders were faculty at major research universities and the third was a fourth-year doctoral candidate. The two coders and the moderator met regularly over the course of the study to discuss and resolve explanatory, ontological, and methodological differences coded from the articles. The percentage of coding agreement is shown in Table 5.

Table 5. Coding Agreement

<i>Coded Category</i>	<i>Percent Agreement</i>
Explanation Type	79%
Ontology	91%
Research Method	92%

These percentages indicate reliable application of the explanation definitions to the articles and are consistent with accepted coding agreement (Boudreau, Gefen and Straub, 2001).

Findings

Our findings suggest that the ontological perspective does not determine the explanation type furnished by the research (Table 6). There is a tendency for specific explanation types to be produced in studies following a specific ontological approach (e.g. positivist studies predominantly furnish statistical-relevance explanation).

Table 6. Explanation Types and Ontology

		<i>Explanation Type</i>			
		Statistical-Relevance	Contrast-class	Functional	Total
		Count	Count	Count	Count
1990-1991	Ontology	21	4	2	27
	Ontology	0	2	0	2

³ The term 'positivist' is used in a broad sense to refer to researchers interested in hypothesis testing, measurement, and validity (Chen, W. and Hirscheim, R. (2004) A Paradigmatic and Methodological Examination of Information Systems Research From 1991 to 2001, *Information Systems Journal*, **14**, 197-235., it does not refer to 'logical positivist'.

⁴ The term 'interpretive' refers to researchers interested in the understanding that the human subjects have of themselves, each other, their local setting, and their history (Orlikowski, W. and Baroudi, J. (1991)

	Both	1	0	0	1
2000-2001 Ontology	Positivist	36	7	1	44
	Interpretive	0	1	0	1
	Both	0	1	0	1
Total					76

But positivist approaches also produced examples of contrast-class and functional explanation. In all, explanatory research using a positivist approach resulted in statistical-relevance (80%), contrast-class (15%), and functional (4%) explanations. It is noteworthy that no examples of deductive-nomological (covering-law) explanation were identified (therefore the category was not included in Table 5). Covering-law variants (See Appendix A) have found empirical support in some social science areas and we suggest that the lack of this explanation type is due, in part, to our limited sample and also to the difficulties of identifying law-like relationships when explaining human behavior, rather than any logical exclusion of such relationships. The limited interpretive research in our sample also furnished result in two explanation types. This implies that designing research questions that will furnish specific types of explanation is a better means of achieving pluralistic explanation than integrating ontological approaches. Combining positivist and interpretative approaches will not necessarily result in explanatory pluralism. These findings also suggest that researchers are unaware of the potential for more comprehensive explanation possible through pursuit and construction of other explanation types.

The results of our examination of the relationship between explanation type and research method are presented in Table 7. Specific research methods did tend to produce specific explanation types (e.g., statistical-relevance explanation is the result of 87% of the articles using experimental methods), but do not determine explanation type. In addition to statistical-relevance explanation, experiments also resulted in contrast-class (2), and functional explanations (1). Conversely, other research methods can also be used to produce statistical-

Studying Information Technology in Organizations: Research Approaches and Assumptions, *Information Systems Research*, **2**, 1-62, Walsham, G. (1995) The Emergence of Interpretivism in IS Research, *Information Systems Research*, **6**, 376-394.

relevance explanations (e.g., case study (2 papers), survey (14), field study (5), and mixed method (5)). The lack of binding of specific explanatory outcomes to specific research methods poses both opportunities and pitfalls for researchers. Producing a richer set of explanations does not necessitate a change in method. At the same time, changing methods does not necessarily result in producing a different level of explanation of a phenomenon.

Table 7. Explanation Type and Research Method

		<i>Explanation Type</i>			Total Count
		Statistical-Relevance Count	Contrast-class Count	Functional Count	
Research Method	Experiment	21	2	1	24
	Case Study	2	5	0	7
	Survey	14	2	2	18
	Field Study	5	3	0	8
	Mixed Method	5	1	0	6
	Instrument Development	2	0	0	2
	Other	9	2	0	11
	Total				76

5. DISCUSSION

This study of explanation in IS is informative in four ways. First, we argue that the prescription of a singular best practice explanation type is neither possible nor desirable in the interdisciplinary field of IS. Different types of explanation provide complementary knowledge regarding different aspects of phenomena. A wide variety of questions arise at the intersection of material information artifacts and social and purposeful human behavior. Answers to these questions require different types of explanation. We suggest that recognition of the complementary and distinctive explanation types can help researchers develop questions relevant to their line of inquiry.

Second, clarifying the language of explanation will help researchers describe their results clearly and avoid confusion regarding the meaning of the research. Researchers currently use the term "explanation" to refer to many different concepts and have unintentionally conflated different types of explanation when describing what their own research "explains." Data supporting a statistical-relevance explanation does not support discussion of explanation regarding a

general law. The reverse also holds: covering-law explanation does not support conclusions about the relevance of factors contributing to a phenomenon. Our clarification of the meaning, scope and limits of explanation will enable researchers to be clear and consistent in the explanation their research provides. Familiarity with the types and limitations of explanation in research can help avoid confusion about the meaning and scope of research results and can result in more complete explanation of phenomena.

