WHAT IS A 'WICKED PROBLEM' FOR IS RESEARCH?

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Abstract

This study investigates the types of research problem for which Design Science Research (DSR) is suitable. This requires that DSR approaches are compared and contrasted with traditional empirical approaches, in order to determine the strengths and weakness of each paradigm. From this distinction, three guidelines are presented to allow Information Systems (IS) researchers to identify appropriate research problems for DSR, namely (1) when the prescriptive aspect of the research problem is less mature than the descriptive or normative aspect of the research problem, (2) when causal factors impacting upon the problem variable are difficult to identify and/or isolate, and (3) when mediating influences and interactions between causal factors impacting upon the problem variable are difficult to identify and/or isolate. These three guidelines are discussed in the context of the IS design literature, and illustrated using examples of existing DSR studies.

Keywords: Design Science Research, Wicked Problems, Guidelines.

1 Introduction

The paradigm of Design Science Research (DSR) represents an important part of the Information's Systems (IS) research landscape [Iivari 2007, Winter 2008, Baskerville et al. 2011]. The role of DSR arises from the argument that some research problems are fundamentally 'wicked', in the sense that they represent vast and complex interconnected socio-technical systems in which the outcomes of specific actions are difficult to predict [Mason and Mitroff 1973, Ackoff 1974, Hevner et al. 2004]. Such problems are not suitable for traditional science approaches and instead require the situated theorizing afforded in the context of active design in order to ensure proposed solutions behave as expected [Rittel 1972, Buchanan 1992, Brown 2008].

Much of the dialogue regarding wicked problems has taken place in the context of 'design thinking' in the broader managerial literature [e.g. Brown and Wyatt 2010, Dunne and Martin 2006] as well as in the Human-Computer Interaction (HCI) literature [Fallman 2003, Zimmerman et al. 2007]. However, an IS-specific definition of what constitutes a wicked problem was presented by Hevner et al. [2004, p.81], based upon the following five criteria: (1) Unstable requirements and constraints based upon ill-defined environmental contexts, (2) Complex interactions among subcomponents of the problem and its solution, (3) Inherent flexibility to change design processes as well as design artifacts (i.e., malleable processes and artifacts), (4) A critical dependence upon human cognitive abilities (e.g., creativity) to produce effective solutions, and (5) A critical dependence upon human social abilities. Such criteria present a valuable starting point, however given the significant role of the concept of wicked problems for motivating DSR, comparatively little attention in IS research has been afforded to exploring the concept further. This may be because the problem of defining 'wickedness' is itself sufficiently complex to be called wicked (c.f. Coyne 2005). It may also be because all problems with a social component can be considered wicked according to established definitions of wickedness (Conklin 2008), so diminishing the usefulness of the term as a means of distinction between IS research problems.

This study presents a pragmatic exploration of the concept of wicked problems in an IS context. This exploration reframes 'wicked problems' as *the types of research problem for which DSR is suitable*, so allowing concrete guidelines to be developed for the identification of such research problems. The next section describes how the DSR paradigm is defined in this study. This is important, as a number of differing perspectives on DSR have been presented by IS scholars. Following this, the similarities and differences between DSR and traditional science approaches are presented. This is done to clarify where the two paradigms differ, so that the strengths and weaknesses that these differences manifest may be identified. Building upon this, the subsequent section presents three guidelines describing the types of research problem for which a DSR approach should be pursued. These guidelines explore key strengths of DSR approaches over traditional science approaches, and demonstrate how these strengths can be leveraged using examples from existing DSR studies. Finally, these findings are discussed and the implications of the study are presented.

