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When is a problem a design science problem?

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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 intervention-free empirical approaches, in order to determine the strengths and weakness of each approach. 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 analytical, explanatory, or predictive aspect, (2) when an opportunity arises to engage with a class of design problems where effective existing solutions do not yet exist, (3) when important elements of a system may only become visible through the act of design. 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 Problems, Wicked problems, Methodology

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1 Introduction

Design Science Research (DSR) represents an important part of the Information Systems (IS) research landscape [Iivari 2007, Winter 2008, Baskerville et al. 2011]. However there has been little discussion to date about the types of research problems for which DSR is appropriate. In their seminal description of DSR, Hevner et al. [2004] argued that design or intervention-based approaches were important to tackle the ‘wicked’ problems in the field. Such problems occur in vast and complex interconnected socio-technical systems in which the outcomes of specific actions are difficult to predict based on observation alone [Mason and Mitroff 1973, Ackoff 1974]. For this reason, engaging with these wicked problems requires the type of situated theorizing afforded when researchers become actively involved in design and can thus reasonably assert proposed solutions behave as expected [Rittel 1972, Buchanan 1992, Brown 2008].

Yet this characterisation could arguably be applied to all research problems in the IS field [c.f. Orlikowski and Iacono 2001, Orlikowski and Scott 2008], thus very few discriminators exist for DSR researchers in identifying DSR specific research problems. A similar limitation can be found in Peffers et al.'s [2007] discussion of four different 'initiation contexts' for a DSR project (i.e. the cultural and institutional contexts in which DSR projects are initiated), namely (1) problem-centred initiation, (2) objective-centred solution, (3) design and development-centred initiation, and (4) client/context initiation. Understanding the initiation context for a DSR study is certainly important, yet once again each of these contexts could also initiate a purely observation-based (non-DSR) approach based on analysing, explaining, or predicting important considerations that would support industrial designers, rather than the researchers themselves being actively involved in implementing change.

Little, if any, existing work can be found that specifically addresses this issue of why some research problems are more appropriate than others for DSR. Rather, the identification of problems is often implicitly attributed to collaborative serendipity and opportunism, or the predispositions of the researchers involved [Hevner and Chatterjee 2010]. This represents a significant oversight if DSR and intervention-free research approaches are to effectively complement and inform one another, rather than simply operating in parallel. Thus, the research objective of this study is *to develop guidelines that help researchers identify those research problems more appropriate for DSR than intervention-free approaches*.

2 Research Method

This study draws upon existing methodological and empirical research to inform theorising. The next section discusses DSR as it is viewed in this study. Following this, similarities and differences between DSR and intervention-free science approaches are discussed. This is done to clarify where the two approaches differ, so that the strengths and weaknesses manifested by these differences may be identified. The subsequent section presents three guidelines describing when a DSR approach should be pursued, each of which is informed by one existing illustrative exemplar. These guidelines explore key strengths of DSR approaches over intervention-free approaches, and identify the types of research problem for which these strengths are important. Finally, these findings are discussed and the implications of the study are presented.

3 The Many Faces of Design-Science Research

Multiple frameworks have been presented for DSR which differ along several dimensions. Perhaps the most salient dimension is the varying emphasis on pragmatism and theory development [Gregor and Hevner 2013]. More pragmatic DSR studies place greater focus on the usefulness of the situated IT artefact in a working environment [e.g. Nunamaker et al. 1990, March and Smith 1995, Hevner and Chatterjee 2010] whereas more theory-driven DSR studies place greater focus on the abstract and repeatable theoretical characteristics of the IT artefact as a means of solving a class of problems [Walls et al. 1992, Purao 2002, Gregor and Jones 2007]. Pragmatic and theory-driven studies often make contributions at varying levels of abstraction. For example pragmatic DSR is more likely to contribute situated instantiations and nascent design principles and rules, while theory-driven DSR is more likely to pro-

