Evaluation of the Information Systems Research Framework: Empirical Evidence from a Design Science Research Project

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Abstract: The purpose of this paper is to provide empirical evidence that the design science framework Information System Research (ISR) works in practice. More than ten years has passed since ISR was published in the well-cited article 'Design Science in Information Systems Research'. However, there is no thoroughly documented evaluation of ISR based on primary data. That is, existing evaluations are based on reconstructions of prior studies conducted for other purposes. To use an existing data set to answer new or extended research questions means to conduct a secondary analysis. We point to several risks related to secondary analyses and claim that popular design science research frameworks should be based on primary data. In this paper, we present an evaluation consisting of empirical experiences based on primary data. We have systematically collected experiences from a three-year research project and we present ting of both strengths and weaknesses are presented. The main strengths are: the bridging of the contextual environment with the design science activities and the rigorousness of testing IT artefacts. The main weaknesses are: imbalance in support for making contributions to both theory and practice, and ambiguity concerning the practitioners' role in design and evaluation of artefacts. We claim that the identified weaknesses can be used for further development of frameworks or methods concerning design science research.

Keywords: design science, design science research, evaluation, empirical validation, secondary analysis, primary data.

1. Introduction

Design science research (DSR) is widespread and often viewed as the dominant paradigm in the discipline of information systems (IS) (e.g. Iivari, 2007; Baskerville et al., 2009; Gregor and Hevner, 2013). One reason for this popularity is that there has been a growing interest in IS research as design research (e.g. March and Smith, 1995; Markus et al., 2002; Hevner, 2007; Peffers et al., 2008; Sein et al., 2011; Gregor and Hevner, 2013). DSR has roots in the science of the artificial and constitutes a problem-solving paradigm that seeks to create innovations (Simon, 1996). The DSR approach emphasises IT as the core of IS and challenges the managerial and organisational issues that have been in focus within the IS discipline for many years (Orlikowski et al, 2001). One purpose of DSR is to guide design and evaluation of IT artefacts (Hevner et al., 2004; Sein et al., 2011). Another purpose is to reduce the gap between responding to the need of practitioners and research rigor (Gallupe, 2007). According to Iivari (2007), DSR has been practiced in the IS discipline for decades and many scholars have contributed to the development of DSR (e.g. Walls et al., 1992; March and Smith, 1995; Markus et al., 2002; Hevner et al., 2004; Hevner, 2007; Iivari, 2007; Gregor and Jones, 2007; Vaishnavi and Kuechler, 2007; Peffers et al., 2008; Sein et al., 2011; Gregor and Hevner, 2013).

The purpose of this paper is to empirically evaluate the DSR framework Information System Research (ISR) (Hevner et al. 2004; Hevner 2007) based on primary data. With more than 7 000 citations ISR is the most well cited DSR publication in the IS discipline. No doubt, ISR has had a huge impact on DSR, not only in terms of usage, but also in terms of suggestions for improvements and extensions (e.g. Vaishnavi and Kuechler, 2007; Peffers et al., 2008; Sein et al. 2011). Despite the popularity of ISR, *it lacks empirical evidence based on primary data*. The empirical evidence of ISR provided by Hevner et al. (2004) is based on reconstructions of three prior studies conducted for other purposes. Our criticism is supported by the authors' own words "To illustrate the application of the design-science guidelines to IS research, we have selected three exemplar articles for analysis from three different IS journals, one from Decision Support Systems, one from Information Systems Research, and one from MIS Quarterly." (Hevner et al., 2004, p. 90). We view this way of evaluating ISR as pragmatic since to include a full empirical evaluation based on primary data would probably not be possible due to the formal restrictions such as page limit. However, a rigorous evaluation of ISR based on primary data is not conducted.

