Towards an Information Systems Design Research Framework: A Critical Realist Perspective

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Abstract

Information Systems (IS) research has a serious utilization and relevance problem. To increase IS research utilization and relevance, scholars argue that the mainstream IS research, which is based on the behavioral science paradigm, should be complemented with research based on the design science paradigm. The current IS design science frameworks and approaches have a strong focus on the IT artifact, in most cases an exclusive focus on the IT artifact. The frameworks and approaches have very little discussions and clarifications regarding underpinning philosophies, but most seem to be based on positivism, traditional realism, or pragmatism. This paper presents an alternative framework for IS design science research. The framework builds on that the aim of IS design science research is to develop practical knowledge for the design and realization of different classes of IS initiatives, where IS are viewed as socio-technical systems and not just IT artifacts. The underpinning philosophy of the framework is critical realism which has been developed as an alternative to positivism and traditional realism as well as to constructivism (relativism). The framework proposes that the output of IS design science research is practical IS design knowledge in the form of field-tested and grounded technological rules. The IS design knowledge is developed through an IS design science research cycle. The paper presents how technological rules can be developed as well as the nature of such rules.

1. Introduction

In the last years we have seen an intensive debate in the Information Systems (IS) community on the "crisis in the IS field"—see, for example, the debates in journals like *MIS Quarterly* and *Communications of the Association for Information Systems*. Some commentators argue that part of the crisis is related to the utilization and relevance problem (Agarwal & Lucas, 2005; Hirschheim & Klein, 2003): research not addressing relevant issues and research not producing usable results. To increase IS research utilization and relevance it is argued that the mainstream

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IS research, which is based on the behavioral science paradigm, should be complemented with research based on the design science paradigm (Walls et al, 1992, 2004; March & Smith, 1995; Hevner et al. 2004; Purao, 2002, Järvinen, 2005).

Research can be divided and classified in different ways. Herbert Simon (1988) in his seminal book "The Sciences of the Artificial" distinguishes between "natural sciences" and "sciences of the artificial". The former focuses on how "things" (natural and social things) are and how they work—for clarity and consistency we will in the rest of the paper use the concept "behavioral science" instead of "natural science". The sciences of the artificial focus on how to design and construct artifacts and artifical systems having desired properties. Even if it is common to think of engineers, architects, and industrial designers as typical professional designers, Simon stresses that "Everyone designs who devises courses of action aimed at changing existing situations into preferred ones." (ibid.) Simon's work on the sciences of the artificial and design science has influenced IS scholars. We have in the last years seen a growing interest in IS design science research and IS design theory/knowledge (Walls et al., 2004); and there is also a fairly new ISWorld web-site on "Design Research in Information Systems" (Vaishnavi & Kuechler, 2005). Behavioral science is description- and explanatory-driven whereas design science is prescription-driven. Simon argues that there has been a movement towards behavioral science and away from the design sciences in engineering, business and medicine. Although, the IS field is quite young and Simon's book was first published in 1969, reviews of articles published in the leading IS journals reveal a picture where the majority of published articles belong to the behavioral science paradigm (Glass et al., 2004; Chen & Hirschheim, 2004). Based on the IS field's utilization and relevance problem it has been suggested that one way to advance the IS field is to increase IS design science research (Hirschheim & Klein, 2003; Iiivari, 2003). Interesting IS design science research frameworks have emerged, but from our perspective two major issues have not been carefully addressed.

First, there is too little discussion about what IS design science research should include and what should be excluded. This is related to the discussion about what the IS discipline ought to be and what ought to be at the core of the IS discipline. When there is a discussion the hold view is that it is IT artifact design theories that should be developed. Simon's view on design science shows that it can be more than IT artifact design knowledge that the IS field should develop. We will argue that there is a need for IS design science research frameworks having a broader view on IS and IS design knowledge.

Second, there is no, or little, discussion about underlying philosophical assumptions in the IS design science research literature. Said Purao (2002): "…the scientific foundations underlying this critical area of the IS field — design research — have remained largely undeveloped. … Over the years, in spite of important writings about research (e.g. March and Smith [1995]), philosophical underpinnings of this form of research have been largely unexplored. Without adequate scientific foundations, research in the technology of information systems (TIS) continues to be a lost child still searching for its scientific home." (Purao, 2002). The underlying ontological view an IS design science research framework is built on will ultimately affect how to do IS design science research and what types of outcomes (design knowledge) that can be produced. Although, current frameworks lack in clearness on underpinning philosophies and ontological views, they seem to be based on positivism, traditional realism, or pragmatism. In IS research based on the behavioral science paradigm there is an increased and fruitful use of alternative philosophies, for example, the use of constructivism. Consequently, we suggest that it can be fruitful to develop and explore IS design science research frameworks based on alternative philosophies, that is, frameworks based on alternative ontologies and epistemologies.

The remainder of the paper is organized as follows: the next section reviews IS design science research frameworks and elaborates the above two issues. The section argues for a broader view on IS design science research and for grounding IS design science research in the philosophy of critical realism. A short presentation of critical realism follows and this is followed by a presentation of an IS design science research framework based on the philosophy of critical realism. Guiding our work is Pettigrew's (1997) idea of the primary double hurdle: IS design science research should meet the criteria of scholarly quality *and* practical (professional) relevance.

2. A Review of Information Systems Design Science Research Frameworks

Simon's distinction has influenced the IS field. For example, Järvinen (2004) distinguishes between research stressing "what is reality" (behavioral science) and research stressing "utility of artifacts" (design science). Although using different concepts, Walls et al. (1992), March & Smith (1994), and Hevner et al. (2004) in presenting their IS design science research frameworks make a similar distinction.