duce design principles and rules within the context of explicit mid-range theories [Gregor and Hevner 2013].
A second significant dimension differentiates between the product-centric IT-dominant DSR approaches listed above and more process-oriented organization-dominant DSR, such as 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 artefacts 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.
A third dimension has also been discussed which differentiates between deductive ‘theory first’ DSR and inductive/abductive DSR, in which theory building occurs based on first-hand empirical observations [Lee et al. 2011, Iivari 2015]. This goes further than basic methodological differences, as competing frameworks for DSR may build 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, Agerfalk 2010, Goldkuhl 2012].
Yet these varying formulations of DSR share one central characteristic, namely an emphasis on producing prescriptive knowledge, rather than analytical, explanatory, or predictive theories. The following section uses this distinction to compare DSR and intervention-free approaches in more detail.

4 Comparing DSR and Intervention-free Approaches

Before considering the extent to which different IS research problems are suitable for DSR rather than intervention-free approaches, it is worth laying out the elements of research that transcend this distinction and typify all IS research problems (see Figure 1). The elements described are not intended to necessarily imply linearity; rather they are an attempt to make sense of complex interdependent processes by isolating and discussing different aspects of them.

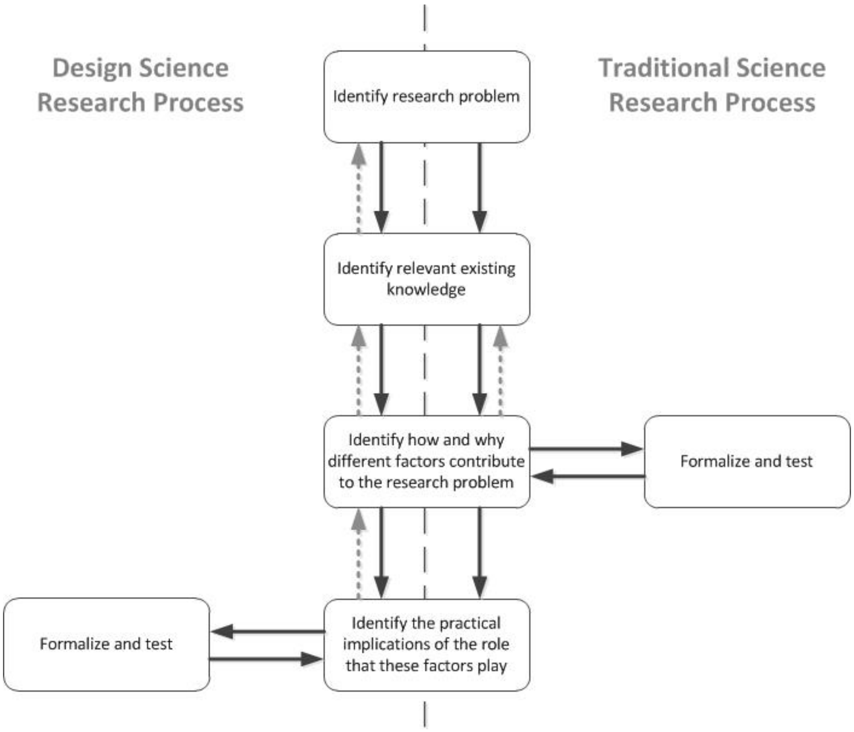

Figure 1: The research process for Design Science and intervention-free approaches.

4.1 Identifying a Research Problem

As a business discipline, all IS research is expected to afford some practical industrial relevance [Benbasat and Zmud 1999, Chiasson and Davidson 2005]. Among other things, this requires that any research problem contain both an analytical/explanatory/predictive aspect and some prescriptive aspect. The prescriptive aspect is required to demonstrate relevant practical implications, albeit these implications may occasionally be somewhat tacit or indirect [Lyytinen 1999]. Conversely, the academic credibility of the discipline could suffer if researchers were to engage with research problems that offered no new analytical/explanatory/predictive understanding of the subject matter, both across related disciplines and in practice [Robey and Markus 1998]. Thus, the basic research process for both DSR and intervention-free approaches in IS demands the identification of some research problem that contains valuable analytical/explanatory/predictive dimensions and prescriptive dimensions.

