A Theory of Theories in Information Systems

Shirley Gregor

School of Business and Information Management
Australian National University
Canberra ACT 0200

Abstract

The aim of this paper is to explore what is meant by ‘theory’ in Information Systems. Different conceptions of causality are discussed, as they are seen as key to understanding different types of theory. Five different types of theory are distinguished: (i) theory for analysing and describing, (ii) theory for understanding, (iii) theory for predicting, (iv) theory for explaining and predicting, and (v) theory for design and action. Illustrations of relevant work in Information Systems are provided, as are relevant research methods, and the form of contributions to knowledge in each. The limited discussion of the nature of theory in Information Systems indicates that further work is needed, particularly with respect to theory for design and action.

Introduction

The aim of this paper is to explore what is meant by “theory” in the discipline of Information Systems. There are a number of grounds for believing that this meta-theoretical exploration is both necessary and timely. Calls for “good theory” in Information Systems continue. Watson (2001, vii) argues that:

Over the years, as a discipline we have used a variety of theoretical bases from other disciplines and have developed a number of frameworks that classify MIS research. A core set of concepts that we collectively agree are the foundations and driving forces of MIS research are emerging in our field. We need to accelerate this materialization of a ‘good grand theory’.

Moreover, research students in Information Systems, as in other disciplines, are asked to make a contribution to knowledge in their theses and to present their work in terms of an overall conceptual framework (Moses, 1985). Our leading journals expect that papers accepted for publication will make theoretical contributions and add to knowledge (for example, Benbasat, 2001).

Despite the recognition of the need for theory development and for contributions to knowledge, there is surprisingly little discussion in Information Systems forums of what constitutes theory in our discipline and what form contributions to knowledge can take. Many information systems researchers who use the word ‘theory’ repeatedly in their work fail to give any explicit definition of their own view of theory. An example is the text from Boland and Hirschheim (1987) on critical issues in information systems research. This text does not contain a general entry for “theory” in the index or detailed discussion of what constitutes theory. A number of papers that discuss different research paradigms (for example, Mingers, 2001; Klein and Myers, 1999) offer little in the way of definitions or discussion of the nature of theory or types of knowledge that can be expected to result from different research approaches. This state of affairs should be redressed. Surely what we are trying to build (theory) takes precedence over the tools and methods we use.
Examinations of what is meant by theory occur in other disciplines. An issue of the *Academy of Management Review* (1989, Vol. 14, No. 4) focussed on theory and theory development. Similarly an issue of *Administrative Science Quarterly* (1995, Vol. 40, No. 3) had articles about what theory is, what theory is not and how theorizing occurs. Descriptions of theory in the social sciences can also be found in Dubin (1976), Freese (1980), Kaplan (1964), Merton (1967) and Weick (1989). More established disciplines have considerable histories of enquiry into the nature of theory. In the philosophy of science there has been discussion of scientific knowledge and the formulation of theory over a very long period (Locke, 1689; Hume, 1748; Popper, 1980).

Information System has a number of referent disciplines, including mathematics, logic, philosophy, psychology, sociology, and management, from which theoretical bases are drawn and adapted. It is not surprising, given that many of our community have come from these different disciplines, that there are different views on what constitutes theory. The Information Systems discipline is now, however, recognized as a distinct discipline and we should devote some effort to considering the nature and form of theory in our own discipline. Some thought on what delineates Information Systems is needed. One definition is that Information Systems concerns:

> the effective design, delivery, use and impact of information technology in organizations and society (Avison and Fitzgerald, 1995, p. xi).

We do not agree with Webster and Watson (2002) that Information Systems is another management field, like organizational behaviour. A characteristic that distinguishes Information Systems from these fields is that it concerns the use of artefacts in human-machine systems. Thus, we have a discipline that is at the intersection of knowledge of the properties of physical objects (machines) and knowledge of human behaviour. Information Systems can be seen to have commonalities with other design disciplines such as architecture or engineering, which also concern both people and artefacts, or with other applied disciplines such as medicine, where the products of scientific knowledge (drugs, treatments) are used with people.

From a definition of Information Systems, we turn to a consideration of what is meant by the word “theory”. In this exploratory paper a wide rather than a narrow view of theory is adopted, to encompass a number of different views. Dictionary definitions show that the word “theory” can take on many meanings, including: “a coherent group of generic propositions used as principles of explanation for a class of phenomena”; “a proposed explanation whose status is still conjectural, in contrast to well-established propositions that are regarded as reporting matters of fact”; “that department of a science or art which deals with its principles or methods, as distinguished from the practice of it”, “a system of rules or principles”; or “conjecture or opinion” (Macquarie Dictionary, 1981). Thus, the word theory will be used here rather broadly to encompass what might be termed elsewhere conjectures, models, frameworks, or “body of knowledge”.