Below we review IS design research frameworks by primarily focusing two issues: 1) what is focused in the IS design science research frameworks, and 2) what underlying philosophies — for example, ontological and epistemological views — have the frameworks. The first issue is related to the discussion on what the IS discipline ought to be and what ought to be at the core of the discipline. The second issue is critical since in all research, including IS design science research, ontology is non-optional (Fleetwood, 2004).

As far as we know, the first article on developing IS design theories (ISDT) and IS design knowledge was published in 1992 by Walls et al. (1992). Walls et al. argue that successful construction of ISDT would create an endogenous base for theory in the IS discipline, and could be used by scholars to prescribe design products and processes for different classes of IS as they emerged. The authors build on Simon's distinction — behavioral science and design science — and argue that design is both a *product* and a *process*, which means that a design theory must have two aspects — one that deals with the design product and one that deals with the design process. Using their framework the authors propose an ISDT for the IS-class "Vigilant Information Systems." The components of an IS design theory are summarized in Table 1.

Walls et al. use the concept "artifact" quite freely, but in reflecting on their 1992-paper they say: "We did not use the current phrase 'IT artifact', but in essence it was that to which we were referring." (Walls et al., 2004).

Design Product		
1.	Meta-requirements	Describes the class of goals to which the theory applies
2.	Meta-design	Describes a class of artifacts hypothesized to meet the meta-requirements
3.	Kernel theories	Theories from natural or social sciences governing design requirements
4.	Testable design product hypotheses	Used to test whether the meta-design hypotheses satisfies the meta-requirements
Design Process		
1.	Design method	A description of procedure(s) for artifact construction
2.	Kernel theories	Theories from natural or social sciences governing design process itself

3.	Testable design process hypotheses	Used to verify whether the design hypotheses method results in an artifact which is consistent with the meta-design

Table 1. Components of an IS design theory (Walls et al., 1992)

Building on Simon's work, March and Smith (1995) distinguish between design sciences and natural sciences. The former involves building and evaluating: 1) *constructs* which are "concepts with which to … characterize phenomenon", 2) *models* that "describe tasks, situations, or artifacts", 3) *methods* as "ways of performing goal directed activities", and 4) *instantiations* which are "physical implementations intended to perform certain tasks".

Hevner et al. (2004), building on March and Smith, present a design science framework and guidelines around building and evaluating IT artifacts—Figure 1 depicts their IS research framework.

Hevner et al. expressed their view on what constitutes good — rigorous and relevant — IS design science in the form of seven guidelines. The authors contend that each of the guidelines should be addressed in some manner for IS design science research to be complete. Guideline one—"design as an artifact"—says: "Design-science research must produce a viable artifact in the form of a *construct*, a *model*, a *method*, or an *instantiation*." (Hevner et al. 2004, italics added to indicate similarity with March and Smith's view on the output of design science research). And, the "result of design-science research in IS is, by definition, a purposeful IT artifact created to address an important organizational problem. … Our [Hevner et al.'s] definition of IT artifacts is both broader and narrower [than other IT artifact definitions] … It is broader in the sense that we include not only instantiations in our definition of the IT artifact but also the constructs, models, and methods applied in the development and use of information systems. However, it is narrower in the sense that we do not include people or elements of organizations in our definition nor do we explicitly include the process by which such artifacts evolve over time."

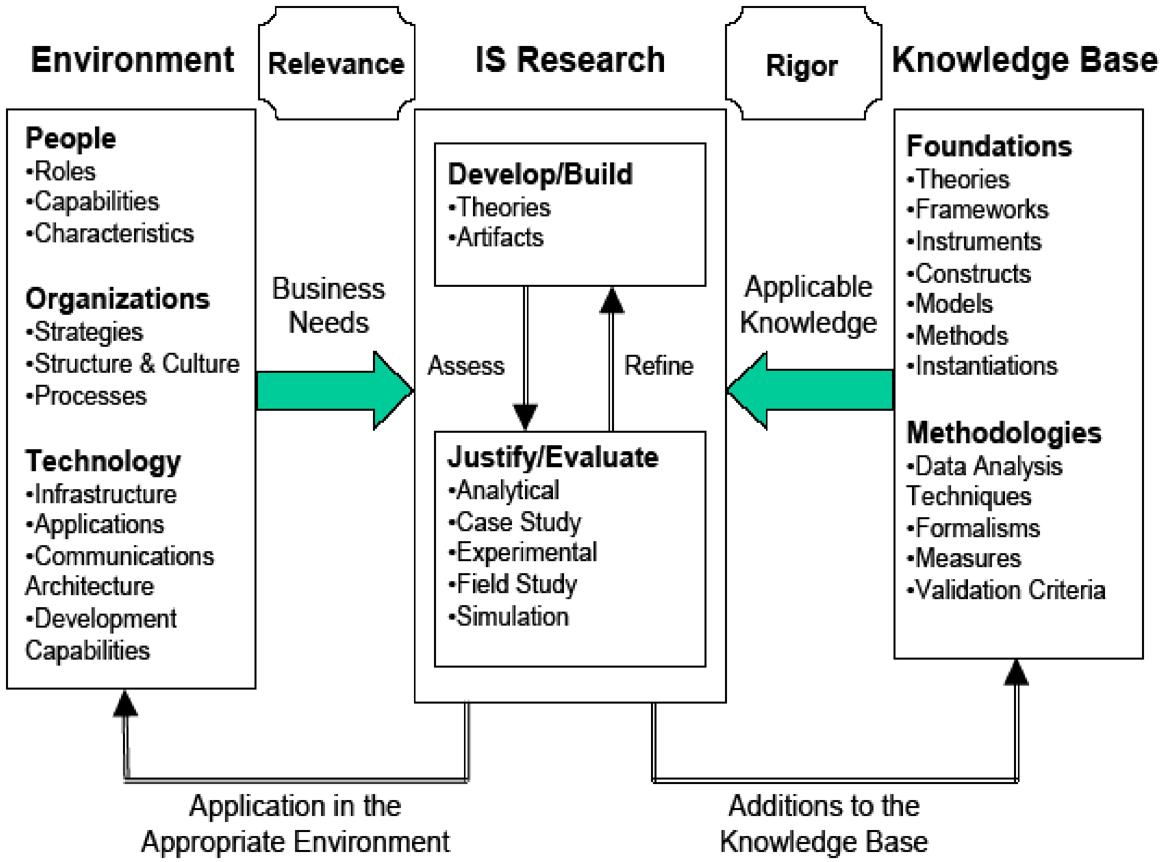

Figure 1. IS research framework (Hevner et al., 2004).