2 The Many Faces of Design-Science Research

Several frameworks have been presented for DSR approaches to IS research. At the forefront of these competing frameworks is a distinction between pragmatic DSR and theory-driven DSR [Gregor and Hevner 2013]. Pragmatic DSR studies emphasise the usefulness of the situated IT artefact in a working environment [e.g. Nunamaker et al. 1990, March and Smith 1995, Gerfalk 2010] whereas theory-driven DSR studies emphasise the abstract and repeatable theoretical characteristics of the IT artifact as a means of solving a class of problems [Walls et al. 1992, Purao 2002, Gregor and Jones 2007]. The studies make contributions at varying theoretical levels, for example pragmatic DSR studies are more likely to contribute situated instantiations and nascent design principles and rules, while theory-driven DSR studies are more likely to produce design principles and rules within the context of explicit mid-range theories [Gregor and Hevner 2013]. A second significant distinction is between the product-centric DSR approaches listed above and more process-oriented DSR, which generally place greater emphasis upon how design was carried out, rather than the output of that design, e,g, action-design research [Cole et al. 2005, Sein et al. 2011], collaborative practice research [Mathiassen 2002], and engaged scholarship [Mathiassen and Nielsen 2008]. Rather than viewing the instantiation of IT artifacts as a means of evaluating their utility, such process-oriented DSR approaches emphasise the learning that takes place collaboratively between researchers and practitioners when interventions are introduced. Further complicating the concept of DSR is the observation that competing frameworks may built upon a variety of philosophical foundations, including divergences between positivist and interpretivist epistemologies [Love 1998, Levy and Hirschheim 2012], as well as purely pragmatic assumptions [Cross 2001, Goldkuhl 2012].

Yet the varying definitions of DSR share one central characteristic, namely an emphasis on producing prescriptive knowledge, rather than descriptive or normative theories. Thus this characteristic may be used at a high-level to bound the paradigm of DSR and differentiate it from traditional science approaches, even if the specific approaches employed within either paradigm may vary greatly along other dimensions. This central distinction affords a means of comparing DSR and traditional science approaches. This is a critical step, as for wicked problems to be identified (i.e. the type of research problems for which DSR is suitable), the relative strengths of DSR must be made lucid. To this end, the following section uses this distinction to compare DSR and traditional science approaches in more detail.

3 Comparing DSR and Traditional Science Approaches

Just as DSR represents a broad spectrum of approaches, so traditional science varies significantly in terms of the philosophical assumptions and empirical methods adopted [c.f. Iivari 1991]. The exploration of these differences in traditional science is beyond the scope of this study. Instead, consistent with others who have contrasted DSR and traditional science [e.g. Walls et al. 1992, March and Smith 1995, Hevner et al. 2004], traditional science is considered here as research that produces descriptive or normative theory, rather than prescriptive knowledge.

The first step for both traditional science approaches and DSR is to identify a research problem. IS is characterized as a business discipline wherein research is expected to address relevant practical problems [Benbasat and Zmud 1999, Chiasson and Davidson 2005]. This requires that any research problem contain both a descriptive/normative aspect and some prescriptive aspect. The descriptive/normative aspect is important, as IS research must aspire to understand 'how' and 'why' phenomena occurs to maintain the academic credibility of the discipline, both across related disciplines and in practice [Robey and Markus 1998]. Conversely, the prescriptive aspect is important to ensure research problems are of interest to practitioners, albeit the relevance of some problems may manifest less directly than others [Lyytinen 1999]. Thus, the basic research process for both DSR and traditional science approaches in IS begins with the identification of some research problem that contains descriptive/normative dimensions and prescriptive dimensions.

The second step in traditional science approaches is to identify relevant existing knowledge that may inform theory development [Truex et al. 2006]. This is mirrored in DSR, in which such existing knowledge is referred to under a number of tiles, including 'kernel theory' [Walls et al. 1992, Vaishnavi and Kuechler 2007], 'justificatory knowledge' [Gregor and Jones 2007], and 'applicable knowledge' [Hevner et al. 2004]. The nature of the existing knowledge identified in by DSR and traditional approaches differs, as DSR approaches often rely upon less well-defined theory [March and Smith 1995, Venable 2006], as well as industrial 'theory in use' [Sarker and Lee 2002, Markus et al. 2002]. This is especially true of pragmatic and process-oriented DSR approaches, for which large quantities of relevant and applicable scholarly material are unlikely to be available [Gregor and Hevner 2013]. Nonetheless, at a high-level the process remains the same across paradigms, researchers consider what is already known about the subject matter.

The third step for traditional science approaches is to adopt some theoretical understanding of the factors relating to the research problem. These theoretical understandings can range from theories for analysis, theories for explaining, theories for predicting, and theories for explaining and predicting [Gregor 2006]. However for each of these theory types, the aim is to identify what relevant factors should be considered, as well as how and why these factors influence the research problem [Orlikowski and Iacono 2001, Lee and Baskerville 2003, Yin 2008]. This theoretical understanding is formalized into structures such as propositions, hypotheses, and models, according to the maturity of the theory [Weick 1995, Gregor 2006], and tested with/informed by empirical observations of existing technological systems. The third step for DSR approaches is also to adopt some theoretical understanding of the factors relating to the research problem, although this receives little or no formalisation or testing. Constructs are identified within theories for analysing, explaining and/or predicting that can subsequently be manipulated by design theories seeking to impact upon the problem variable [Kuechler and Vaishnavi 2012]. This step may be tacit in pragmatic studies, for which explanations of how and why solutions work may not be the core issue [Venable 2006, Goldkuhl 2012]. Yet without some underlying model of the relevant factors, either explicit or implicit, the set of possible interventions would be limitless.