To draw conclusions based on data collected for other purposes requires a number of methodological considerations. To use an existing data set, such as previous studies, to answer new or extended research

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questions is often referred to as secondary analysis (Schutt, 2011). A secondary analysis on an existing data set means an analytic expansion (Thorne, 1998). According to Hinds et al. (1997), two methodological issues can be raised when conducting a secondary analysis of a qualitative data set: a) the degree to which the data generated by individual qualitative methods are amenable to a secondary analysis, and b) the extent to which the research purpose of the secondary analysis can differ from that of the primary analysis without invalidating the findings. In Hevner et al. (2004) and Hevner (2007) there are no such methodological discussions. Moreover, the authors of ISR have not participated in the studies used for reconstruction. This means that there is a risk that the contextual information has been lost and that the information about these studies is de-contextualised (e.g. Corti and Bishop, 2005; Van den Berg, 2008). We are not saying that the reconstructions of the studies conducted for other purposes have invalidated the results. However, we claim that the popular and widely accepted ISR, which are predominant in the IS discipline, should be properly evaluated and rest on empirical evidence that is grounded in primary data. Our claim is supported by other scholars, who recognise the need for proper evaluation of ISR (e.g. Alturki et al., 2013; Goldkuhl, 2004). Empirical evidence provides arguments for specific knowledge and makes actors more confident in using this knowledge (Goldkuhl, 1999).

We have not found any report that contains a systematically documented evaluation of ISR. However, there are several studies that have used ISR. Some of these studies are using ISR with no intention to evaluating ISR, while a few others provide important insights based on empirical experiences (see section 2.3). However, these insights are fragmented and they are not considered as the main contribution of the study, since these studies have had other purposes than to evaluate ISR. There are also several promising DSR methods that build on ISR (e.g. Peffers 2008; Sein et al., 2011; Venable et al., 2016). The purpose of these methods is to not to evaluate ISR. Rather, the purpose is to add method guidance to DSR. The following section includes a description of central concepts and related work. In section 3, we describe the research method and in section 4 we present the findings. Section 5 includes a discussion of the findings. Finally, in section 6 we draw conclusions.

2. Central concepts and related work

2.1 Primary vs. secondary analysis

In section 1, we are criticising ISR for not being evaluated based on primary data. Primary analysis is defined as the original analysis of data in a research study (e.g. Glass, 1976). That is, the data are collected in an original context and for an original purpose. Secondary analysis is the re-analysis of primary data (e.g. Hinds et al., 1997). Secondary analysis is the use of an existing data set done either by the original researcher or another researcher which addresses new questions or looks at the same questions with different analysis methods (Hinds et al, 1997; Szabo and Strang, 1997).

The main advantages of secondary analysis are:

- Takes less time and requires less funding (Thorne, 1998)
- Cost-effective (maximises the usefulness of collected data) (Hinds et al., 1997)
- No need to spend time on administration of respondents and data collection; more effort can be spent on analysis and interpretation of findings (Szabo and Strang, 1997)
- Secondary analysts have the opportunity to view the data set with a detachment that may be difficult to achieve by the original researcher (Szabo and Strang, 1997)

The main methodological and data disadvantages of secondary analysis are:

2.1.1 Methodological challenges

- It undoubtedly creates the potential to intensify or exaggerate the researchers' bias in either a positive or negative direction (Thorne, 1998)
- Salient features of the context that are obvious to a primary researcher may not be obvious to a secondary researcher (Thorn 1998)
- There may be a tacit knowledge, which is impossible to reconstruct (Hinds et al., 1997)
- The phenomenon of interest is not accurately studied since it was not part of the research question in the primary analysis (Hinds et al., 1997)
- The researcher is unable to ask questions that come to mind during the analysis (Szabo and Strang, 1997)

2.1.2 Data challenges

- Risk of de-contextualisation. Data is context-depended and it can be hard to validate whether the data is valid in other contexts (Hinds et al., 1997; Corti and Bishop, 2005; Van den Berg, 2008)
- There is lack of control in generating the data set (Jacobson et al., 1993)
- To minimise interpretation errors, a data set can be validly used only if there is access to primary analysis team (Hinds et al., 1997)
- The primary analysis team's experiences in qualitative methods must be validated (Hinds et al., 1997)

These challenges require a number of methodological considerations, since they might restrict the quality and depth of the contextual nature of the study (Szabo and Strang, 1997). According to Heaton (2008) and Thorne (1994), a description of how methodological challenges were addressed has to be included in the final report. As mentioned in section 1, a weakness in the justification of ISR is that it does not include any methodological discussions concerning how the challenges of the secondary analyses discussed above are tackled.