Regarding what should be included in an IS design research framework, and consequently in IS design theory and IS design knowledge, it is clear that Walls et al., March and Smith, and Hevner et al. focus the IT artifact. They exclude the non-technological context by excluding people and organizations. Given, the frameworks' focus, and what the exclude, the framework might better be named IT design science research frameworks.

There is a lively debate in the IS-community on what constitutes the "IS core" — see, for example the debate in *Communications of the Association for Information Systems*, especially volume 12 (2003). Benbasat and Zmud (2003) suggest that the core of the IS discipline and IS research should be the IT artifact — a narrow view on the IS discipline and IS research. Alter (2003) suggests a broader view and argues that the core of the IS discipline should be "work systems". In the IS core debate, Myers (2003) argues for that the IS discipline is nowhere near ready to define an IS core —he argues for open, flexible, and adaptive views. Hence, he argues for broad and emergent views on the IS core. Said Myers: "I believe that diversity is a positive attribute and ensures the continued viability of the field in a rapidly changing environment." (Myers, 2003). We agree with Myers. The above IS design science research frameworks have views more in line with Benbasat and Zmud's view than with Alter's and Myers' views. It should be noted that Walls et al. and Hevner et al. say that IS design theories and frameworks can encompass more than the IT artifact. Furthermore, Hevner et al's second design guideline — problem relevance — states: "The objective of design-science research is to develop technology-based solutions to important and relevant business problems". (Hevner et al. 2004). It is noteworthy that lists, based on business needs, ranking current and future critical IS-issues, for example, lists published by the Gartner Group, often have non-technological issues as the most critical (relevant) and less easy to solve issues like "how to align our business strategy and IT strategy".

Our view is that an IS design science research framework should be explicit on what should be produced, that is, what kind of design knowledge should be developed. We suggest that the aim of IS design science research is to develop practical knowledge for the design and realization of "IS initiatives" or to be used in the improvement of the performance of existing IS. By an IS initiative we mean the design and implementation of an intervention in a social-technical system where IS (including IT artifacts) are critical means for achieving the desired outcomes of the intervention. Our IS initiative view is in line with Alter's (2004) and Agarwal and Lucas' (2005) views. Agarwal and Lucas (2005) argue that IS research to become more relevant needs to have a more macro-oriented focus and should address the transformational impact of information technology and IS, that is, a focus on how information technology and IS can be used to change (transform) an organization or a network of organizations.

The second issue we address is the underpinning philosophies and ontologies of IS design science research frameworks. The above discussed IS design science research articles do not explicitly address ontology, but ontology is non-optional in all research (Fleetwood, 2004). Although, the above papers do not address underpinning philosophies and ontologies, it is possible to conclude that they are based in positivism, traditional realism, or pragmatism. This conclusion is based on the few philosophical and philosophy of science references used by the authors and that they use concepts like "prove"; Hevner et al. explicitly refer to pragmatism and Cole et al. state that "..DR [Design Research] is rooted in pragmatism" (Cole et al., 2005).

It is noteworthy that the ISWorld web-site on "Design Research in Information Systems" has a section on the "philosophical grounding of design research" (Vaishnavi & Kuechler, 2005). Unfortunately, the authors mix concepts and definitions and their use of key concepts are inconsistent with what can be found in the philosophy and philosophy of science literature. For example, they say that "ontological and epistemological viewpoints shift in design research as the project runs through circumscription cycles ... This iteration is similar to but more radical than the hermeneutic processes used in some interpretive research." (ibid.) This means that in IS design science research a researcher's assumptions about how the world is "constructed" should change during a design research project. What the authors probably mean is that our knowledge of the world changes which is quite a different matter. They also make what Bhaskar (1978) calls an "epistemic fallacy" in that they transpose what is an ontological matter — concerning what exists — into an epistemological matter of how to develop reliable knowledge about the world. It is interesting to note that the authors make a reference — using Mario Bunge's work — to critical realism: "Bunge (1984) implies that design research is most effective when its practitioners shift between pragmatic and critical realist perspectives, guided by a pragmatic assessment of progress in the design cycle." (Vaishnavi & Kuechler, 2005). Unfortunately, they do not explore Bunge's view.

To summarize, writings on IS design theory, IS design knowledge, and IS design science research do almost never explicitly discuss ontological issues and underpinning philosophies, but most papers (work) seem to be based in positivism, traditional realism, or pragmatism. This is consistent with studies on publications in the IS field. The overwhelming majority of articles are based on a positivistic philosophy (Chen & Hirschheim, 2004). IS research commentators point out weaknesses in positivism, etc., and suggest the use of alternative philosophies, like constructivism — for good examples, see the chapters in Mingers and Willcocks (2004), Whitman and Woszczynski (2004), Trauth (2001), and Kaplan et al. (2004). This paper articulates a view on IS design science research based on the philosophy of critical realism which is an alternative to positivism as well as to constructivism.