The fourth step for traditional science identifies the practical implications of this novel theoretical understanding of the research problem. Where this theoretical understanding is causal in nature, the practical implications are often more obvious, to the point that a fully causal abstraction of the problem system can be argued to present a design artifact in and of itself [c.f. Baskerville and Pries-Heje 2010]. Where this theoretical understanding is correlational in nature, the practical implications may be presented at an additional degree of separation. For example, the assimilation of structuration theory into IS by Orlikowski & Robey [1991] presented few obvious immediately implementable directives for practice. Yet that study did nonetheless present a prescriptive component by bringing to light new issues to be considered in IS development, such as the process of IT deployment, and how human action can change the functionality of institutionalized IT.

The fourth step for DSR is also to identify practical implications. Yet unlike traditional science approaches that consider this prescriptive component peripherally, these prescriptive 'design theories' form the focal point of theory generation and testing in DSR [Walls et al. 1992, 2004]. These design theories have been described as 'technological rules' [Van Aken's 2005], 'interventions' [Cole et al. 2005], and 'design propositions' [Carlsson et al. 2011], and at a fundamental level represent "goal-directed plans for manipulating constructs" [Vaishnavi and Kuechler 2007, p.13]. The degree of formalisation of the design theory may lessen in pragmatic DSR studies, yet this abstraction of the IT artifact is necessary to ensure findings are reusable and qualify a study as research [vom Brocke and Buddendick 2006]. Moreover the instantiation and empirical testing of these rules is fundamental to the iterative design process [Hevner 2007, Mathiassen and Nielsen 2008, Carlsson et al. 2011].

Thus it is argued here that although there are significant differences between the research process employed in traditional science approaches and DSR (and indeed between approaches within either of those paradigms), there are also four common high-level components (see Table 1 and Figure 1). The central departures between DSR and traditional science approaches arise from the varying focuses for theory formalization and testing. Traditional approaches formalise and test the analytical/explanatory/predictive theories using observations of existing technological systems. Because these systems already exist, a strong theoretical foundation is more likely to exist which allows precise and rigorous testing to take place in a comparatively sequential manner. DSR is often more iterative [Hevner et al. 2004, Vaishnavi and Kuechler 2007] with a greater focus upon abductive reasoning than hypothetico-deductive or inductive theory building [Fischer and Gregor 2011]. However such generalisations should also be applied with caution, as pragmatic studies may be more iterative than theory-driven studies [Hevner 2007] and process-oriented studies may be more inductive than artifact-centric studies [Mathiasson 2002, Sein et al. 2011].

Stage of Research	Traditional Science	Design Science
Identify research problem	Phenomena are identified, the nature of which is of interest to both academics and practitioners	Phenomena are identified, the nature of which is of interest to both academics and practitioners
Identify relevant existing knowledge	Theory is identified in existing literature that describes how and why different factors contribute to the target phenomena	Theory is identified in both practice and existing literature that describes how and why different factors contribute to the target phenomena
Identify how and why different factors contribute to the research problem	A model of contributing factors, as well as the relationship between them, is developed, formalised and tested	A model of contributing factors, as well as the relationship between them, is developed
Identify the practical implications of the role these factors play	Prescriptions for practitioners are developed, based upon the manipulation of contributing factors	Prescriptions for practitioners are developed, formalised and tested, based upon the manipulation of contributing factors

Table 1. Key stages of IS research for both traditional science approaches and DSR.