2.2 Evaluation

A common definition of evaluation in the DSR literature reads, "the process of determining how well the artifact performs" (March and Smith, 1995, p. 254). An artefact can be a construct, a model, a method or an instantiation (e.g. Hevner et al., 2004; March and Smith, 1995). In this respect, even ISR is considered as an artefact. The main purpose of evaluation is to generate knowledge that can be used for improvement of the artefact. Another purpose of evaluation is to conclude that the new artefact should provide greater relative utility than existing artefacts that can be used to achieve the same purpose (Venable et al., 2016). There exist many strategies for evaluation (e.g. Venable et al. 2016; Cronholm and Goldkuhl, 2003) and evaluation is especially important in cumulative approaches, since to build further on something that is not properly evaluated means to take high risks (Cleven et al., 2007). Moreover, evaluation adds "science" to "design". This is clearly stated by Iivari (2007, p. 50): "The essence of Information Systems as design science lies in the scientific evaluation of artifacts". Venable et al. (2016, p. 425) emphasises, "Without evaluation, we only have an unsubstantiated design theory or hypothesis that some developed artifact will be useful for solving some problem or making some improvement".

Goldkuhl (1999) discusses evaluation in terms of grounding and three types of grounding processes are discussed: external theoretical grounding, internal grounding and empirical grounding. External theoretical grounding means to relate method knowledge to relevant theoretical knowledge. The purpose of internal grounding is to eliminate internal contradictions and to check that there is meaningful and logical consistency between different parts. Our conclusion from analysing ISR is that the authors of ISR have done an excellent theoretical and internal grounding/evaluation. They have also done informative illustrations of how ISR can be used based on reconstructions of prior studies conducted for other purposes. As mentioned above, ISR lacks empirical evaluation based on primary data. Empirical evaluation means to provide the research community with empirical evidence. It means to use and reflect upon ISR in relation to results and consequences, and it means to give a reference to empirical findings (Goldkuhl, 1999). This is sometimes called causal-pragmatic relations that can be reconstructed and inferred from the observations made (Goldkuhl, 2004). Eisenhardt and Graebner (2007) add that a useful way to support transparency of the analysis to readers is to link each proposition, implicitly or explicitly stated, to supporting empirical evidence.

2.3 Evaluation of ISR – the state of the art

To collect information about the state of the art, we have analysed prior evaluations of ISR. One prior study in conducted by Cronholm and Göbel (2015). In that study, we analysed other scholars' empirical experiences of using ISR. The findings in that paper constitute an important input to this paper since one of the conclusions from that study was that there is need for a more extensive empirical evaluation of ISR based on primary data. We have also analysed the literature in order to find previously conducted evaluations of ISR. An impressive literature analysis concerning the proliferation, nature and quality of DSR in IS conferences since the publication of Hevner et al. (2004) is reported in Indulska and Recker (2008). They have analysed 142 articles published at five major IS conferences in the years 2005-2007, and they report that only a small percentage of the papers discuss a concise and consistent implementation of ISR as suggested by Hevner et al. (2004). According to their categorisation of the articles, none is explicitly discussing ISR from the perspective of empirical evaluation.

Since analysis in Indulska and Recker (2008) is presented eight years ago, we decided to look for prior research more specifically in relevant conference proceedings and IS journals. We have analysed: ten conference proceedings (years 2006-2015) of Design Science Research in Information Systems (DESRIST); a special issue on design science research in Management Information Systems Quarterly (vol. 32, no 4), European Journal of Information Systems (years 2006-2015); a special issue on design research in Scandinavian Journal of Information Systems (vol. 19, no. 2), and a special issue on organisation studies as a science for design in Organisation Studies, (vol. 29, Issue 3). Our search has included use of ISR and proposals for extensions of ISR.

We have found that several studies report from the use of ISR in order to develop design principles of some kind (e.g. Tremblay et al., 2010; Göbel and Cronholm, 2016; Mustafa and Sjöström, 2013). There are also papers that suggest interesting extensions to ISR (e.g. Gill and Hevner, 2013; Venable et al., 2016). *But our conclusion is that none of these studies has had an explicit purpose to evaluate ISR*. We have found fragmented experiences from use based on primary data. However, these fragments appear as side effects since these studies have had other research purposes than to evaluate ISR.