The remainder of this paper proceeds as follows. First, it considers general notions of theory in more detail and different conceptions of causality. The body of the paper is devoted to an exploration of five different types of theory, which are labelled: (i) theory for analysing and describing, (ii) theory for understanding, (iii) theory for predicting, (iv) theory for explaining and predicting, and (v) theory for design and action. These headings are not regarded as mutually exclusive, and the different types of theory are interrelated. Some theories would include components from all the types of theory discussed here. Illustrations of relevant work in Information Systems are provided under each heading, as are related research methods, and the form a contribution to knowledge could take. The paper concludes with some implications that arise from consideration of these different views of theory.
The scope of this article should be noted. Within the confines of a single paper only a brief description can be given of philosophical arguments that are complex and contentious. The aim is to give a general perspective on the nature and types of theory in Information Systems, and to provide references for further reading.

About theory

In this section underlying ideas relevant to theory in general are presented to enable the subsequent discussion of theory in Information Systems. The discussion avoids as far as possible the use of labels of the various “isms” that occur in much discussion of research methods, especially the depiction of dichotomies such as “subjectivism-objectivism”, “interpretivism-positivism”. Often the discussion of these positions occurs at such a level of generality that deeper issues are avoided and confusion results. Mingers (2001) argues that paradigm incommensurability has been overstated. In addition, these labels are given different meanings by many different authors. Rather than conflate many different ideas under one label, the aim here is to discuss each issue separately, and refer to original sources where possible. The positions adopted on these issues are such that the perspectives on the different types of theory presented in the following sections are not incommensurable.

The nature of theory

In general, theory answers a human need to make sense of the world and to accumulate a body of knowledge that will aid in understanding, explaining, and predicting the things we see around us, as well as providing a basis for action in the real world. In the words of Popper (1980, p. 59):

> Scientific theories are universal statements. Like all linguistic representations they are systems of signs or symbols. Theories are nets cast to catch what we call ‘the world’; to rationalize, to explain and to master it. We endeavour to make the mesh even finer and finer.

Theories are seen as uncertain and as approximate representations of reality (fallibilism):

> The empirical basis of objective science has thus nothing ‘absolute’ about it. Science does not rest upon solid bedrock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down into any natural or ‘given’ base; and if we stop driving the piles deeper it is not because we have reached firm ground. We simply stop when we are satisfied that the piles are firm enough to carry the structure, at least for the time being (Popper, 1980, p. 111).

Ontological and epistemological position

The ontological position adopted here recognizes theory as having an existence separate from the subjective understanding of individuals. A theory can be regarded as:

> constructions about which there is relative consensus (or at least some movement towards consensus) among those competent (and in the case of more arcane

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1 Sarantakos (1998, p. 4) refers to Karl Popper as “one of the last and most influential logical positivists”. Popper himself vigorously denied being a logical positivist and in fact claimed responsibility for the death of logical positivism (Popper, 1986, p 88). See also McGee (1977, p 11).

2 Saranatokos (1998, p. 41 and following) identifies quantitative methods with naïve realism – a position rejected quite strongly by people who carry out quantitative work but certainly do not regard themselves as naïve realists (for example, Weber, 1997).
material, trusted) to interpret the substance of the construction (Guba and Lincoln, 1994, p.113).

This position corresponds to ideas expressed by both Habermas and Popper. Habermas (1984) recognizes three different worlds - the objective world of actual and possible states of affairs, the subjective world of personal experiences and beliefs, and the social world of normatively regulated social relations. These three worlds are related to Popper’s worlds 1, 2 and 3 (Popper, 1986). World 1 is the objective world of material things. World 2 is the subjective world of mental states, and World 3 is an objectively existing but abstract world of man-made entities – language, mathematics, knowledge, science, art, ethics and institutions. Thus, theory belongs to World 3.

Theory and theoretical knowledge are invented by human beings rather than being discovered. We invent concepts, models and schemes to make sense of experience and, further, we continually test and modify these constructions in the light of new experience. Theoretical terms are abstractions, human inventions that are simply convenient devices for managing and expressing the relations among observables. Concepts and ideas are invented but correspond to something in the real world (Schwandt, 1994, pp. 125-126).

There is at least one paradigm which is incommensurable with this ontological perspective. Some proponents of constructivism and interpretivism argue that constructions (knowledge) are “resident in the minds of individuals”, that is, they cannot be said to exist outside the self-reflective capacity of an individual mind and cannot be publicly or extensively shared (Guba and Lincoln, 1989). Acceptance of this paradigm makes the discussion of theory in this paper problematic, as it does many other concepts such as education and meaningful interpersonal communication.