4.2 Identifying Relevant Existing Knowledge

Once a problem has been identified, researchers adopting intervention-free approaches look to identify relevant existing knowledge that may inform theory development [c.f. Truex et al. 2006], though this is minimised for heavily inductive methods, e.g. ‘grounded theory’, whereby researchers delay committing to any particular view of a problem until after data gathering has begun [Strauss and Corbin 1990]. This is mirrored in DSR, wherein such existing knowledge is referred to under a number of titles, 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 intervention-free 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]. Nonetheless, at a high-level the elements involved are similar, i.e. researchers look for existing knowledge that can be related to the research problem.

4.3 Identifying How and Why Different Factors Contribute to the Problem

The identification of relevant existing knowledge helps those researchers adopting intervention-free approaches to propose some theoretical understanding of the factors contributing to the problem. These theoretical understandings may be process-oriented or variance-based [Crowston 2000] and may be formalized into structures such as propositions, hypotheses, and models, according to the maturity of the theory [Weick 1995]. In addition to prescriptive *theories for design*, Gregor [2006] described four types of understanding-based theories, namely *theories for analysis*, *theories for explaining*, *theories for predicting*, and *theories for explaining and predicting*. The aim for such understanding-based perspectives is to identify what abstract 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]. The third element for DSR approaches is also to adopt some theoretical understanding of the factors relating to the problem, although such understanding often receives little explicit formalisation or testing [Kuechler and Vaishnavi 2012]. This allows constructs [Gregor and Jones 2007] or ‘general components’ [Baskerville and Pries-Heje 2010] to be identified that are amenable to manipulation, particularly where those constructs can be related causally to behavioural outcomes [Kuechler and Vaishnavi 2008, Gleasure 2014]. This element 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, be it explicit or implicit, detailed or vague, the set of possible interventions would be limitless and impenetrable.

4.4 Identifying the Practical Implications of the Role Played by these Factors

Finally, researchers adopting intervention-free approaches must identify some 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 artefact 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 and Robey [1991] presented few obvious immediately implementable directives for practice. Yet that study did nonetheless present a prescriptive element 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. DSR also identifies practical implications, though unlike intervention-free approaches this prescriptive element forms the focal point of theory generation and testing in DSR [Walls et al. 1992, 2004]. Where the level of abstraction is high, these prescriptions have been described as 'technological rules' [Van Aken 2005], 'interventions' [Cole et al. 2005], and 'design propositions' [Carlsson et al. 2011], while other design theorising may take place at the level of situational design decisions and instance-specific solutions for an exemplar problem [c.f. Purao 2002]. The degree of abstraction typically lessens as studies become more pragmatic in nature, yet some form of abstraction (or abstractability) is necessary to ensure findings are reusable and to qualify a study as research [vom Brocke and Buddendick 2006].

5 Guidelines for Identifying Research Problems Suitable for DSR

The previous section argues that although there are differences between the research processes employed in intervention-free approaches and DSR (and between methods within either of those approaches), there are four common high-level elements. The central departures between DSR and intervention-free approaches arise from the varying focuses for theory formalization and testing. Intervention-free approaches formalise and test the *analytical/explanatory/predictive* element using observations of existing technological systems. Because these systems already exist, some clear theoretical foundation may be available to allow precise and rigorous testing to take place in a comparatively structured manner. In contrast, DSR approaches formalise and test the *prescriptive* element by implementing changes in some *ipso facto* new system and observing the results. It is noteworthy than the resulting additional instability and uncertainty often means DSR is more iterative than intervention-free approaches [Hevner 2007, Carlsson et al. 2011, Abraham et al. 2014, Conboy et al. 2015] with a greater focus upon abductive reasoning than hypothetico-deductive or inductive theory building [Fischer and Gregor 2011, Lee et al. 2011, Gregor et al., 2012].