3. Research Method

Over the years there have been some discussions whether ISR should be considered as a framework or a method. A framework provides a structure to help connect a set of methods or concepts (Jayaratna, 1994) while a method consist of prescriptive actions and clear guidelines to arrive at certain goals (e.g. Goldkuhl et al., 1997; Cronholm and Ågerfalk, 2001). That is, a framework provides of structure that can be utilised to connect appropriate methods. However, a framework is not method independent since the framework and the method(s) should share the same underlying perspectives or philosophies. In the case of ISR, the explicit underpinning philosophies are behavioural science and design science. Based on the definitions above, we consider ISR as a framework. Thus, we have evaluated ISR as a framework and not as a method. Many scholars have already criticised DSR for the lack of proper methods and nowadays there are several proposals for DSR methods that are building on ISR (e.g. Peffers et al., 2008; Sein et al. 2011; Venable et al., 2016). We have evaluated ISR with respect to structure, objectives, purposes and the underlying implicit perspective of researcher-practitioner collaboration.

In section 1, we criticised ISR for the lack of evaluation based on primary data. Thus, the conclusions in this study are based on our own experiences (primary data) collected in a research project. We have used ISR in a research project that investigated the efficiency and effectiveness of IT service delivery. However, the IT artefacts developed in the research project by using ISR have been of secondary interest and the experiences from the use of ISR have been of primary interest. In this respect, our approach can be regarded as a meta-study. The research project comprised five researchers and 12 practitioners from eight organisations. The organisations were selected in order to obtain a variation in terms of type of business and size (see table 1)

Table 1: Participating organisations.

Type of business	Private/ public	Size	Experience of IS/IT project	Experience of ISR
Forest and Logistics	Private	Medium	High	Low
Transport	Private	Medium	High	Low
Academy IT	Public	Medium	High	Low
Automotive retail services	Private	Medium	High	Low
IT consultant	Private	Large	High	Low
Social Service IT tools	Private	Medium	High	Low
IT consultant	Private	Small	High	Low
University	Public	Medium	High	High

The researchers had a background in the disciplines' information systems and business administration. The research project lasted for three years and included organisations facing similar challenges concerning the efficiency and effectiveness of IT services. That is, they experienced problems related to the field of IT service management (ITSM). ITSM can be regarded as a subset of service science that we define as a process- and customer oriented approach for the management of IT as a service. ITSM is customer oriented and relies on several well-defined processes that enable IT services to fulfil the needs and requirements in the service ecosystem (e.g. Göbel and Cronholm, 2016). Besides the evaluation of ISR, the purpose of the research project was to develop key performance indicators and a digital assessment model to support efficient and effective IT service delivery.

We used the following qualitative research approach. First, we searched for propositions in ISR (Hevner et al., 2004; Hevner, 2007). In line with the framework definitions above, we searched for propositions consisting of structure, objectives, and purposes. We added propositions concerning researcher-practitioner collaboration since this is specific characteristic of ISR. The result from this exercise was a long unstructured list of propositions. Secondly, to bring order in the list of propositions we organised them according to the three cycles in ISR (see figure 1). That is, each proposition was explicitly related to the Relevance Cycle, the Design Cycle or the Rigor Cycle. We also added a fourth category consisting of general propositions since some propositions overlapped several cycles. Then, we used the propositions as a lens for the collection of empirical experiences from the participants in the research project. We collected a wide range of empirical experiences over a three-year period by taking notes on: 1) specific comments with respect to ISR from both practitioners and researchers during project meetings and workshops. This has meant that we collected experiences of ISR in relation to: the attributes of the developed IT artefacts (e.g. how the artefacts contributed to the fulfilment of business goals), the benefit of created documents that supported the development process, and the process of researcher-practitioner collaboration; and 2) interviews of the researchers who participated in the project. The reason for not interviewing the practitioner is that ISR is a research method and the main target group is researchers. Two of the five researchers conducted interviews with five researchers. That is, the interviewing researchers were also interviewed. The interviews contained two open-ended questions: 'what are the strengths in ISR?' and 'what are the weaknesses in ISR?'. The answers from the interviewees were then matched to the ISR propositions. All data was collected and analysed by the researchers. Two of the four researchers who participated in the project are the same as the authors of this paper. However, the IT artefacts were developed in close collaboration between the researchers and the practitioners.

The analysis of the collected experiences has followed the recommendation of Eisenhardt and Graebner (2007). That is, we have created an explicit link between the identified propositions in ISR and the collected experiences from the research project. In this way, we created constructions consisting of matched propositions and empirical experiences (see table 2-9 in section 4). That is, a single construction can be regarded as an attribute of a specific cycle in ISR and thus constitute a piece of empirical evidence. Finally, we classified the matched constructions as strengths or weaknesses. Due to limited space, the findings in section 4 consist of a representative selection of the constructions.