The epistemological position adopted follows that of Kant. Kant (1781) argued that our knowledge of objects of nature must conform in advance to the structures of the human mind, *(a priori* knowledge) and that we can therefore have knowledge only of objects as they appear to us, and not as they are in themselves (transcendental idealism). Knowledge arises both empirically from experience and through reason.

**The need for generalization**

A number of different views of theory are encompassed in this paper with a view to being inclusive. There is still a limit, however, to what is classed as theory. From the definitions above it can be seen that abstraction and generalisation about phenomenon, interactions and causation are thought to be at the core of a theory. We do not regard a collection of facts, or knowledge of an individual fact or event, as theory. “Data are not theory” (Sutton and Shaw, 1995, p. 374), though data may form the foundation for theoretical development. For this reason, the word “knowledge” when used in this paper does not refer to knowledge of specific events or objects, but means body of knowledge, or theoretical knowledge.

Views differ on the degree to which generalization or universality is required in theory. Popper (1980) provides a detailed coverage on universality and the problems associated with this concept. His view is that the natural sciences should aim at strictly universal statements and theories of natural laws (covering laws), though these laws can never be held with certainty. In the social sciences, however, it is thought unlikely that social phenomena are determined in accordance with strict laws of nature. For example, wars do not result from antecedent political tensions in the same way that earthquakes result from antecedent conditions on plate tectonics (Little, 1999). Nevertheless, we expect in the social sciences (and Information Systems) that theory should still include generalizations to some degree.
Causality

The idea of causality, or the relation between cause and event, is central to many conceptions of theory. When theory is taken to involve explanation and understanding, it is intimately linked to ideas of causation. Often, to ask for an explanation of an event is to ask for its cause. Similarly, the ability to make predictions from theory can depend on knowledge of causal connections. For example, the knowledge that user involvement contributes to the development of “successful” information systems warrants the inference that if users are not involved in the development of a particular system, then the system is less likely to be “successful”.

The concept of causality is problematic. Hume believed that we are unable to see or prove that causal connections exist in the world, though we continue to think and act as if we have knowledge of them (Norton, 1999, p. 400). Kant (1781) believed that understanding in terms of cause and effect was an a priori characteristic of the human mind underlying all human knowledge.

Four prominent approaches to the analysis of event causation are distinguished (Kim, 1999).

1. **Regularity (or nomological) analysis.** Universal regularity gives rise to universal or covering laws. There are some causes, which are entirely uniform and constant in producing a particular effect; and no instance has ever been found of any failure or irregularity in their in their operation (Hume, 1748, p. 206). An example is Ohm’s Law in physics.\(^3\)

2. **Counterfactual analysis.** Here, what makes an event a cause of another is the fact that if the cause had not occurred the event would not have (the cause is a necessary condition). Depending on how counterfactuals are understood, counterfactual analysis may turn into a form of regularity analysis. Methods for the identification of necessary conditions, sufficient conditions and necessary and sufficient conditions for causality were proposed by J. S. Mill (Wilson, 1999, p. 571).

3. **Manipulation analysis.** Here, a cause is an event or state that we can produce at will, or otherwise manipulate to bring about a certain other event as an effect. This analysis relies on an everyday understanding of a cause as an act by an intentional agent – for example, flicking a switch causes a light to turn on.

4. **Probabilistic causation.** This type of causality was recognized as early as Hume (1748, p. 206): Compared to universal laws, there are other causes, which have been found more irregular and uncertain; nor has rhubarb always proved a purge, or opium a soporific to everyone, who has taken these medicines. This view of causal analysis is thought to be suited to the social sciences, where the lack of a closed system and the effects of many extraneous influences make other analysis difficult to undertake. To say that C is the cause of E is to assert that the occurrence of C, in the context of social processes and mechanisms F, brought about E, or increased the likelihood of E (Little, 1999, p. 705).

\(^3\) Boyle’s Law and Ohm’s Law are given as examples of universal laws (variance theories) (Mohr, 1982, p. 41). However, others say these are not theories, but laws of nature, which are different. “Laws of nature are descriptive, they describe the way nature works” (Hospers, 1967, p. 230). “The distinction between a theory and a law of nature is somewhat vague, but is very important: in general, we construct or devise theories, but we discover laws of nature” (Hospers, 1967, p. 236). The possibility of true “laws”, similar to the laws of nature in social affairs is thought unlikely (Hospers, 1967, p. 232; Cook and Campbell, 1979, p. 15; Audi, 1999, p. 705) primarily because of the very large number of conditions (X\(_n\)) that might impact on any outcome (Y).
Cook and Campbell (1979) give a more detailed coverage of causality, though they believe: The epistemology of causation, and of the scientific method more generally, is at present in a productive state of near chaos (p. 10). They present Mill’s criteria for causality as being of practical use: (i) the cause has to precede the effect in time, (ii) the cause and effect have to be related, and (iii) other explanations of the cause-effect relationship have to be eliminated.