These alternative areas of focus for formalizing and testing theory each come with advantages and disadvantages in terms of the potential findings. Viewed in this manner, the question of when to adopt DSR approaches takes a different form, namely: when is it more appropriate to formalise and test the prescriptive theoretical element of a study, rather than the analytical/explanatory/predictive element? This section presents three guidelines to enable researchers to identify research problems for which a DSR approach is suitable. Each guideline matches a class of research problem with some relative advantage of DSR over intervention-free approaches. Thus it is argued here that each of these guidelines is independently sufficient to justify a DSR approach.

5.1 DSR and the lack of mature implications around existing theory

The first (and perhaps most intuitive) 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, Hevner et al. 2004]. Under such circumstances, it is crucial to formalize and test the prescriptive theoretical findings from a study to ensure their reliability (see Figure 2). 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, Venable et al. 2012, Abraham et al. 2014]. Without such formally 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]. This approach of formalising implications and practices emphasises the deductive element of DSR [Fischer et al. 2011], to the point that an empirical element may not even be strictly necessary [Gleasure 2014]. Thus:

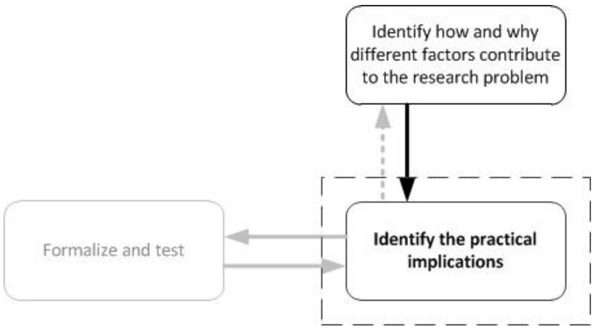

Figure 2: Deducing practical implications via DSR.

Guideline 1: A DSR approach is suitable when the prescriptive aspect of the research problem is less mature than the analytical, explanatory, or predictive aspect.

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 behaviour on mobile Web devices. They formalized the prescriptive implications of this understanding into a set of practical design recommendations advocating tree-view layouts, hierarchical text summarization, and coloured 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 element, which was already mature, but rather the prescriptive element, which was untested and open for interpretation.

5.2 DSR and engagement with design contexts lacking effective existing solutions

A recent meta-analysis of DSR [Iivari 2015] divided existing research into two strategies. Strategy 1 studies typically include a significant deductive theorising component which may or may not involve an industrial partner. Strategy 2 studies on the other hand emerge within the context of some live design project, wherein interesting theoretical findings are developed inductively/abductively as researchers reflect upon instances of success and failure during design (see Figure 3). That meta-analysis concludes that neither strategy is essentially superior, each simply represents a different approach to conducting DSR. Yet it also notes that comparatively few strategy 2 studies are evident in published IS research.

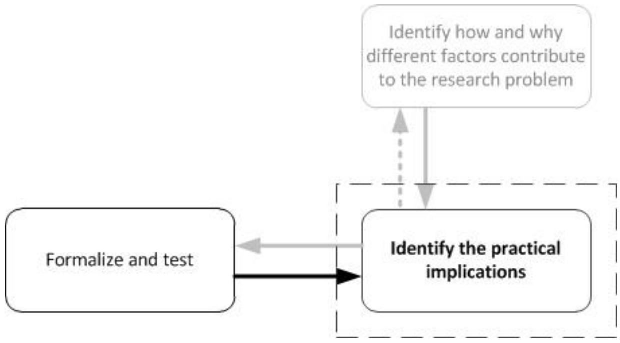

Figure 3: Inducing/abducing practical implications via DSR.