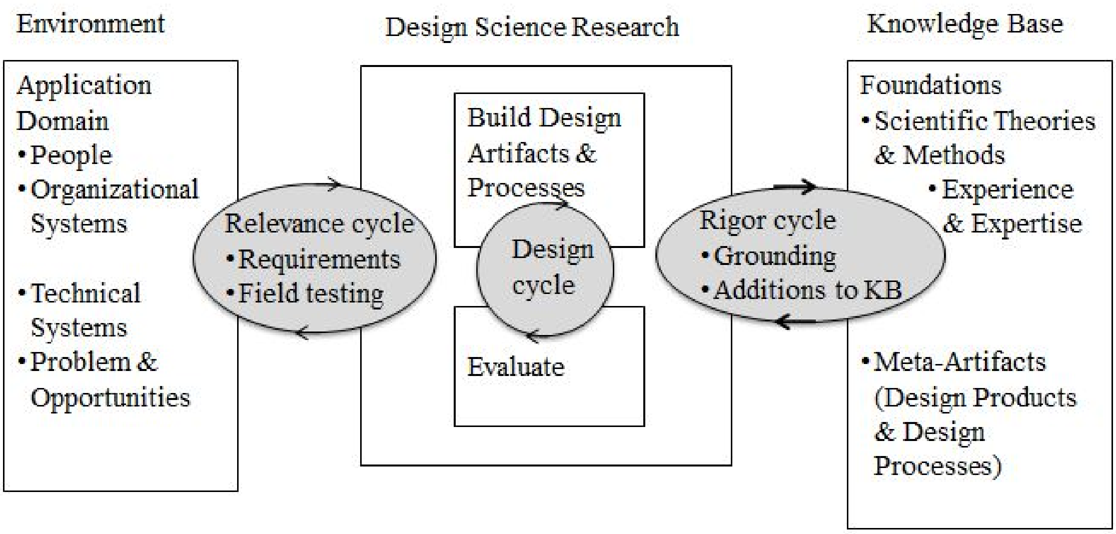

Figure 1: Design Science Research Cycles (Hevner, 2007)

4. Analysis of Empirical Experiences

4.1 The Relevance Cycle

The purpose of the Relevance Cycle is to link the design science research domain to the environment domain. It should not only provide the requirements for the artefact that will be built, but also define acceptance criteria for evaluation of the results (Hevner, 2007). The overall question for the relevance cycle reads, “Does the design artifact improve the environment, and how can this improvement be measured?” (Hevner, 2007, p. 89). The environment refers to an application domain that consists of the people, organisational systems and technical systems that interact to work toward a goal. The constructions consisting of matched propositions and empirical experiences with respect to the Relevance Cycle are presented in table 2 and table 3.

Table 2: Constructions regarded as strengths with respect to the Relevance Cycle

ISR proposition	*Experience*
“The objective of design-science research is to develop technology-based solutions to important and relevant business problems.” (Hevner et al., 2004, p. 83)	Through the use of ISR we identified problems that otherwise would remain hidden. The list of suggested design evaluation methods in Hevner et al. (2004) was much appreciated.
“… the relevance cycle initiates design science research with an application context.” (Hevner, 2007, p. 89)	The concept of context is recognised in ISR which was crucial since the different cultures of the participating organisations was important to consider during problem solving.

Table 3: Constructions regarded as weaknesses with respect to the Relevance Cycle

ISR proposition	*Experience*
“… we encourage collaborative industrial/academic research projects and publications” (Hevner et al., 2004, p. 98)	The three cycles in ISR span over the business environment, the design science research and the knowledge base. That is, there was a lot of interaction between practitioners and researchers. Our experience is that the emphasis on what roles the practitioner can play in a collaborative researcher-practitioner design science project is insufficient.
“The relevance cycle initiates design science research with an application context that not only provides the requirements for the research … as inputs but also defines acceptance criteria for the ultimate evaluation of the research results.” (Hevner, 2007, p. 89)	Using criteria means to focus on certain qualities that according to a specific perspective or theory is important to evaluate. At the same time other qualities, which are not focused by the criteria, are de-emphasized. Since there exists a vast amount of acceptance criteria it would have been helpful if ISR had pointed out some directions where we could have found acceptance criteria that correspond to ISR’s two underpinning philosophies behavioural science and design science.