A current in-depth treatment of causality from a mathematical perspective is given by Pearl (2000).

Types of theory

Theory can be considered on many different dimensions and can be classified in ways that differ from the categorization adopted in this paper. For example, Neuman (2000) believes theory can be categorized in terms of (i) the direction (deductive or inductive), (ii) the level of the theory, (iii) whether it is formal or substantive, (iv) the forms of explanations it employs, and (v) the overall framework of assumptions and concepts in which it is embedded.

Markus and Robey (1988) distinguished theory in terms of causal structure, considering (i) the nature of the causal agency (technological, organizational or emergent, (ii) the logical structure (whether variance or process theory), and (iii) the level of analysis. The first dimension is really about the adoption of a particular theoretical stance, rather than a meta-theoretical dimension. The second dimension relies heavily on a distinction drawn by Mohr (1982) which has some confusing aspects (see Gregor, 2001). It appears preferable to speak of variance-type (cross-sectional) or process-type (longitudinal) studies rather than theory, as one theory can encompass both dimensions (Dubin, 1978).

Lee, Barua and Whinston (1997) discuss theory in Information Systems in terms of underlying causal relationships, but primarily from a statistical viewpoint.

In this paper the categorization of theory depends on the primary purpose that the theory under consideration is to serve. This purpose will in turn depend on the focal question of any research undertaken. For example, if we are interested in describing and categorizing the entities that we believe are relevant to a particular area of enquiry, development of descriptive theory is appropriate. Whether this endeavour is judged to be a useful contribution to knowledge would depend on the state of existing theoretical development in that area.

The distinction among the categories is not clearcut. For example, a theoretical development may have a primary aim of advancing understanding of some phenomena, but in addition make some limited predictions about what can be expected to occur in other contexts.

A number of the dimensions distinguished by Neuman (2000) could also be applied to the categories of theory distinguished here, to give a multidimensional framework. For example, the level of abstraction and universality of statements made can vary within each category. In a descriptive theory we could aim at a taxonomy that covered only a small slice of time, space, people or organizations, or a more general taxonomy that attempted to classify larger aggregates such as whole industries, or all types of systems development.

We argue that it is particularly appropriate to classify theories in Information Systems in terms of the purpose the theory serves in terms of knowledge building, as we are an applied discipline, one in which knowledge can be expected to be put to use. That is, we expect that at some point our work should have relevance and application to individuals, organizations and society.

The following sections describe five different types of theory that are seen as relevant to Information Systems.
Theory for analysing and describing

Descriptive theory says “what is”.

*Descriptive theories are the most basic type of theory. They describe or classify specific dimensions or characteristics of individuals, groups, situations, or events by summarizing the commonalities found in discrete observations. They state ‘what is’. Descriptive theories are needed when nothing or very little is known about the phenomenon in question.* (Fawcett and Downs, 1986, p. 4)

There are two categories of descriptive theory – naming and classification (Stevens, 1984). A naming theory is a description of the dimensions or characteristics of some phenomenon. A classification theory is more elaborate in that it states that the dimensions or characteristics of a given phenomenon are structurally interrelated. The dimensions may be mutually exclusive, overlapping, hierarchical, or sequential. Classification theories are frequently referred to as typologies, taxonomies or frameworks.

An example of an important classificatory theory in botany is Linnaeus’ eighteenth century system for classifying plants into groups depending on the number of stamens in their flowers, which provided a much needed framework for identification. He also devised the concise and precise system for naming plants and animals using one Latin word to represent the genus and a second to distinguish the species (Wordsworth, 1994).

An example in Information Systems is Kwon and Zmud’s (1987) effort to unify the fragmented models of information systems implementation. These authors provide a description of the factors thought to be related to the implementation process under the category headings: (i) individual factors, (ii) structural factors, (iii) technological factors and (iv) environmental factors.

Research approaches for building descriptive theory include analysis of existing evidence or data, philosophical and historic enquiry and empirical observation.

What constitutes a contribution to knowledge with theory of this type? Descriptive theory is valuable, as stated above, when little is known about some phenomena. Any empirical evidence gathered would be expected to have credibility. Descriptions presented should correspond as far as possible to “what is” (Miles and Hubeman, 1994).