In addition, by explicating the differences between types of explanation, and the inherent scope and limitations of each type, we increase the understanding of how research results contribute to knowledge. Each explanation type provides different information about a specific phenomenon so that pluralistic explanation provides a more complex and complete view of the world. Classification of explanation types presented by research therefore provides an additional criterion for assessing research outcomes and can lead to insights about future research.

Finally, research streams that produce a limited explanatory scope provide opportunities for researchers to exploit other types of explanation in the pursuit of fuller understanding of the phenomenon. For example, research can focus on (1) rich description of the phenomenon, (2) general laws which influence whole classes of phenomena, (3) variables or factors which make a causal difference in the probability of an phenomenon, (4) explanation based on contrast classes and relevance conditions and, (5) functional explanation providing insights into what functions "go together" when people use information technologies and how people and technologies adapt and evolve. Taken together, this pluralistic explanation would provide a more comprehensive knowledge of a phenomenon than would be produced by relying on multiple methods.

IMPLICATIONS FOR RESEARCH

We propose that analysis of explanation types produced in ongoing and in prior research can guide future research and can help researchers develop a more comprehensive pluralistic explanation of the different aspects of a

phenomenon. For example, a description of a phenomenon will include what happened, provide background, identify the boundaries of the phenomenon, the context of the research. Based on this description, different research questions may be developed which pertain to different aspects of the phenomenon. In one direction, a researcher may seek statistical-relevance explanation of the relationships among internal material components and of statistically relevant causal factors. Other research questions may pursue a functional explanation of goals of actors or adaptation of an IS artifact in relationship to the external environment. Additional lines of questioning may be used to find general law-like relationships that unify a wide class of phenomenon under a covering-law explanation. Each of these research questions will produce a different type of explanation, that when taken together, will produce a greater comprehension of the phenomenon than any single explanation type alone.

Different types of explanation result from questions about different aspects of the phenomenon. As previously demonstrated, simply changing research method may result in the same type of explanation. Although this may be beneficial, it may not advance our knowledge of the phenomenon to the degree expected. Application of this explanatory framework is not merely an issue of terminology; it can guide researchers in designing research that will provide insightful and original explanation of the phenomenon under investigation. By analyzing the types of explanation in existing research on a topic, researchers can identify opportunities to either confirm existing explanation or advance knowledge by creating a pluralistic explanation of the phenomenon.

The results presented in Table 6 and 7 are generally in agreement with the trends in paradigmatic and methodological pluralism observed in previous studies of the IS discipline (Chen and Hirscheim, 2004; Orlikowski and Baroudi, 1991). The dominance of statistical-relevance explanation in our sample reflects the observed dominance of positivist research based on survey and experimental data (Chen and Hirscheim, 2004). Although our study sample came from North American journals, the different research emphasis of European journals (Chen and Hirscheim, 2004; Galliers and Whitley, 2002), would change the relative

frequency of use of difference explanation types but would not alter our argument that a more pluralistic approach to explanation would provide valuable insights for the field.

Pursuing explanatory pluralism may occur at three levels: the IS discipline, multi-researcher research streams, and at individual research programs. At the discipline level, awareness of multiple explanation types will allow editors and reviewers to critique the actual explanatory content of research contributions and accept research that provides alternative explanations to the dominant statistical-relevance models. If the field were to move in the other direction, toward a singular prescribed explanation type, we would be at risk of losing valuable insights into phenomenon. Researchers working within well established streams of research could analyze extant literature by explanation type. Identification of underutilized explanation types may provide the best opportunity for unique contributions to the research stream. Individual research programs can benefit from knowing what explanation types exist for the researcher's areas of interest and therefore where contributions can be made. As with all research design judgment calls, circumstances, available data, methodological expertise, and other factors may dictate pragmatic choices regarding the research questions and type of explanation pursued. There are also practical considerations. For example, a statistical-relevance explanation will require researchers to carry out quantitative research involving samples from populations (the basis of inferential statistics). However, if case-based data is available, a contrast class explanation might be easier to develop. It should be noted that, with careful planning of data collection of large archival or survey-based datasets, it is possible and potentially insightful to develop relevant contrast-classes and produce a contrast class explanation in addition to a statistical-relevance explanation of factors and outcomes. This is possible because explanation types are not determined by research methods, data type, or ontological approach. Planning research that allows for the development of multiple explanation types requires imagination, forethought, and the creation of questions that will lead to different explanation types.

6. CONCLUSIONS

In this paper we demonstrate the need for a better understanding of the concept of explanation by exhibiting the inconsistent use of the concept in a selection of research articles. By examining a successful research stream, media richness, we show that the variety of outcomes that *explain* the phenomenon in different ways adds to our knowledge of a phenomenon. These different types of explanation are explicated by examining the literature from the philosophy of science and are shown to complement rather than supersede each other. We return to the media richness stream of IS research to show how its success can be attributed to explanatory pluralism rather than ontological or methodological pluralism. Finally, we examine a sample of articles across a ten year timeframe from two top-ranked IS journals to illustrate the multiple explanation types that exist in IS research and demonstrate that specific explanation types do not necessarily result from different ontological approaches or methods used. This indicates that explanatory pluralism requires more than simple methodological or ontologically pluralist research. These steps underlie our argument that IS researchers can benefit by understanding the different explanation types of when they critique research and by applying this framework in the design of research.