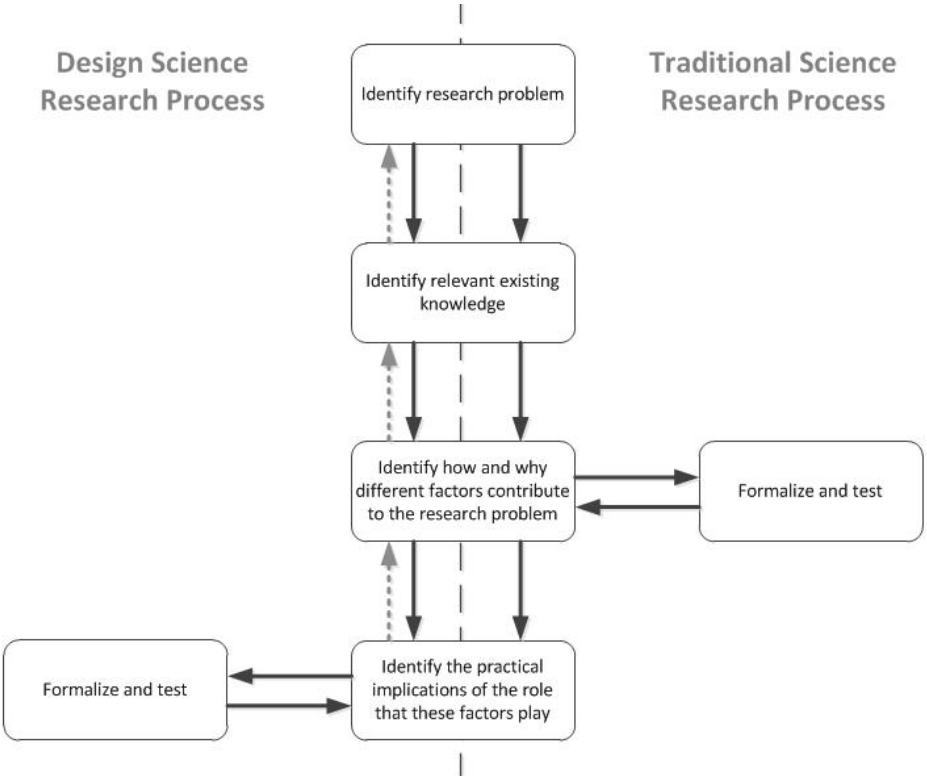

Figure 1. The research process for Design Science and traditional science approaches

These two alternative areas of focus for the formalization and testing of theory each come with advantages and disadvantages, particularly with regards the conclusions that can be drawn from the research. Viewed in this manner, the question of 'what is a wicked problem in IS research' takes on a slightly different form, namely when is it more appropriate to formalize and test the prescriptive theoretical component of a study, rather than the analytical/explanatory/predictive component? The following sections address this question by presenting three guidelines, each of which describe circumstances in which the value of some strength of DSR over traditional science approaches is brought into focus.

4 Guidelines for Identifying Wicked Problems for IS Research

This section presents three guidelines for identifying the types of IS research problem for which a DSR approach is suitable. Each guideline matches a class of research problem with some strength of DSR as it has been defined in previous sections. Thus it is argued here that each of these guidelines is independently sufficient to justify a DSR approach.

4.1 DSR and the Need for Prescriptive Theory

The first, and best-developed argument for conducting DSR arises when the prescriptive aspect of the research problem is of most priority [e.g. March and Smith 1995, Nunamaker et al. 1990, Venable 2006]. Under such circumstances, it is crucial to formalize and test the prescriptive theoretical findings from a study to ensure their reliability. This testing takes place in the interaction between 'design cycles' and 'relevance cycles', in which the utility of design alternatives are iteratively evaluated in a working environment [Hevner 2007]. Without such formal tested design theory, the process of translating academic IS understanding into practical results is reduced from a science to a 'craft', requiring high levels of interpretation [Gregor and Jones 2007]. Thus:

Guideline 1: An IS research problem is 'wicked' when the prescriptive aspect of that research problem is less mature than its descriptive or normative dimensions.

An example of a study that adopts a DSR approach to address a primarily prescriptive problem is that of Adipat et al [2011]. Adipat et al. incorporated both cognitive fit theory and information foraging theory as a means of understanding users' browsing and searching behavior on mobile Web devices. They then formalized the prescriptive implications of this understanding into a set of practical design recommendations advocating tree-view layouts, hierarchical text summarization, and colored keyword highlighting. These recommendations were then tested in a laboratory environment. This experiment demonstrated that subjects performed search tasks faster and with fewer errors in interfaces that complied with several of these design prescriptions inferred from kernel theories, though not others (e.g. hierarchical text summarization was not as effective as was anticipated). Adipat et al. note that their study not only serves to clarify the practical implications of cognitive fit theory and information foraging theory in a mobile Web context but also to demonstrate that such implications exist. They remark that "Extant studies on presentation adaptation methods for mobile devices lack theoretical support. The results of this study indicate that the cognitive fit theory could be well extended to the mobile Web context" [Adipat et al. 2011, p.116]. Thus the priority for their research problem was not the analytical/explanatory/predictive component, which was already mature, but rather the prescriptive element, which remained untested and open for interpretation.