Apart from this, there appears to be no straightforward way of “testing” a descriptive theory. Some implicit claims, however, might be made, which can be assessed. If any classification system is developed implicit claims are that the classification system is useful in aiding analysis in some way, that the category labels and groupings are meaningful and natural, and that hierarchies of classification are appropriate (most important divisions first). Analysis of the relationships among categories and their characteristics should be logical. In addition, important categories or elements should not be omitted from the classification system – that is, it should be complete. A previous classification system could be revised as new entities come to light, or some preferable way of grouping or naming categories is identified.

A judgement as to the degree whether these criteria are met allows the contribution to knowledge to be assessed.

Theory for understanding

This type of theory says explains “how” and “why” something occurred. It is not formulated in such a way, however, that predictions about the future are made so that they can be tested.

At least two types of work may be distinguished here. In the first, theory is used as a “sensitising device” to view the world in a certain way (Klein and Myers, 1999, p. 75).
Similarly, DiMaggio (1995, p. 391) describes “theory as enlightenment” where theory serves as:

A device of sudden enlightenment. From this perspective theory is complex, defamiliarizing, rich in paradox. Theorists enlighten not through conceptual clarity... but by startling the reader into satori. The point of theory, in this view, is not to generalize, because many generalizations are widely known and rather dull. Instead, theory is a ‘surprise machine’... a set of categories and domain assumptions aimed at clearing away conventional notions to make room for artful and exciting insights.

Examples of theory used in this way in Information Systems are structuration theory and actor-network theory (Klein and Myers, 1999). Structuration theory is a meta-theoretical social framework developed by Giddens (1984) that argues that action and structure operate as a duality, simultaneously affecting each other. Orlikowski (1992) developed a structurational model of technology which made the claim that technology is both constituted by human agency and constitutes human practice.

In a second type of theory for understanding, “conjectures” are drawn from a study of how and why things happened in some particular real world situation. These conjectures could form the basis of subsequent theory development, or be used to inform practice.

Research approaches that can be used to develop this type of theory include case studies (Yin, 1994), surveys, ethnographic, phenomenological and hermeneutic approaches (Denzin and Lincoln, 1994), and interpretive field studies (Klein and Myers, 1999).

What constitutes a contribution to knowledge with theory of this type? The theory developed, or conjectures, need to be new and interesting, or explain something that was poorly or imperfectly understood beforehand. Again, we expect plausibility and credibility of any accounts given of events in the real world. As an aim of this type of theory is to explain how and why events happened as they did, we expect any ascriptions of causality to be made very carefully. The identification of a cause is subject to the same set of difficulties as with other research approaches. Possible alternate explanations as to what caused a particular outcome should be examined and eliminated (internal validity).

Generalizations from this type of theory can be made but need to be made with care. Klein and Myers (1999, p. 75) argue that with interpretive field studies there is a philosophical basis for abstraction and generalization:

Unique instances can be related to ideas and concepts that apply to multiple situations.

Nevertheless, it is important that theoretical abstractions and generalizations should be carefully related to the field study details as they were experienced and/or collected by the researcher.

As the main aim of this theory is not prediction, care should also be taken in the wording of any claims made so that they do not appear to go beyond what is warranted from a particular investigation. For example, consider Klein and Myers’ (1999, p. 80) statement that the “key findings” of an interpretive case study by Myers were:

Most theories of IS implementation are too narrow and mechanistic; IS implementation can only be understood as part of the broader social and organizational context.

Similarly these authors (p. 76) report the outcomes from Monteiro and Hanseth’s (1996) case study of the Norwegian health case sector as:
In this case, their findings are used to show how organizational behaviour is inscribed into “technical” details of standards and how adoption and diffusion of a standard involves making it irreversible.

In both cases the findings from the single cases studies have been reported as general propositions that appear to have predictive power. Possibly this is not what was intended, and these outcomes could be better termed “conjectures”. Thus, judgement regarding the contribution to knowledge for this type of theory is made primarily on the basis of whether new or interesting insights are provided, and also on the basis of plausibility, credibility and validity of the arguments made.

**Theory for predicting**

Theories aiming at prediction say “what will be”. These theories are able to predict outcomes from a set of explanatory factors, without necessarily understanding or explaining the causal connections between the dependent and independent variables.

Associated research approaches include statistical techniques such as correlational or regression analysis. Correlational work can be longitudinal, that is, we can show how Y varies with a number of independent variables ($X_1$, $X_2$, ...) over a time period. Correlation studies can also be multi-directional, that is we can say larger values of X are related to larger values of Y, and also larger values of Y are related to larger values of X (as in height and weight of the population).