3. Critical Realism

Critical realism (CR) was developed as an alternative to positivism (empiricism) and as an alternative to non-positivism, e.g. constructivism (relativism). The most influential writer on critical realism is Roy Bhaskar (1978, 1989, 1998, 2002). Unfortunately, Bhaskar is an opaque writer, but clear summaries of critical realism are found in Archer et al. (2000) and Chapter 1 in Bhaskar (2002).

Critical realism can be seen as a specific form of realism: "To be a realist is to assert the existence of some disputed kind of entities such as gravitons, equilibria, utility, class relations and so on. To be a scientific realist is to assert that these entities exist independently of our investigation of them. Such entities, *contra* the post modernism of rhetoricians, are not something generated in the discourse used in their investigation. Neither are such entities, *contra* empiricists, restricted to the realm of the observable. To be a *critical* realist is to extend these views into social science." (Fleetwood, 2002) Critical realism's manifesto is to recognize the reality of the natural order and the events and discourses of the social world. It holds that "we will only be able to understand—and so change—the social world if we identify the structures at work that generate those events or discourses … These structures are not spontaneously apparent in the observable pattern of events; they can only be identified through the practical and theoretical work of the social sciences." (Bhaskar, 1989). Bhaskar (1978) outlines what he calls three domains: the *real*, the *actual*, and the *empirical* (Table 2). The *real* domain consists of underlying structures and mechanisms, and relations; events and behavior; and experiences. The generative mechanisms residing in the real domain exist independently of, but capable of producing, patterns of events. Relations generate behaviors in the social world. The domain of the *actual* consists of these events and behaviors. Hence, the actual domain is the domain in which observed events or observed patterns of events occur. The domain of the *empirical* consists of what we experience; hence, it is the domain of experienced events.

Domain of	Domain of	Domain of

	Real	Actual	Empirical
Mechanisms	X		
Events	X	X	
Experiences	X	X	X

Table 2. Ontological assumptions of the critical realist view of science (Bhaskar, 1978). Xs indicate the domain of reality in which mechanisms, events, and experiences, respectively reside, as well as the domains involved for such a residence to be possible.

Bhaskar argues that; "…real structures exist independently of and are often out of phase with the actual patterns of events. Indeed it is only because of the latter we need to perform experiments and only because of the former that we can make sense of our performances of them. Similarly it can be shown to be a condition of the intelligibility of perception that events occur independently of experiences. And experiences are often (epistemically speaking) 'out of phase' with events — e.g. when they are misidentified. It is partly because of this possibility that the scientist needs a scientific education or training. Thus I [Bhaskar] will argue that what I call the domains of the real, the actual and the empirical are distinct." (Bhaskar 1978). Critical realism also argues that the real world is ontologically stratified and differentiated. The real world consists of a plurality of structures and generative mechanisms that generate the events that occur and do not occur. From an epistemological stance, concerning the nature of knowledge claim, the realist approach is non-positivistic which means that values and facts are intertwined and hard to disentangle.

The philosophy of science literature discusses the differences between positivism, constructivism, and critical realism; for example, contrasting their ontological views. Good discussions in terms of doing real world research based on the different philosophies of sciences, including critical realism, are available in Robson (2002) and Bryman (2001). Table 3 summarizes a critical realism view of science.

“1. There is no unquestionable foundation for science, no ‘facts’ that are beyond dispute. Knowledge is a social and historical product. ‘Facts’ are theory-laden.
2. The task of science is to invent theories to explain the real world, and to test these theories by rational criteria.
3. Explanation is concerned with how mechanisms produce events. The guiding metaphors are of structures and mechanisms in reality rather than phenomena and events.
4. A law is the characteristic pattern of activity or tendency of a mechanism. Laws are statements about things that are ‘really’ happening, the ongoing ways of acting of independently existing things, which may not be expressed on the level of events.
5. The real world is not only very complex but also stratified into different layers. Social reality incorporates individual, group and institutional, and societal levels.
6. The conception of causation is one in which entities act as a function of their basic structure.
7. Explanation is showing how some event has occurred in a particular case. Events are to be explained even when they cannot be predicted.”

Table 3. A critical realist view of science (Robson, 2002).

Critical realism is a well-developed philosophy of science, but on the methodological level it is less well-developed. The writings of Derek Layder (1993, 1998, 2005) and Mansor Kazi (2003), as well as some of the chapters in Ackroyd and Fleetwood (2000) and Fleetwood and Ackroyd (2004), can serve as guidelines for doing research based on critical realism. Unfortunately, from an IS design science research perspective, most of the writings on critical realism have been in the behavioral science paradigm, i.e., for theory development and theory “testing”.

Critical realism has influenced a number of social science fields, e.g., economics, management and organization studies. With few exceptions, CR is almost invisible in the IS field. Mingers (2004), Mutch (2002), Carlsson (2004), Dobson (2001), and Longshore Smith (2005) argue for the use of critical realism in IS research and discuss how this can overcome problems associated with positivism and constructivism. The writings on CR in IS have been focusing on the use of CR in the behavioral science paradigm and not in the design science paradigm. This paper uses CR as an underpinning philosophy for IS design science research.

4. Developing Information Systems Design Knowledge

This section presents and discusses an IS design science research framework based on critical realism. It starts with discussing what types of IS design knowledge should be produced and for whom. This followed by a presentation of how IS design knowledge can be produced.

4.1 For whom should IS design research produce knowledge?

The primary constituent community for the output of IS design science research is the professionals in the IS field (Hevner et al., 2004; Agarwal & Lucas, 2005). This means primarily professionals who plan, manage and govern, design, build, implement, operate, maintain and evaluate different types of IS initiative and IS. The developed IS design knowledge is to be applied by individuals who have received formal education, or a similar training, in the IS field. An IS-professional can be defined as a member of a fairly well-defined group who solves real-world IS-problems with the help of skills, creativity and (scientific) IS-design knowledge. (For simplicity we call the problems IS-problems although it is more correct to say that someone has defined a problem where one, for one reason or another, has decided to solve the problem with an IS-initiative). Another important community is IS education, which means that the knowledge should be useful in different types of IS study programs and IS courses.