4.2 The Design Cycle

The purpose of the Design Cycle is to generate design alternatives and to evaluate the alternatives against requirements, until a satisfactory design is achieved. The Design Cycle is the heart of the design science research project (Hevner, 2007). Research activities iterate rapidly between the construction of an artefact, its evaluation, and subsequent feedback to refine the design further. The constructions consisting of matched propositions and empirical experiences with respect to the Design Cycle are presented in table 4 and table 5.

Table 4: Constructions regarded as strengths with respect to the Design Cycle

ISR proposition	*Experience*
“… design and evaluation theories and methods are drawn from the rigor cycle.” (Hevner, 2007, p. 91)	We experienced this recommendation as most valuable since ISR is a framework. A systematic search for suitable theories and methods in knowledge base was conducted.
“The results of the field testing will determine whether additional iterations of the relevance cycle are needed …” (Hevner, 2007, p. 89)	The iterative process supports a critical stance and relates the Relevance Cycle to the Design Cycle. That is, deficiencies concerning the quality of the artefacts are discovered in the Relevance Cycle and returned to the Design Cycle for further improvement.

Table 5: Constructions regarded as weaknesses with respect to the Design Cycle

ISR proposition	*Experience*
"… artifacts must be rigorously and thoroughly tested in laboratory and experimental situations before releasing the artifact into field testing …" (Hevner, 2007, p. 91)	Our experience is that these recommendations are useful. However, the role of the practitioner is unclear. The experience from the research project is that the researchers were responsible for conducting the laboratory testing and field testing. The practitioners contributed with feedback on the artefacts during the field testing but they did not participate in technical development.
"The utility, quality and efficacy of a design artifact must be rigorously demonstrated via well executed evaluation methods. Evaluation is a crucial component of the research process". (Hevner et al., 2004, p. 85)	We agree that evaluation is crucial in ISR projects. However, our experience is that ISR focuses too much on the evaluation of how the artefact contributes to business goals. Following ISR means to evaluate the artefact (relevance) and the rigour of the knowledge developed. Evaluation also includes theorizing about why the artefact works. Evaluation of knowledge rigour is not emphasised in ISR.

4.3 The Rigor Cycle

The purpose of the Rigor Cycle is to connect the research project with the knowledge base. There is a bi-directional relation between the research project and the knowledge base. The knowledge base provides past knowledge (e.g. theory and methods) to the research project in order to enhance the degree of innovation of the artefacts. In turn, the purpose of the research project is to extend the knowledge base by suggesting additions in terms of new theories and methods developed during the research (Hevner, 2007). The constructions consisting of matched propositions and empirical experiences with respect to the Rigor Cycle are presented in table 6 and table 7.

Table 6: Constructions regarded as strengths with respect to the Rigor Cycle

ISR proposition	*Experience*
"The rigor cycle provides past knowledge to the research project to ensure its innovation."(Hevner, 2007, p. 90)	ISR has supported a rigour and cumulative approach which encouraged us to build further on past knowledge to ensure innovation.
"Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies." (Hevner et al., 2004, p. 83)	The developed artefacts constituted and excellent base for theorising and for generating design principles for efficient and effective delivery of IT services.

Table 7: Constructions regarded as weaknesses with respect to the Rigor Cycle

ISR proposition	*Experience*
"… the principal aim is to determine how well an artifact works, not to theorize about or prove anything about why the artifact works." (Hevner et al., 2004, p. 88)	This proposition favours the practitioners' interest over the researchers' interest. Our experience is that it is equally important to theorize about why an artefact works, as it is to determine how the artefact fulfils the business objectives.
"Research contributions to the knowledge base are key to selling the research to the academic audience, just as useful contributions to the environment are the key selling points to the practitioner audience." (Hevner, 2007, p. 90)	This quote contradicts the quote above. Our experience is that description concerning contributions to the practitioners' audience is much richer than descriptions concerning research contributions to the knowledge base.

4.4 General experiences

The purpose of this section is to inform about experiences that address overall propositions in ISR and not a specific cycle. The constructions consisting of matched propositions and empirical experiences with respect to the general experiences are presented in table 8 and table 9.