Analysis of explanation types is an important tool for identifying and classifying the outcomes of IS research. Classification of the explanation type provided by research can guide research planning to produce explanatory pluralism and greater comprehension of a phenomenon than can be achieved solely through methodological or ontological variation. Specific explanation types have limits and scope in regard to what and how they account for phenomena. Understanding the nature of explanation will enable researchers to understand the actual meaning of research outcomes and will help avoid overreaching or misapplication of the concept of explanation to their data. As seen in the case of media richness, different research questions produce different types of explanation that combine to increase our scientific knowledge.

Both the academic and practitioner communities will benefit from understanding the scope of research explanations and the implications for the

relevance of research. By examining explanation types and associated terminology, and understanding the relationships among explanations, ontologies, and methods, researchers are better equipped to recognize what the research literature and their own research studies are, in fact, explaining.

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Exhibits

Appendix A

These alternative types of explanation were not used in our analysis for three reasons. First, some are variants of included explanation types were classified under the more general type. Second, some types are more closely aligned with meaning and understanding than with explanation.

Deductive-nomological (covering-law) Explanation Variants

There are variations of the deductive-nomological including the Inductive-Statistical model, dispositional model, motivational model, functional interdependence model, Brody's Essential Property model, and Jobe's Priority Model (for details see Achinstein, 1983). As these are variations that add conditions to the initial covering law logic, we chose to subsume them under the general model.

Causal-mechanical Explanation

In his discussion of historical changes in the role of science in explaining phenomenon, Salmon (1998 p. 87) states, "we want to know *how things work* and...*what they are made of*. This may be characterized as causal-mechanical understanding [original emphasis]." Salmon uses the term "causal-mechanical" to contrast this type of explanation with the unification, or law-governed, view of scientific explanation. The causal-mechanical (Salmon, 1984) model is a process theory characterized by the ability to transmit a *mark*, or local modification, in a continuous way. The causal mechanical model is most applicable in physical systems when energy is transmitted. When "action at a distance" or there exists arguably causal interactions without continuous transfer of energy and momentum are involved the model fails to provide explanation. As previously noted, identification of causal processes in human behaviors is problematic and therefore this model is not well suited for human-system interactions. Furthermore, in developing the concept of causality, Salmon asserts the "centrality of certain kinds of statistical relevance relations in the notions of

causal explanation" (Salmon, 1998 p. 109) and that "every relation of statistical relevance must be explained by relations of causal relevance" (p. 111). Given that statistical-relevance explanation and causal-mechanical explanation are each based on causal relations and each pertains to antecedent-consequent relations, we believe that in IS research the distinction between these two types is not of value and that most IS researchers view statistical models as (implicitly) causal models.

Rational-choice (Reasons) Explanation

Rational-choice explanation (Elster, 1996b) seeks to explain intentional behavior or action, based upon the beliefs and desires of an agent. For Rosenberg (1988) the fundamental question for social science researchers is how to explain human action and we must ask "why is citing the desires and beliefs explanatory? What connection obtains between the desires and the beliefs and the action that makes them relevant to the behavior, that enables them to satisfy our curiosity about the behavior?" (Rosenberg, 1988 p. 24). One approach is to consider beliefs and desires as causes which "bring about", "result in", or "determine" action. From this perspective, causal models and law-like generalizations will underlie explanation in the social sciences. To operationalize beliefs and desires, we can consider them as independent variables, which are statistically and causally related to a dependent outcome. Therefore we suggest that this application of rational-choice explanation can be subsumed under the more general statistical-relevance explanation.

On the other hand, beliefs and desires can be considered *reasons*, or *justification* for action in that "they justify it, show it to be rational, appropriate, efficient, reasonable, correct." (Rosenberg, 1988 p. 28). This is the position taken by Searle who states "the beliefs, desires and other reasons are not experienced as causally sufficient conditions for a decision (the formation of a prior intention)" (Searle, 2001 p. 62). From this perspective "the aim of [social] science is interpretation and intelligibility" (Rosenberg, 1995, p. 34). This type of justificatory explanation makes the action understandable to the actor or to others, and

therefore it is aligned with interpretive understanding rather than the types of explanation we are analyzing.

Illocutionary Explanation and Dialectical Explanation

Achinstein's (1977; Achinstein, 1983) Illocutionary theory characterizes explanation as both a *process* and a *product*. He defines the act of explanation as a process in which one person produces understanding in another by answering a certain kind of question with a content-giving proposition. An explanation is deemed sufficient when the questioner is satisfied with the answer and "will also depend on what the audience already knows and is interested in finding out." (Achinstein, 1984 p. 84). Dialectical explanation (Walton, 2004) is also based upon the concept of understanding achieved via dialog. Along with the non-causal version of reasons explanation, we consider these types directly aligned with understanding rather than with explanation.