Although, the primary constituent community works primarily in organizations driven by profit (utility) "maximization", it should be stressed that CR also has a critical and emancipatory component (Bhaskar, 2002). The frameworks discussed in section 2 have a clear management perspective and certainly not an emancipatory or critical stance. The emancipatory and critical issue is important, but here we just note it and leave the issue for further exploration and development. Longshore Smith (2005) and Wilson and Greenhill (2004) address how the use of critical realism in IS research can work critically and emancipatory.

4.2 What types of IS design knowledge can IS design research produce?

IS design science research should develop practical design knowledge to solve classes of IS-problems. This means the development of abstract knowledge that can be used in designing and implementing IS initiatives. It is abstract in the sense that it is not a recipe for designing and implementing a specific IS-initiative for a specific organization. A user (IS professional) of the abstract design knowledge has to ”transform” the knowledge to fit the specific problem situation and context. The knowledge takes the form of field-tested and grounded technological rules — will be discussed below.

Following Pelz (1978), we can distinguish between conceptual and instrumental use of science and research output. The former involves using knowledge for general enlightenment on the subject in question and the latter involves acting on research results in specific and direct ways. Although, both types are relevant design science research addresses primarily the development of design knowledge for instrumental use.

Using van Aken's (2004) classification we can distinguish three different types of designs an IS professional makes when designing and implementing an IS-initiative: 1) an *object*-design, which is the design of the IS intervention (initiative), 2) a *realization*-design, which is the plan for the implementation of the IS intervention (initiative), and 3) a *process*-design, which is the professional's own plan for the problem solving cycle and includes the methods and techniques to be used to design the solution (the IS intervention) to the problem. IS design science research should produce knowledge that can be used by the professionals in the three types of designs. Compared to the distinction between *product* design and *process* design, the three designs include process and product design and also realization-design. Given, that the framework has a broader perspective — IS intervention in a socio-technical system — than the frameworks presented in Section 2, it can be argued, based on the IS implementation and IS failure literature, that realization-design knowledge should be developed.

4.3 Design knowledge as field-tested and grounded technological rules

Following Bunge (1967), we can say that design science research aims at developing "stable" norms of successful human behavior, i.e. rules. Van Aken (based on Bunge) defines a technological rule as "…an instruction to perform a finite number of acts in a given order and with a given aim." (Bunge, 1967); and a technological rule is "*a chunk of general knowledge, linking an intervention or artefact with a desired outcome or performance in a certain field of application"* (van Aken, 2004). A technological rule is general, which for IS design knowledge means that a rule is a general prescription for a class of IS-problems and not a specific prescription for a specific situation and context. Since a technological rule should be used by practitioner it should be applicable and actionable. Generally, the form of the technological rules is like "if you want to achieve A (outcome) in situation B (problem) and context C, then something like action/intervention D can help because E (reason)". "Something like action/intervention D" means that the rule is to be used as a design exemplar.

A field-tested and grounded technological rule has been tested empirically and is grounded in science. The latter means primarily grounding in results and theories from the behavioral science paradigm. How to develop and test technological rules will be discussed in the next section. Field-tested and grounded technological rules will in most cases be in the form of heuristics. This is consistent with critical realism's view on causality (Bhaskar, 1978, 1998; Groff, 2004) and means that the indeterminate nature of a heuristic technological rule makes it impossible to prove its effects conclusively, but it can be tested in context, which in turn can lead to sufficient supporting evidence (Hedström & Swedberg, 1998; Groff, 2004).

4.4 Developing IS design knowledge

Van Aken (2004) suggests that management design science research has much in common with evaluation research of social programs based on the philosophy of critical realism. We agree with van Aken and suggest that evaluation research based on CR can work as a major contributor to IS design science research. Related work has started on developing a critical realistic IS evaluation perspective (Carlsson, 2003) which builds on critical realism and realistic evaluation (Pawson & Tilley, 1997; Kazi, 2003; Mark et al., 2000). In line with CR-based evaluation research, the intention of our IS design science research framework is to produce ever more detailed answers to the question of *why* and *how* an IS initiative works, for *whom,* and in *what* circumstances. Using the framework means that a researcher attends to how and why an IS initiative has the *potential* to cause the (desired) change. In this perspective, an IS design science (ISDS) researcher works as an experimental scientist, but not according to the logics of the traditional experimental evaluation research. Bhaskar states: "The experimental scientist must perform two essential functions in an experiment. First, he must trigger the mechanism under study to ensure that it is active; and secondly, he must prevent any interference with the operation of the mechanism. These activities could be designated as 'experimental production' and 'experimental control'." (Bhaskar 1998). Figure 2 depicts the realist experiment.