Table 8: Constructions regarded as strengths with respect to the general experiences

ISR proposition	*Experience*
"Design-science research requires the creation of an innovative, purposeful artifact … for a specified problem domain." (Hevner et al., 2004, p. 82)	ISR has supported us to design new innovative artefacts for a specified domain which have created new business opportunities.
"Two paradigms characterize much of the research in the Information Systems discipline: behavioral science and design science."(Hevner et al., 2004, p. 76)	These two underpinning philosophies have contributed to the quality of the artefacts.

Table 9: Constructions regarded as weaknesses with respect to the general experiences

ISR proposition	*Experience*
"The primary goal of this paper is to inform the community of IS researchers and practitioners of how to conduct, evaluate, and present design science research. We do so by describing the boundaries of design science within the IS discipline via a conceptual framework for understanding information systems research and by developing a set of guidelines for conducting and evaluating good design-science research." (Hevner et al., 2004, p. 77)	Our general experience is that ISR provides an excellent support for artefact development but the emphasis on knowledge rigor could be improved. Although, the guidelines were considered as useful, the presence of guidelines cause confusion whether ISR is a method or a framework. Moreover, the presence of the guidelines made the project members to believe that ISR provided method support. This hampered the project members to search for complementing methods, processes and guidelines in the knowledge base.
"Design-science research holds the potential for three types of research contributions based on the novelty, generality, and significance of the designed artifact." (Hevner et al., 2004, p. 87)	Our experience is that it is hard to generalize from one single project. We experienced increased possibilities to generalize due to the fact that several organizations participated in the project.

5. Discussion

As described in section 4, we have been able to relate empirical experiences to the Relevance Cycle, the Design Cycle and the Rigor Cycle. We have also presented a few general experiences. No doubt, based on the identified strengths we consider ISR as useful. Below, we have chosen to discuss three of the experienced weaknesses that we claim are important to consider for future use and possible framework improvement.

Imbalance in support for making contributions to theory and practice: Hevner et al. (2004, p. 83) claim that "Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methods". Out of these three areas it is design foundations and design methods that correspond to the action Additions to Knowledge Base in the Rigor Cycle (see figure 1). Although there are clear recommendations for making theoretical or methodological contributions to the knowledge base, our understanding is that a major part of ISR is discussing contributions to practice in terms of design of the artefact. Our undestanding is supported by the following quote: "The objective of design-science research is to develop technology-based solutions to important and relevant business problems." (Hevner et al., 2004, p. 83). Our understanding is also based on our findings and the fact that six of the seven guidelines mainly provide recommendations concerning contributions to practice (Design as an Artefact, Problem Relevance, Design Evaluation, Research Rigor, Design as a Search Process and Communication of Research). The remaining guideline is discussing contributions to both practice and to theory (Research Contribution). We find all the seven guidelines supportive but their orientation towards practice contribution can mean that users of ISR become too focused on design of the functionality of the artefact and not on the development of theories or design principles that explain *why* the artefact works. That is, it seems as the dual mission of contributing to both research and practice, which is expressed in both Hevner et al. (2004, p. 80, figure 2) and Hevner (2007, p. 88, figure 1), could be better balanced. This imbalance might have a ground in the somewhat confusing claim from Hevner et al. (2004) "… the principal aim is to determine how well an artifact works, not to theorize about or prove anything about why the artifact works" (p. 88). An insightful comment and example of the dual mission is made by Venable et al., (2016, p. 425): "When an artifact is evaluated for its utility in achieving its purpose, one is also evaluating a design theory that the design artifact has utility to achieve that purpose. From the point of view of design theory, a second purpose of evaluation in DSR is to confirm or disprove (or enhance) the design theory". This comment describes insightfully how the evaluation of the artefact and the theory interplay.

The role of the practitioner is unclear. No doubt, ISR is positive towards researcher-practitioner collaboration. This is emphasised in the following statement: "… we encourage collaborative industry/academic research projects …" (Hevner et al., 2004, p. 98). However, neither success factors nor barriers for collaboration are mentioned, which is a bit surprising since a lot of project work, especially in the Relevance Cycle, is supposed to be conducted in interaction with practitioners. Our experience is that this is crucial since research projects that include collaboration with practitioners can be hard to manage. It is not unusual for these projects to be confronted with dilemmas between practice-driven and research-driven interests (Mathiassen, 2002). One modern view of collaboration in service design can be found in service marketing (e.g. Vargo and Lusch, 2015). Vargo and Lusch (2015) emphasise the importance of that the value offered from the use of services, such as IT artefacts, should be co-created by multiple actors, always including the beneficiary. In ISR it is not clear whether the practitioners are regarded as passive information suppliers or active co-creators.