Pearl (2000) points out that statisticians have tended to avoid the concept of causality altogether, because it is a mental construct that is not well-defined, preferring to deal only with correlations and contingency tables and with some believing that causation is only a species of correlation.

No examples of this type of theory are readily evident in Information Systems. There are, however, some components of theories that are of this type. One example is the use of organizational size as an explanatory variable in studies of organizational innovativeness. Rogers (1995, p. 379) reports that the size of an organization has consistently been found to be positively related to its innovativeness. Work by Goode (2002), however, has shown that many studies offer little or no supportive analysis or justification for their use of organizational size as a predictor variable. Organizational size could be a surrogate for several dimensions that lead to innovation, such as organizational resources, organization levels and economies of scale.

What constitutes a contribution to knowledge with theory of this type? The discovery of regularities that allow prediction can be of interest if these were unknown before. Statistical methods are well developed for testing the significance of relationships identified and the degree of generality with which statements can be made.

The limitations of this type of theory should be recognized, however. The existence of regularities or correlations between two variables does not necessarily imply a causal relationship. Height and weight are related but one does not cause the other. The number of ice creams sold at beaches in Australia has a strong positive relationship with the frequency of shark attacks. We would not conclude that ice cream eating caused shark attacks. In both cases, a third variable which is a determinant of both is of more interest.

In addition, our theory can improve if we understand why two variables are related. Use of a proxy such as organizational size, though it may have high predictive power in many circumstances, can lead to inconsistent results (Goode, 2001). From a pragmatic viewpoint, we are interested in which variables can be manipulated to bring about an outcome, so we need to know where causal relationships lie. Organizational size could be less easy to
manipulate than organizational resources, which may be the “real” precondition for innovation.

Thus, judgments as to whether theory of this type constitutes a contribution to knowledge may be debatable. If high predictive power can be gained from some model that was not previously known, the model could have value as an indicator of possible causal relationships that need to be investigated further. Models where there is some explanation of relationships are to be preferred.

**Theory for explaining and predicting**

This type of theory says “what is”, “how”, “why” and “what will be”. To many it is the real view of theory (the traditional view).

A theory is a set of interrelated constructs (concepts), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining and predicting the phenomena. (Kerlinger, 1973, p.9)

This theory type implies both prediction and understanding of underlying causes, as well as good description of theoretical constructs. Authorities can be found for the dimensions and specification of theories of this type (for example, Dubin, 1978).

From the introductory discussions on the nature of work in the social sciences, including Information Systems, it can be seen that the aim of deriving predictive-type theory does not entail a belief in the derivation of universal or covering laws, but rather in probabilistic-type propositions.

There are surprisingly few well-developed examples of this type of theory in Information Systems. Baskerville and Myers (2002) (following Davis, 2000) identify five bodies of knowledge that are unique or somewhat unique to Information Systems. None of these bodies of knowledge is given the status of “a theory”. However, within these areas movements towards a theory can be found.

For example, one of these five areas is referred to as “representations in information systems”. Weber (1997) provides what could be termed a “Theory of Representation in Information Systems” using a formulization of a system based on the ontology of Mario Bunge. This theory clearly makes predictions about the strengths and weaknesses of various forms of information system representations (grammars) that can be tested in empirical work. Cumulative work on this theory has continued with studies aimed at testing propositions derived from the theory (for example, Bodart et al., 2001). A proposition from this study shows the nature of knowledge claims made:

Conceptual schema diagrams that use optional properties to represent a real-world domain will assist users to undertake tasks that require a surface-level understanding of a domain better than conceptual schema diagrams that use only mandatory properties (Bodart et al., 2001, p. 389).

Note that although this proposition is cast in a fairly strong form, the manner in which it is tested shows that is not expected to be applied in the sense of a universal law as found in science. The proposition is tested in a probabilistic sense and found to be supported if one group of participants in an experiment performs significantly better than another group. The relationship is not tested as if it holds universally for every individual.

Almost all research methods can be used to investigate aspects of theory of this type, including case studies, surveys, experiments, statistical analysis, field studies, and also interpretive methods if they are used to build theory with predictive power. The grounded
theory approach (Strauss and Corbin, 1994a, 1994b) can be used to develop theory, which is at some point capable of prediction, and thus being tested.

The controlled laboratory experiment is widely recognized as one way to investigate predicted casual relationships, relying on Hume’s methods for identifying causality. An alternative method for exploring causal relationships is a process study, which explains the temporal order of events, based on a story or historical narrative.