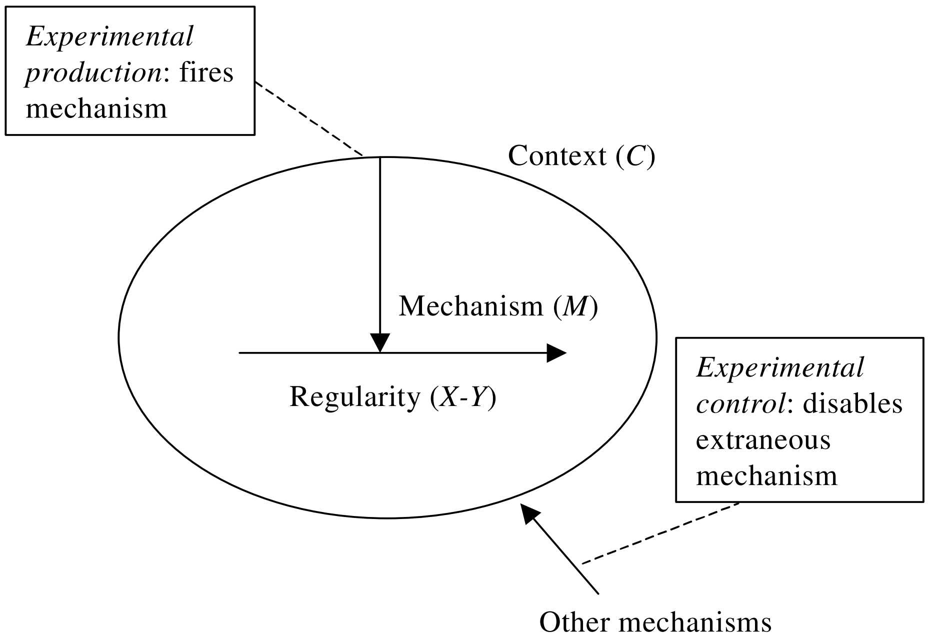

Figure 2. The realist experiment (Pawson & Tilley 1997).

ISDS researchers do not perceive that IS initiatives "work". It is the actions of the stakeholders that make them work, and the causal potential of an IS initiative takes the form of providing the reasons and resources to enable different stakeholders and participants to "make" changes. This means that an ISDS researcher seeks to understand *why* and *how* an IS initiative, for example, the implementation of a CRM systems, works through understanding the action mechanisms. It also means that an ISDS researcher seeks to understand *for whom* and *in what circumstances* (*contexts*) an IS initiative works through the study of contextual conditioning.

ISDS researchers orient their thinking to context-mechanism-outcome pattern configurations (CMO configurations). This leads to the development of transferable and cumulative lessons from ISDS research. A CMO configuration is a proposition stating what it is about an IS-initiative which works for whom in what circumstances. A refined CMO configuration is the finding of an evaluation of an IS initiative. Outcome patterns are examined from a "theory-testing" persepctive. This means that an ISDS researcher tries to understand what the outcomes of an IS initiative are and how the outcomes are produced. Hence, the researcher does not just inspect outcomes in order to see if an IS-initiative works, but analyzes the outcomes to discover if the conjectured mechanism/context theories are confirmed.

In terms of generalization, an ISDS researcher through a process of CMO configuration abstraction creates "middle-range" theories. These theories provide analytical frameworks for interpreting differences and similarities between classes and sub-classes of IS-initiatives. Given that the goal is to develop design theories and knowledge — to construct and test context-mechanism-outcome pattern explanations — for practitioners ISDS researchers need to engage in a learning relationship with IS practitioners.

ISDS research based on the above can be carried out through an IS design science research cycle (Figure 3).

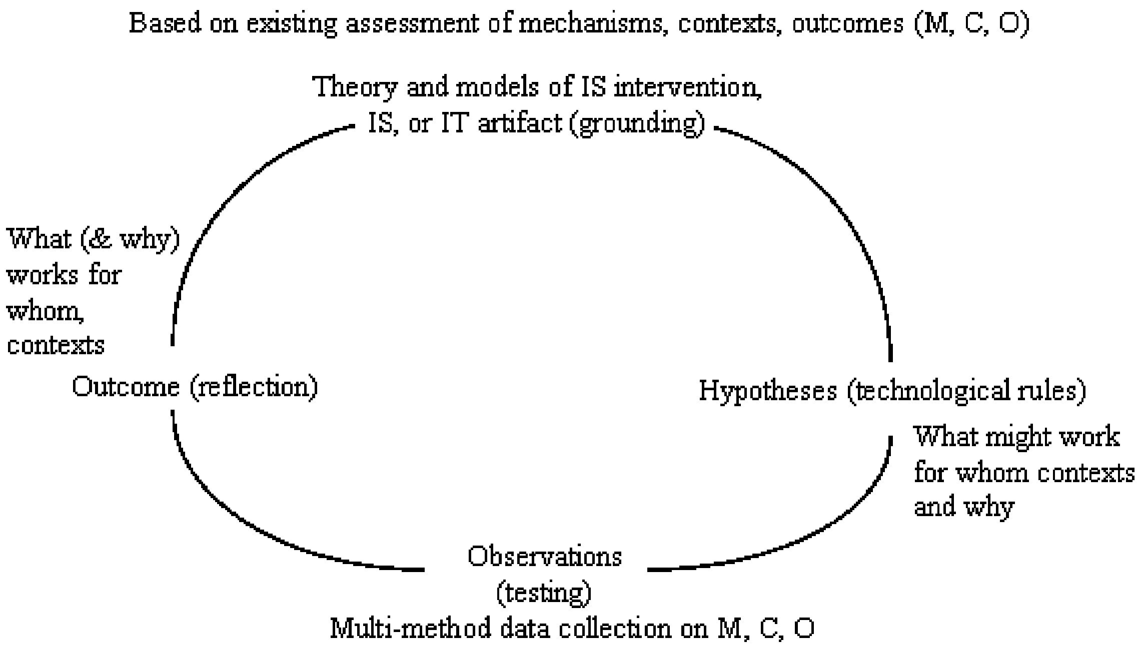

Figure 3. The Information Systems design science research cycle—based on Pawson and Tilley (1997) and Kazi (2003)

The starting point is theory and problems or issues. The research is driven by problems or issues. Problems or symptoms can be identified by practitioners or by researchers. For example, an organization can have the problem that their "KMS-enabled KM projects are not leading to desired outcomes". The problems can also be identified through quantitative studies carried out by a researcher. For example, the researcher can analyze a data base containing use data for an IS and is looking for unwanted patterns. The theory includes propositions on how the mechanisms introduced by an IS-invention into a pre-existing context can generate (desired) outcomes. This entails theoretical analysis of mechanisms, contexts, and expected outcomes. This is the first step in developing technological rules and means that one tries to generate technological rules using our current knowledge, that is, grounding in theory. The second step consists of generating more specific "hypotheses". Typically the following questions would be addressed in the hypotheses: 1) what changes or outcomes will be brought about by an IS-intervention (initiative), 2) what contexts impinge on this, and 3) what mechanisms (social, cultural and others) would enable these changes, and which one may disable the intervention. In this step the technological rules are refined.