This underrepresentation of inductive/abductive DSR is a significant limitation of the field, as while deductive approaches may appear more rigorous, their ability to generate legitimately new knowledge is limited [Fischer et al. 2013, Gregory and Muntermann 2011, Gregor et al. 2012]. This can be likened to comparisons of inductive and deductive research methods in the intervention-free approach, in which compelling arguments have been put forward as to the shortcomings associated with sole reliance on deductive theorising [e.g. Lee 1989, Myers and Avison 1997]. One issue may be that researchers don't have the time and resources to engage in a large volume of industrial projects. The challenge is therefore to identify those projects likely to produce novel insights, as routine consultancy projects offer little DSR contribution [vom Brocke 2007, Winter 2008]. This suggests that researchers must prioritise classes of design problems at the cutting edge of practice, or those where accepted practice is falling short. In such cases an intervention-free approach may offer little value, as mature artefacts may not yet exist to inform intervention-free methods. Thus:

Guideline 2: A DSR approach is suitable when an opportunity arises to engage with a class of design problems where effective existing solutions do not yet exist.

The meta-analysis by Iivari [2015] is informed by two stand-out exemplars of strategy 2 DSR, namely Markus et al [2002] and Sein et al. [2011]. The latter of these illustrates how researchers might engage with an unsolved class of design problem inductively/abductively. Sein et al. [2011, p.46] elected to take part in the design of a competence management system (CMS) at Volvo because they "suspected that existing CMS and their associated, implicit, design theories would not adequately serve the unique requirements of this class of design situations". Sein et al. began to observe the people, processes, and technologies of Volvo to better formulate the details of the problem, as well as working design hypotheses for a solution. As development continued, these hypotheses gradually evolved into high-level design principles that might also be applied in similar projects in future, i.e. principles of transparency, realtime capture, and interest-integration. The starting point for the study, i.e. the point when they knew it was a DSR problem, was their realisation the class of problems in question was not addressed by current knowledge. By solving the problem first at an instance-level, they were then able to reflect and abstract upon this solution to create repeatable knowledge.

5.3 DSR and the identification of phenomena that may only become visible through the act of design

The final proposed category of research problem for which a DSR approach is suitable is also inductive/abductive in nature; however the target for theorising is analytical/explanatory/predictive in nature (see Figure 4). As noted already, prescriptive theoretical knowledge builds upon some assumptions regarding the relevant behavioural and technological components of a system. However what has not yet been discussed is the multi-directional nature of this theorising 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 those constructs, as well as causal relationships between them and some outcome/utility variable. Indeed, 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 do not easily lend themselves to 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 2007, Abraham et al. 2014, Conboy et al. 2015]. This is summarised by van Aken's [2004] claim (paraphrasing Kurt Lewin) that 'if you want to understand a system, try to change it'. Put differently, "truth and utility are inseparable. Truth informs design and utility informs theory. An artefact may have utility because of some as yet undiscovered truth" [Hevner et al. 2004, p.80]. This has been likened to 'technological design' in fields such as physics and biology, where some valuable contributions involve simply enabling observation of previously invisible phenomena [Woo et al. 2014].

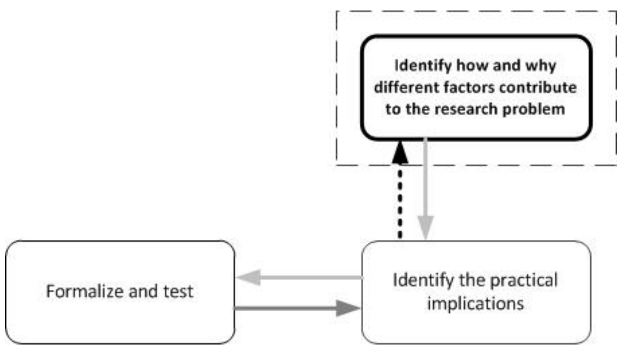

Figure 4: Inducing/abducing analytical/explanatory/predictive theory via DSR.