ISR lacks a clear definition of what it represents. The purpose of ISR is to promote and contextualise DSR, not to propose a method for conducting DSR. However, Hevner et al., (2004, p. 75) claim "Our objective is to describe the performance of design-science research in Information Systems via a concise conceptual framework and clear guidelines for understanding, executing and evaluating the research". Our understanding is that a framework should not consist of *clear guidelines* for how to carry out actions. According to the definition of method in section 3, guidelines should be part of methods. By using the term *'clear guidelines'* there is a risk that false user expectations can take place concerning *how* to conduct ISR. At the same time, Hevner et al. (2004) state that ISR is a framework, i.e. a structure that leaves room for other methods, processes, guidelines or tools to be integrated. This is illustrated by the presentation of a list of Design Evaluation Methods that can be selected according to how they match the designed artefact and the evaluation metrics (see Hevner et al. 2004, p. 86). However, ISR would benefit from clearer definition of whether it constitutes a framework or a method which would help users to understand what kind of support they can expect.

6. Conclusions

As stated in section 1, the purpose of this study has been to provide empirical experiences based on primary data whether ISR works in practice. Wilson (2002) claims that research contributions should be "true", "new" and "interesting". In order to claim "truth", we have in a transparent way matched propositions in ISR to empirical experiences based on primary data. This has meant that we have reduced or eliminated several risks compared to the secondary analysis of an existing data set (see section 2.3): 1) contextual knowledge has not been lost since the data collection and the data analysis are conducted by the same researchers and 2) the evaluation of ISR has been the main research interest and thus part of the original research question. We also claim that our contribution is "new". Based on our literature review, we can conclude that prior studies report: fragmented empirical experiences from the use of ISR, experiences that exist as side contributions since there are other primary contributions such as design principles concerning a specific artefact, and illustrations based on secondary analyses. Moreover, we have systematically documented empirical experiences that in a new and cumulative way expand prior knowledge. The experiences have been anchored to the Design Science Research Cycles in a way that has not been done before. Finally, we claim that the contributions are interesting in two ways: a) we have exposed the fact that evaluation of the popular ISR framework is not based on primary data; and b) the identified shortcomings in ISR can be considered as a base for a redesign of DSR frameworks. Below, our conclusions are presented in relation to each cycle and to the general experiences.

Relevance Cycle: The purpose of the Relevance Cycle is to answer the following questions: "Does the design artefact improve the environment and how can this improvement be measured?" Based on the empirical experiences, our conclusion is that this purpose is fulfilled. However, the role of the practitioner is unclear.

Design Cycle: The purpose of the Design Cycle is to iterate between the construction of an artefact, its evaluation, and subsequent feedback to refine the design further. This process ends when a satisfactory design is achieved. Our conclusion is that the purpose is fulfilled in respect of its iterative character and that it connects the knowledge base with the business environment. We can also conclude that there are negative experiences concerning the lack of collaboration aspects in laboratory testing and field testing.

R*igor Cycle*: The purpose of the Rigor Cycle is to connect the research project to the knowledge base. That is, the Rigor Cycle provides past knowledge to ensure innovation, and to support research contributions to the Knowledge Base. We can conclude that the purpose is fulfilled with respect to the action 'Grounding' (see figure 1). With respect to the action 'Additions to Knowledge Base' (see figure 1), we can conclude that the support is experienced as insufficient. One explanation is that ISR sets a stronger focus on the evaluation of the IT artefact than on the evaluation of knowledge rigour such as explanations concerning *why* the artefact works.

General experiences: The overall conclusion about ISR is that the framework has been useful concerning artefact development and development of design principles for effective and efficient delivery of IT services. Our conclusion is that the purpose to promote and to contextualise DSR is fulfilled.

As further research, we suggest an empirical evaluation of other DSR frameworks or methods (e.g. Peffers et al., 2008; Sein et al., 2011; Vaishnavi and Kuechler, 2007) that will complement the findings in the study and make it possible to draw conclusions concerning DSR in general.

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