The third step is the empirical test. It is done through intervention and guided by theory and technological rules. The step includes also the selection of appropriate data collection methods. ISDS research employs no standard research design formula. The base strategy is to develop a clear theory of IS initiative mechanisms, contexts and outcomes. Given the base strategy, an ISDS researcher has to design appropriate empirical methods, measures, and comparisons. ISDS research is supportive of: 1) the use of both quantitative and qualitative evaluation methods, 2) the use of extensive and intensive research design, and 3) the use of fixed and flexible research design. In this step it might be possible to generate support of the IS-intervention's ability to "change" reality. Based on the result from the third step, we may return to the IS-intervention to make it more specific as an intervention of practice. Next, but not finally, we return to theory. The theory may be developed, the hypotheses and the technological rules refined, the data collection methods enhanced, etc. To develop the technological rules means that the cycle will be repeated. As said above most of the technological rules will be heuristic. Through multiple case-studies one can accumulate supporting evidence which can continue until 'theoretical saturation' has been obtained. The researcher can be more or less active in the implementation (use) of the technological rules. The researcher can be very active and work like an action researcher, but can also be quite passive and work like an observer.

The suggested framework can be summarized as (adapted from van Aken, 2004):

Characteristic	*IS design science research framework*
Dominant paradigm	Design sciences
Focus	Solution focused
Perspective	Researcher as experimenter (intervener)
Logic	Intervention-outcome
Typical research question	Alternative IS interventions for classes of problems
Typical research product	Tested and grounded technological rules (design knowledge)
Nature of research product	Heuristic
Justification	Saturated evidence
Type of resulting theory	Practical and abstract IS design theory and knowledge

5. Conclusion, Discussion and Further Research

This paper points out some limitations and weaknesses in the current IS design science research frameworks and suggests that critical realism (CR) could be a fruitful philosophical underpinning for IS design science research and for an IS design science research framework. We presented a framework based in critical realism. The framework has a broader view on what types of knowledge IS design science research should produce. This broader view is a direct consequence of that we do not just focus the IT artifact, but instead focus a socio-technical system containing IS and IT.

Further theoretical and empirical work is required to develop and test the use of CR in IS design science research. Currently, we are using the framework in a major study focusing on the implementation of customer relationship management where CRM-systems are critical means. Our suggestions make no claims to be the final word in the debate on IS design science research, but research based on the framework can lead to a stream of research that can develop high scholarly quality *and* practical (professional) IS design science knowledge.

References

Ackroyd, S. & S. Fleetwood (Eds.)(2000): *Realist Perspectives on Management and Organisations*, Routledge, London.

Alter, S. (2004): Desperately seeking systems thinking in the information systems discipline, *Proceedings of the Twenty-Fifth International Conference on Information Systems,* 757-769.

Archer, M., Bhaskar, R., Collier, A., Lawson, T. & A. Norrie, A (Eds.)(1998): *Critical Realism: Essential Readings*, Routledge, London.

Agarwal, R. & H.C. Lucas, Jr. (2005): The information systems identity crisis: focusing on high-visability and high-impact research, *MIS Quarterly*, 29(3), 381-398.

Benbasat, I. & R.W. Zmud (2003): The identity crisis within the IS discipline: Defining and communicating the discipline's core properties, *MIS Quarterly*, 27(2), 183-194.

Bhaskar, R. (1978): *A Realist Theory of Science*, Harvester Press: Sussex.

Bhaskar, R. (1989): *Reclaiming Reality*, Verso, London.

Bhaskar, R. (1998): *The Possibility of Naturalism*, third edition, Routledge, London.

Bhaskar, R. (2002): *From Science to Emancipation: Alienation and the Actuality of Enlightenment*, Sage, New Delhi.

Bryman, A. (2001): *Social Research Methods*, Oxford University Press, Oxford.

Bunge, M. (1967): *Scientific Research II: The Search for Truth*, Springer Verlag, Berlin.

Bunge, M. (1984): Philosophical inputs and outputs of technology, In G. Bugliarello and D. Donner (Eds.), *History and Philosophy of Technology*, University of Illinois Press, Urbana, IL, 263-281.

Carlsson, S.A. (2004): Using critical realism in IS research, In M.E. Whitman & A.B. Woszczynski (Eds.), *The Handbook of Information Systems Research*, Idea Group Publishing, Hershey, PA, 323-338.

Carlsson, S.A. (2003): Advancing information systems evaluation (research): a critical realist approach, *Electronic Journal of Information Systems Evaluation*, 6(2), 11-20.

Chen, W. & R. Hirschheim (2004): A paradigmatic and methodological examination of information systems research, *Information Systems Journal*, 14(3), 197-235.

Cole, R., S. Purao, M. Rossi & M.K. Sein (2005): Being proactive: where action research meets design research, *Proceedings of the Twenty-Sixth International Conference on Information Systems*, 325-336.

Dobson, P.J. (2001): The philosophy of critical realism — an opportunity for information systems research, *Information Systems Frontier*, 3(2), 199-201.

Fleetwood, S. (2002): Boylan and O'Gorman's causal holism: a critical realist evaluation, *Cambridge Journal of Economics*, 26, 27-45.