4.2 DSR and the Identification of Causal Relationships

As noted already, prescriptive theoretical knowledge builds upon formative theories for analysis, explanation, and/or prediction. However what has not yet been discussed is the multi-directional nature of this relationship, i.e. the ability of prescriptive theory to inform analytical/explanatory/predictive theory. The value of design prescriptions is ultimately a reflection of their ability to bring about a desired change in the system [March and Smith 1995, Simon 1996]. However, as these design prescriptions are essentially "goal-directed plans for manipulating constructs" [Vaishnavi and Kuechler 2007, p.13], their utility also serves to validate the existence of causal relationship between target constructs and the utility variable. Put differently, "truth and utility are inseparable. Truth informs design and utility informs theory. An artifact may have utility because of some as yet undiscovered truth" [Hevner et al. 2004, p.80]. In this way, by adopting a DSR methodology IS researchers can study and manipulate embedded phenomena indirectly to develop theoretical insights at multiple different levels [Gregor and Hevner 2013, Purao 2002].

This ability to uncover causal relationships through their indirect measurement is significant, as it allows theoretical sense to be made of complex environments where individual causal links may not otherwise be possible to isolate. One of the defining features of the concept of 'wicked problems' as described in existing literature is the difficulty encountered when attempting to bound a problem in social and organizational domains [Ackoff 1974, 9]. This is because the range and complexity of factors that contribute to social environments does not easily lend itself to reliable reduction, to the point where understanding what factors are relevant often becomes the key challenge [c.f. Rittel 1972]. Yet the iterative, empirically grounded nature of design allows for alternative possibilities to be repeatedly tested in comparable contexts [Hevner et al. 2004, Venable 2006], so allowing anticipated causal relationships to be supported or challenged. Furthermore, new causal factors can be identified, occasionally serendipitously but often through observations of 'positive deviance', whereby positive exceptions are exhibited and their source identified [Brown and Wyatt 2010]. Qualitative case studies performed within traditional science approaches are also often motivated by this goal of identifying new factors [Yin 2008]. However the capabilities of DSR differ in that it seeks to identify causal factors, rather than correlations. This identification of such causal factors is not possible without DSR's ability to introduce interventions into a working system and observe the outcome [Bhaskar 2011, Carlsson 2006]. This process is illustrated in Figure 2.