*One must explain an observed sequence of events in terms of underlying generative mechanisms or laws that cause events to happen and the particular circumstances or contingencies that exist when these mechanisms operate.* (Huber and Van de Ven, 1995, p. vii)

This method is given less attention in the literature with fewer guidelines available for researchers. Huber and Van de Ven (1995) and Van de Ven and Poole (1989) are exceptions.

What constitutes a contribution to knowledge with theory of this type? Studies can usefully contribute to either theory building or theory testing. In theory testing, because of the probabilistic nature of the propositions in the theory, one study that disconfirms a theoretical proposition does not constitute a “disproof” of the theory. Refutation requires a number of convincing data-based disconfirmations based on strong tests. In addition, the use of statistical methods does not necessarily eliminate confounding, or false attribution of causality. Pearl (2000, pp. 174-175) shows in a discussion of Simpson’s Paradox how even in scientific trials, such as those of drug effectiveness, a confounding factor can give spurious results. Cook and Campbell (1979) give a thorough discussion of the establishment of validity for studies involving experimental and quasi-experimental and field studies.

**Theory for design and action**

This type of theory says “how to do” something. It is about the methodologies and tools used in the development of information systems. There has been very little discussion in the Information Systems literature of what constitutes theory of this nature.

Cook and Campbell (1979, p. 28) identify something similar in the social sciences, using the term “recipe” rather than “methodology”:

*Knowledge of causal manipulanda, even the tentative, partial and probabilistic knowledge of which we are capable, can help improve social life. What policy makers and individual citizens seem to want from science are recipes that can be followed and that usually lead to desired positive effects, even if understanding of the micromediational processes is only partial and the positive effects are not invariably brought about.*

This idea is based on the concept of causality that involves manipulation or the “activity theory of causation” as espoused by Collingwood (1940). An example in medicine is the knowledge that administration of a vaccine using a certain method reduces the likelihood of some disease.

Relevant work can be found in the Information Systems literature, though it is scattered and appears under different labels. Associated research has been referred to as engineering type research (Cecez-Kecmanovic 1994), as a constructive type of research (livari, Hirschheim and Klein 1998), as prototyping (Baskerville and Wood-Harper, 1998), and a systems development approach (Lau, 1997; Burstein and Gregor, 1999). March and Smith (1995) use the term “design science”. Another area worthy of investigation is the literature on “patterns”, with its origin in architecture (Alexander, 1978) and application to software design.

There appears to be reluctance by some in the Information Systems discipline to accept the importance of this type of knowledge. For example, Galliers (1992) excluded engineering-
type research as a research methodology. It is clear, however, that it occupies an important place in Information Systems. A review by Morrison and George (1995) of three leading management information systems journals showed that software-engineering related research represented about 45% of the information systems articles found in the six-year period from 1986 to 1991. Of the five bodies of knowledge identified by Davis (2000) as being unique or somewhat unique to Information Systems, two relate to what could be termed design science: information systems development processes and information systems development concepts. Iivari et al. (1998) also argue for the particular importance of these types of methods for applied disciplines, such as information systems and computer science.

Example of theory in this area are soft systems methodology (Checkland, 1981) and Multiview (Avison and Wood-Harper, 1990).

Limited discussion of research approaches for this theory type can be found. Exceptions are Burstein and Gregor (1999), March and Smith (1995), Nunamaker, Chen and Purdin (1990-91), Nunamaker and Chen (1990) and Parker et al. (1994). Action research is seen as particularly appropriate (Baskerville and Wood-Harper, 1996). Lau (1997) reviewed the use of action research in information systems studies over a twenty-five year period. Eleven of the thirty articles reviewed were categorized as “systems development”, covering the areas of analysis, design, development and implementation of information systems and decision support systems. Differing underlying philosophical positions were distinguished in the studies, including interpretive, critical, and post-positivistic positions. The case study was the preferred method of presentation.

What constitutes a contribution to knowledge with theory of this type? The question of the criteria to use for this type of research was raised by Weber (1987), who saw the “lure of design and construction” as one of three factors inhibiting the progress of information systems as a discipline.

The conundrum posed by design research for progress in a discipline emerges clearly when a paper describing such research must be evaluated for publication in a learned journal. What are the quality standards the reviewer must apply to decide upon its acceptability? Typically the paper contains no theory, no hypotheses, no experimental design, and no data analysis. Traditional evaluation criteria cannot be used. The paper’s contribution inevitably requires an inherently subjective evaluation (p. 9).

Weber saw a solution to the dilemma posed by design and construction work if:

researchers show how their designs are based in some theory of information systems. The theory can be used to predict the likely success or failure of a design, and these predictions can be tested empirically. Traditional evaluation criteria can then be applied (p. 9).