Fleetwood, S. (2004): An ontology for organisation and management studies, In S. Fleetwood & S. Ackroyd (Eds.): *Critical Realist Applications in Organisation and Management Studies*, Routledge: London, 27-53.

Fleetwood, S., & S. Ackroyd (Eds.) (2004): *Critical Realist Applications in Organisation and Management Studies*, Routledge, London.

Glass, R.L., Ramesh, V. & I. Vessey (2004): An analysis of research in the computing disciplines, *Communications of the ACM*, 47(6), 89-94.

Groff, R. (2004). *Critical Realism, Post-positivism and the Possibility of Knowledge*, Routledge, London.

Hedström, P. & R. Swedberg (1998): Social mechanisms: an introductory essay, In P. Hedström & R. Swedberg (Eds.): *Social Mechanisms: An Analytical Approach to Social Theory*, Cambridge University Press, Cambridge, 1-31.

Hevner, A.R., S.T. March, J. Park & S. Ram (2004): Design science in information systems research, *MIS Quarterly*, 28(1), 75-105.

Hirschheim, R. & H.K. Klein (2003): Crisis in the IS field? A critical reflection on the state of the discipline, *Journal of the Association for Information Systems*, 4(5), 237-293.

Iivari, J. (2003): The IS core — VII towards information systems as a science of meta-artifacts, *Communications of the Association for Information Systems*, 12, Article 37, 568-581.

Järvinen, P.H. (2004): *On Research Methods*, University of Tampere.

Järvinen, P. (2005): Action research as an approach in design science, Working paper D-2005-2, Department of Computer Sciences, University of Tampere, Presented at the EURAM (European Academy of Management) Conference, Munich, May 4-7.
Kaplan, B., D. Truex III, D. Wastell, T. Wood-Harper & J. DeGross (Eds.)(2004): *Information Systems Research: Relevant Theory and Informed Practice*, Kluwer.
Kazi, M.A.F. (2003): *Realist Evaluation in Practice*, Sage, London.
Layder, D. (1993): *New Strategies in Social Research*, Polity Press, Cambridge, UK.
Layder, D. (1998): *Sociological Practice: Linking Theory and Social Research*. Sage, London.
Layder, D. (2005): *Understanding Social Theory*, second edition, Sage, London.
Longshore Smith, M (2005): Overcoming theory-practice inconsistencies: critical realism and information systems research, WP134, Department of Information Systems, London School of Economics.
March, S.T. & G. Smith (1995): Design and natural science research on information technology, *Decision Support Systems*, 15(4), 251-266.
Mark, M.M., Henry, G.T. & G. Julnes (2000): *Evaluation: An Integrated Framework for Understanding, Guiding, and Improving Public and Nonprofit Policies and Programs*, Jossey-Bass, San Francisco.
Mingers, J. (2004): Re-establishing the real: critical realism and information systems, In J. Mingers & L. Willcocks (Eds.): *Social Theory and Philosophy for Information Systems Research*, Wiley, Chichester, 372-406.
Mingers, J. & L. Willcocks (Eds.)(2004): *Social Theory and Philosophy for Information Systems Research*, Wiley, Chichester.
Mutch, A. (2002): Actors and networks or agents and structures: towards a realist view of information systems, *Organization*, 9(3), 477-496.
Myers, M.D. (2003): The IS core — VIII, defining the core proporties of the IS discipline: not yet, not now, *Communications of the Association for Information Systems*, 12, Article 38, 582-587.
Pawson, R. & N. Tilley (1997): *Realistic Evaluation*, Sage, London.
Pelz, D. S. (1978): Some expanded perspectives on the use of social science in public policy, In M. Yinger & S.J. Cutler (Eds.): *Major Social Issues: A Multidisciplinary View*, Free Press, New York, 346–57.
Pettigrew, A. (1997): The double hurdles of management research, In T. Clarke (Ed.): *Advancement in Organisational Behaviour: Essays in Honor of Derek S. Pugh*, Dartmouth Press, London, 277–96.
Purao, S. (2002): Design research in technology and information systems: truth or dare, unpublished paper, School of Information Sciences and Technology, The Pennsylvania State University, University Park, State College, PA.
Robson, C. (2002): *Real World Research*, second edition, Blackwell Publishing, Oxford.
Simon, H.A. (1988): *The Sciences of the Artificial*, second edition, MIT Press, Cambridge, MA.
Trauth, E.M. (Ed.)(2001): *Qualitative Research in IS: Issues and Trends*, Idea Group Publishing, Hershey, PA.
Vaishnavi, V. & W. Kuechler (2005): Design research in information systems, URL: http://www.isworld.org/Researchdesign/drisISworld.htm [Accessed: January 15, 2006)
Van Aken, J.E. (2004): Management research based on the paradigm of design sciences: the quest for field-tested and grounded technological rules, *Journal of Management Studies*, 41(2), 219-246.

Walls, J.G., Widmeyer, G.R. & O.A. El Sawy (1992): Building an information systems design theory for vigilant EIS, *Information Systems Research*, 3(1), 36-59.
Walls, J.G., Widmeyer, G.R. & O.A. El Sawy (2004): Assessing information system design theory in perspective: how useful was our 1992 initial rendition?, *Journal of Information Technology Theory and Application*, 6(2), 43-58.
Whitman, M.E. & A.B. Woszczynski (Eds.)(2004): *The Handbook of Information Systems Research*, Idea Group Publishing, Hershey, PA.
Wilson, M. & A. Greenhill (2004): Theory and action for emancipation: elements of a critical realist approach, In Kaplan, Truex III, Wastell, Wood-Harper & DeGross (Eds.): *Information Systems Research: Relevant Theory and Informed Practice*, Kluwer, 667-675.