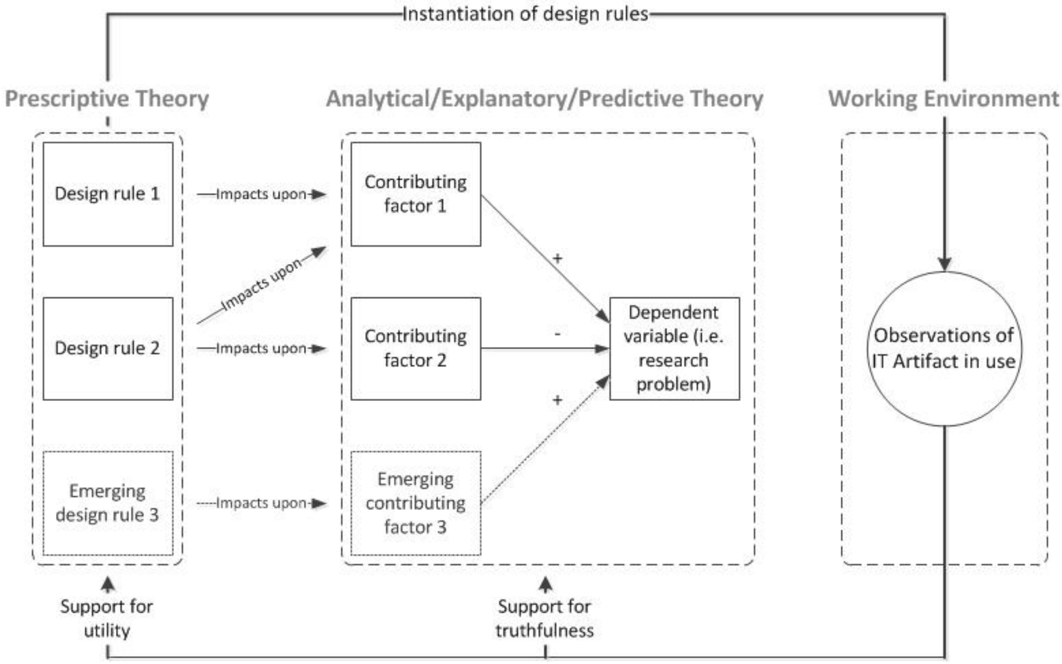

Figure 2. The research process for Design Science and traditional science approaches

Put in engineering terms, DSR allows a researcher's understanding of contributing factors to be 'black-box tested'. If a prescriptive theory premised on such a formative understanding demonstrates the desired utility, then that formative understanding receives some validation. This is not intended to suggest that the level of validation of this 'black-box testing' is comparable to that obtainable in traditional science approaches. Without a doubt, under conditions where the analytical/explanatory/predictive understanding is the explicit focus of the study, the precision of its measurement is likely to be far superior and thus higher standards of rigor can be applied in the evaluation of these measurements. Instead it is proposed that, in areas where such theory may not be constructed by traditional means, DSR has a capacity for exploratory high-level theorizing that may inform future development of theories for analysis, explanation, and/or prediction. Thus:

Guideline 2: An IS research problem is 'wicked' when causal factors impacting upon the problem variable are difficult to identify and/or isolate.

An example of a study that adopts a design-oriented approach to identify new causal factors can be found in Markus et al. [2002]. Markus et al. sought to design an organizational structure for a manufacturing organization that would best capture their knowledge processes. Accordingly, the authors drew upon existing literature describing how an efficient organizational knowledge-base could best be designed. However, upon implementing the practices advocated by this literature, Markus et al. found them to be of limited success. This was evidently because important knowledge processes were not like those described in the research that they had initially drawn upon. Instead these knowledge processes were 'emergent' in the sense that they were knowledge processes for which no best structure or sequence existed, for which the possible actor set was unpredictable, and for which knowledge requirements were variable and far reaching. Consequently, Markus et al. began designing to accommodate such unstructured processes and observed better results. That study demonstrates the ability of DSR to uncover hidden but important causal factors that may have otherwise gone unreported. In the case of Markus et al., these causal factors represented emergent knowledge processes, which were demonstrated to possess a significant impact on the efficiency of organizational structure.

4.3 DSR and the Identification of Relationships between Causal Factors

For some social and organizational research problems, a compartmentalized understanding is harmful even when researchers believe the individual contributing factors to be well-known. This is because it may be difficult to pre-empt the interdependencies between factors that arise under specific conditions [Brown 2008, Rittel 1972]. This may lead to proposed solutions that behave in ways that were not anticipated and that produce new problems greater in scale than the original, the characteristic that first motivated the use of the term 'wicked' [Churchman 1967]. Accordingly, in order to understand how factors interact within a system, it may be necessary to actively implement changes and observe the outcome. This feature of complex systems can be related back to the Kurt Lewin quote paraphrased by van Aken [2004] as 'if you want to understand a system, try to change it'.

Whereas traditional science approaches observe systems from an externally removed vantage point, DSR offers the opportunity to perform theorizing within working holistic systems. This situated holistic form of theorizing allows research problems to be addressed with a minimum of contextual reduction. Such a capacity is significant, as it means that, in addition to the identification of causal factors, a DSR approach may also play an important role as a means of bringing to light key relationships between factors. This capability must again be differentiated from qualitative case studies performed within traditional science approaches, which are also well-suited to uncovering hidden correlations [Kaplan and Duchon 1988]. Yet without the ability to deliberately introduce interventions in a system, it is not possible to draw conclusions regarding the mediating variables with significant sum effects on specific causal outcomes [Shadish et al. 2002]. Hence such qualitative studies do not possess these capabilities. Thus:

Guideline 3: An IS research problem is 'wicked' when mediating influences and interactions between causal factors impacting upon the problem variable are difficult to identify and/or isolate.