In essence, the argument is that we keep searching for the underlying theory of the previous types that will explain why our particular method works. March and Smith (1995) make a similar argument and point out some conditions under which they believe a contribution to knowledge in design science has occurred. Landauer (1988), however, points out some of the problems with the argument that systems design can be guided by other underlying theory:

Previous research findings and theories are likely, at best, to be relevant only to a small portion of the total situation. It means that testing the effectiveness of one total system against that of another is likely to yield information of extremely limited generality (p. 157).
The conclusion from discussion of this type of theory is that there is limited agreement or understanding as to its nature – not a desirable state of affairs for a body of knowledge that is seen as central to our discipline.

**Discussion and conclusions**

This paper has distinguished five different types of theory important for the discipline of Information Systems: (i) theory for analysing and describing, (ii) theory for understanding, (iii) theory for predicting, (iv) theory for explaining and predicting, and (v) theory for design and action.

It is of interest to reflect on possible relationships among the different types of theory. The most basic type of theory, descriptive theory, is necessary for the development of all the other types of theory. Clear definition of constructs is needed in all theory formulation.

Both theory for understanding and theory for predicting can sow seeds for the development of more traditional theory that encompasses both explanation and prediction.

Design theory can be informed by all the other types of theory. A methodology can build on particular idiographic studies of what has worked in practice, on predictive relationships that are known but not fully understood (such as the relationship between organizational size and innovativeness) and on more fully developed, traditional theories such as those relating to data representation or human behaviour. Work on design theory can also feed back to theory development of other types – that is, the outcomes of a trial of a particular method can have implications for an underlying theory (March and Smith, 1995).

It is recognized that many authors would restrict the use of the word “theory” to the fourth, traditional type of theory described here. The approach preferred here is one of comprehensiveness, where, following Weick (1995), theory is seen as a continuum, and theorizing as a process of interim struggles where people intentionally inch towards stronger theory. Weick believes it preferable for people to label their interim struggles theory: *We would like writers to feel free to use theory whenever they are theorizing, modesty is all very well, but leaning over too far backward removes a good word from currency* (p. 386).

No doubt Watson’s (2001) call for good grand theory that was quoted in the introduction was a call for theory of the traditional fourth type of theory discussed here. A theory of this type could include components from all the types of theory discussed above.

An example of the encompassing type of theory that might be our ultimate aim is Rogers’ Theory of the Diffusion of Innovations (1995). This theory has developed in four editions of his book, beginning in 1962. The author notes in the most recent edition how his theoretical framework has been revised in the light of new research findings and new theoretical viewpoints. The theory includes descriptive components in that the main elements of the theory are well described and categorized. The theory has both explanatory and predictive components. The process of innovation is explained and described. Striking idiographic, ethnographic and anthropological studies of adoption and non-adoption are cited to deepen the understanding of the diffusion process. Propositions that predict future behaviour and are capable of being “tested” are given, though these are termed generalizations. For example, Generalization 8 states that *At least some degree of re-invention occurs at the implementation stage for many innovations and for many adopters* (Rogers, 1995, p. 176). The theory also offers practical guidelines (methods) for those who aim to bring about change – for example, by showing practices that increase the likelihood of change agent success.

An advantage of labelling as theory even interim attempts at theory development is that it forces the theorists to think clearly about what type of knowledge they are aiming at, and the types of claims that can be made within that theory type **before** the choice of research method is considered. Another outcome of thinking of theory in this way, is that individual
contributions to theory can be considered as complementary, and work on other types of theory recognized and considered in each project.

As an illustration of the usefulness of the “theory of theories” proposed in this paper, the theory can be applied reflexively. The theory advanced here is of the analysis and description type. The claim of a contribution to knowledge relies on the argument that there has been very little discussion of what constitutes theory in the discipline of Information Systems. Work in other disciplines is relevant but these disciplines do not share the distinguishing characteristic of being about both technological and social systems. The most relevant previous work is that by March and Smith (1995). It is believed that this paper adds to March and Smith’s work, in that it includes discussion of theory in social science, rather than the natural and design sciences alone.

As the paper also provides a classification of theory into different categories, one can ask if this classification system is meaningful, understandable, analytically sound and complete. To some extent these questions are ones for the readers of the paper.

The paper has had to treat some complex topics very briefly and the classification system is somewhat novel. In addition, the general nature of the analysis does not fit comfortably into the prevailing discourse on research paradigms that focuses on research methods rather than theory and offers rather simplistic depictions of various “isms. If the paper promotes deeper thought and further work on theory in Information Systems then it will have achieved a useful aim. The analysis has indicated that the nature of design-type theory in particular needs much further consideration.

References