This process is illustrated in Figure 5. Design and evaluation cycles allow alternative configurations of embedded analytical/explanatory/predictive theory to be 'black-box tested'. If prescriptive theory premised on such a formative understanding demonstrates the desired utility, then that formative understanding receives some validation. While such theory development may lack the degree of formalisation and testing common in intervention-free approaches, it nonetheless offers an otherwise unavailable starting point. Just as Popper [2002, p.298] described a theory 'progressing' by being made more "severely testable" and "easily refutable", so DSR can 'progress' embedded analytical/explanatory/predictive theories. This means that, in areas where such theory may not be constructed by intervention-free means, DSR has a capacity for exploratory theorizing that is otherwise outside of reach. This is particularly relevant for phenomena specific to systems in transition. Most systems do not evolve in pure linear terms but are rather punctuated by interventions (many of which are managerially initiated) that bring about accelerated change [Markus 2004, Jasperson et al. 2005]. DSR offers the opportunity to observe such periods of change at a level of immersion and integrity that may not otherwise be possible. Thus:

Guideline 3: A DSR approach is suitable when important elements of a system may only become visible through the act of design.

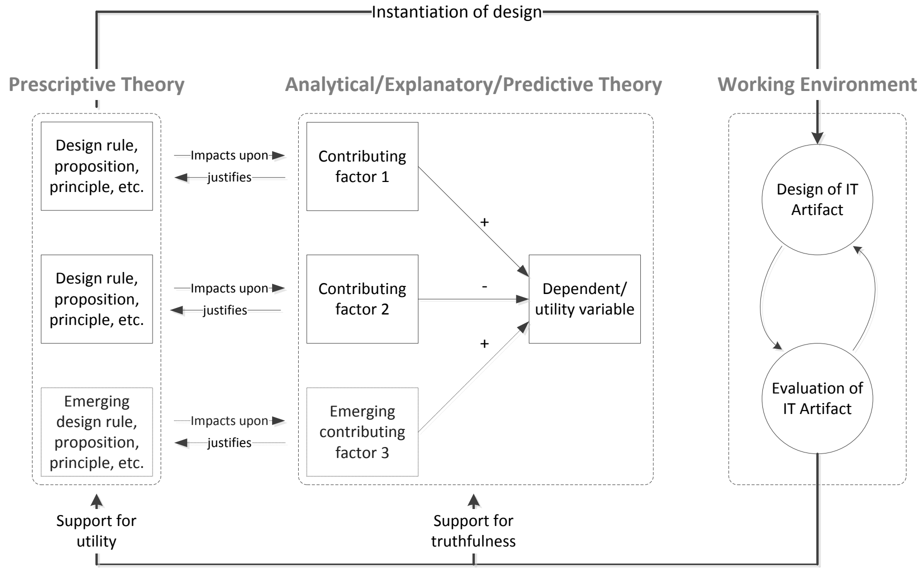

Figure 5: The development of analytical/explanatory/predictive theory in DSR.

This is exemplified by the second inductive/abductive study referenced by Iivari [2015], namely Markus et al. [2002]. Markus et al. sought to design an organizational structure for a manufacturing organization that would best capture their knowledge processes. However, the practices advocated by existing literature presented limited success. This was evidently because the most important knowledge processes for that organisation were not like those described in existing research at the time. 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. The authors noted that prior intervention-free research had studied knowledge processes in stable systems and so formed an impression of them as logical and ordered. Yet due to their participation in the design process, Markus et al. actually observed a system in transition. This allowed them to create better informed design principles, but also to observe novel dynamic sense-making behaviours at an analytical/explanatory/predictive-level hidden by previous studies of such systems in equilibrium.