An example of this within IS research is illustrated in the study performed by Adomavicius et al. [2011]. In order to allow organizations to better predict and understand the impact of future IT developments, Adomavicius et al. developed an IT ecosystem model to predict the return on organizational technology investment. This was a complex task, as a vast range of possible interdependencies exist between technological and organizational variables. Adomavicius et al. first performed a 'face' evaluation of the utility of their model with a qualitative analysis of the digital music ecosystem and a quantitative analysis of data relating to the wireless technology ecosystem. This evaluation provided some empirical validation for their proposed model, however it was not sufficient to determine whether the actual artifact would be useful to real-world practitioners possessing a variety of personal and technological preferences. Hence Adomavicius et al. conducted interviews with a sample of such practitioners seeking to make use of the new IT ecosystem model. Within these interviews, these practitioners indicated that although the information about the IT landscape produced by the model would be useful for both IT-consuming and IT-producing firms, the manner with which it analyzed this data would be more useful to IT-producing/IT-reporting firms. This interaction between the IT-consumption/production dimension of firms and the utility of the IT ecosystem information analysis method would not likely have emerged without the situated utility-based evaluation facilitated by a DSR approach. Furthermore, in addition to the practical implications of this finding, theoretical insights were gained at an analytical/explanatory/predictive level concerning the mediating influence of the IT-consumption/production dimension of firms on preferences towards IT landscape analysis. Such an interaction between factors would not have easily been identifiable within the context of traditional science approaches.

5 Discussion

This study has articulated and addressed a key question for Design Science Research (DSR), namely the types of research problems for which DSR should be adopted. This was done according to three steps. First, a combined view of DSR was presented that subsumes differences between pragmatic and theory-driven accounts, as well as product-oriented and process-oriented frameworks. Second, DSR and traditional science approaches were compared and contrasted in order to identify the commonalities and divergences between the two paradigms. Third, three guidelines were presented for identifying wicked problems in IS that are suitable for a DSR approach.

This research makes several significant contributions to the IS literature. Firstly, the three guidelines afford IS researchers a means of evaluating the value offered by a DSR approach in the context of some research problem. This builds on recommendations made for a higher proportion of DSR studies within the discipline [e.g. Iivari 2007, Winter 2008] by laying out clear motivation for DSR approaches. Secondly, although Guideline 1 is intuitive, Guidelines 2 and 3 demonstrate strengths of DSR that are not widely publicized in IS. These strengths emerge from the ability of DSR to develop and validate analytical/explanatory/predictive theory in environments where traditional science approaches may struggle. This is because DSR allows predicted causal relationships between factors a manner of indirect 'black box testing' by evaluating design prescriptions that build upon those predicted relationships. Thus, just as Popper [2002, p.298] spoke about a theory 'progressing' by being made more "severely testable" and "easily refutable", so DSR can 'progress' formative theories for analysis, explanation, and/or prediction. While theorizing in this manner does not possess the same level of precision as that of traditional science approaches, it does facilitate empirically-grounded theorizing in areas that may not readily be engaged by other means.

Thirdly, this study reduces the conceptual distance between DSR and traditional science approaches in IS. By demonstrating the common research process and isolating the differences between paradigms in terms of the types of theory formalized and tested, the differences between DSR and traditional science approaches are made more lucid. Interestingly, this finding resonates with the argument made earlier in the study that prescriptive findings can inform the development of theories for analysis, explanation, and/or prediction. The prescriptive Guidelines that were developed to identify wicked problems for IS research are essentially prescriptive. Yet, the development of these prescriptive guidelines required the development of a novel basis for those guidelines, in this instance relating to the factors that differentiate DSR from traditional science approaches. Hence the combined model of DSR and traditional science approaches also serves to validate the underlying assumptions of the prescriptive guidelines that build upon it.

Lastly, this study lays the groundwork for future research that considers whether multi-paradigm approaches are feasible, or even desirable, in the same way that multi-method research may be conducted within a paradigm [Kaplan and Duchon 1988]. Given that all IS research has some analytical/explanatory/predictive component and some prescriptive component, it stands to reason that circumstances exist in which the formalization and testing of both types of theories may be valuable. Such attempts to combine paradigms are likely to encounter similar challenges as those encountered when methods are combined, e.g. the additional expertise, effort, and research access required [Clarke and Lehaney 2000]. However, in illustrating the symmetry between DSR and traditional science approaches, the opportunity is presented for a discussion of multi-paradigm IS research.

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