6 Discussion and Conclusions

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, between product-oriented and process-oriented accounts, and between deductive and inductive/abductive accounts. Second, DSR and intervention-free approaches were compared and contrasted in order to identify overlaps and divergences between the two approaches. Third, three guidelines were presented for identifying problems in IS suitable for a DSR approach, each of which was informed by one illustrative exemplar from existing research.

The three guidelines developed each correspond to different areas of theoretical opportunity, as summarised in Table 1. Guideline 1 is applicable when a researcher can identify existing analytical/explanatory/predictive theory relating to a class of problems, allowing them to deduce reusable prescriptive theory, which is then tested in some instance(s). A contribution may be also made to analytical/explanatory/predictive or instance-specific theory where initial assumptions prove unreliable, however this may not be the focus for such studies. Guideline 2 is applicable when a researcher cannot identify existing analytical/explanatory/predictive theory for the class of problems, thus they must rely upon observations from some instance(s) of a problem to inform reusable prescriptive theory. These studies anticipate instance-level design will provide novel insights, therefore instance-level theoretical contribution is also expected. Guideline 3 is applicable when a researcher not only cannot identify existing analytical/explanatory/predictive theory for the class of problems, but also only expects that class of problems to be visible through the act of design. For this reason a novel instance-specific design is required in order to generate observations, from which both prescriptive and analytical/explanatory/predictive theory can be generated for that otherwise hidden class of problems.

This research makes several significant contributions to the IS literature. First, the three guidelines afford IS researchers a means of evaluating the value of a DSR approach for some research problem. Moreover, these guidelines act to identify the subset of research problems for which a DSR approach is *more* appropriate than intervention-free approaches. This extends discussion by Hevner et al. [2004] and Peffers et al. [2007], wherein such comparative discrimination was less salient. It further builds on recommendations made for a higher proportion of DSR studies within the discipline [e.g. Österle et al. 2011, Baskerville et al. 2011, Goes 2014] by laying out clear motivation for DSR approaches under specific conditions. Second, Guidelines 2 and 3 demonstrate strengths of DSR that remain less widely publicised in IS. These strengths emerge from the ability of DSR to develop both prescriptive and analytical/explanatory/predictive theory in environments where intervention-free approaches may struggle. Third, this study reduces the conceptual distance between DSR and intervention-free approaches in IS. By demonstrating the common research elements and isolating the differences between approaches in terms of the types of theory formalised and tested, the differences between DSR and intervention-free 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 guidelines that were developed to identify DSR-appropriate problems 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 intervention-free approaches.

Table 1: Guidelines according to areas of theoretical opportunity.

	Analytical/explanatory/ predictive theory for class of problems	**Prescriptive theory for class of problems**	**Instance-specific theory for exemplar problem**
G#1		✓	
G#2		✓	✓
G#3	✓	✓	✓

This study also lays the groundwork for two key avenues of future research. First, the development of guidelines affords further consideration of how DSR-appropriate research problems can be discriminated from other research problems. The guidelines developed in this study are essentially an extension of ongoing discussion. Future work that tests and extends these guidelines may therefore uncover other considerations that have thus far been overlooked in discussions of DSR. Second, this study has reduced the conceptual distance between DSR and intervention-free approaches. This raises a question as to whether multi-approach studies are feasible, or even desirable, in the same way that multi-method research is conducted [c.f. Kaplan and Duchon 1988]. If all IS research has some prescriptive element and some analytical/explanatory/predictive element, it stands to reason that there may be situations where hybrid approaches are appropriate. For example, where the implications of intervention-free research are vital to its contribution, some formalisation and empirical validation may reinforce that contribution. Likewise, where the explanation underlying a DSR study affords a core contribution, the additional step required to test this explanation should be acknowledged as transcending divisions between analytical/explanatory/predictive and prescriptive theorising. Such attempts to combine approaches 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]. This suggests that labelling such a study as simply DSR or intervention-free research may undermine the multi-sided nature of the contribution, as well as the additional level of effort required.

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