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Abstract:

Senior Scholars have made a concerted effort to help researchers adopt and top-ranked IS journals publish design science research (DSR). However, DSR continues to underperform, and the support that Senior Scholars have provided to it in editorials and exemplars has created both confusion and clarity. In this study, we report on a descriptive literature review that we conducted to bring empirical context and insight to the many discussions that Senior Scholars have had on presenting, implementing, and contributing to DSR. In particular, we reviewed 111 papers in the AIS Senior Scholars' basket of eight journals and found significant transparency issues that have led to methodological slurring. We also found that, while DSR has produced research with a strong focus on utility and usefulness, it has done so through generalized problems and solutions and, thus, overlooked the messy complexity of real IS problems and the actual use of proposed solutions. Finally, we found little evidence to support theory obsession in DSR, a topic of concern for the wider IS research community.

Keywords: Design Science Research, Problem Solving, Literature Review, Methodological Slurring, Open Science, Theory Obsession, Research Transparency, Problem Abstraction, Practical Impact.

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1 Introduction

At a time when many scholars view the information systems (IS) discipline as fixated on theory to the point that it has become an unhealthy obsession and as a major challenge for the discipline (Dennis, 2019; Hirschheim, 2019), design science research (DSR) represents a potential pathway for the discipline to lead technology innovation in a way that balances both rigor and relevance (Baskerville et al., 2018). With design being fundamental to IS (March & Storey, 2008), some scholars see DSR as a natural fit for IS research due to its core design characteristics such as a problem-led and artefact-creation focus (Holmström et al., 2009).

Furthermore, given that DSR exists to enable researchers to develop artifacts that they can apply to solve real-world problems (Peffers et al., 2018, p. 129), it inherently suits efforts to achieve such a task in the IS community. Indeed, in positioning DSR at the nexus of technical research on IT, the application and business uses of IT, and the natural, social and behavioral scientific dimensions of IT” (Baskerville et al., 2018, p. 358), researchers have further supported its recent promotion as the go-to research methodology to solve problems in the IS discipline. In order to encourage scholars to adopt the methodology, many position papers and editorials have provided guidance and support for conducting and positioning DSR studies (see Baskerville, 2008; Baskerville et al., 2018, 2019; March & Storey, 2008; Peffers et al., 2018; Rai, 2017; Winter, 2008). However, “while there has been much research published about DSR, there has not been as much research, as we might have hoped, that applies the DSR research paradigm to carry out IS research” (Peffers et al., 2018, pp. 129-130). Thus, it seems that, while researchers have moved beyond the need for methodological direction to conduct DSR, they have not conducted enough empirical DSR studies as the domain evolves and matures in the IS community. Indeed, Peffers et al. (2018) have noted that “DSR researchers [have] found themselves faced with a difficult challenge, namely an excess of advice and expectations for how to carry out DSR...(that) make it difficult to and costly to carry out DSR projects” (p. 130). However, Peffers et al. (2018) have also noted that researchers have found it difficult to publish DSR studies partly due to the multiple guidelines that exist and partly due to DSR studies’ undifferentiated nature, which makes them problematic for reviewers (Peffers et al., 2018). Aligned with these observations, some researchers have adopted the view, that despite the “pronounced value” that DSR possesses for the IS community, empirical DSR studies have appeared relatively rarely in highly ranked IS journals (Baskerville et al., 2018, p. 358) nothwithstanding such studies in special issues dedicated to empirical DSR studies in two journals in the Senior Scholars’ basket of eight: the *European Journal of Information Systems* (2008 and 2018) *MIS Quarterly* (2008).

Given this challenge, we conducted a descriptive literature review (e.g., Paré, Trudel, Jaana, & Kitsiou, 2015) of all empirical DSR studies published (111 in total) up to December, 2018, in the Senior Scholars’ basket of eight journals. Conscious of the existing body of methodological papers and editorials on DSR, we conducted our review to bring empirical context and insight to the many discussions that Senior Scholars have had on presenting, implementing, and contributing to DSR. In addition, we provide an open data set and the coding matrix we used for future studies to leverage and build on. Finally, the focus of this analysis is bounded within the scope of the following three research questions:

RQ1: How have IS scholars presented DSR?

RQ2: How have IS scholars conducted DSR?

RQ3: What impacts have IS DSR studies reported?

2 Literature Review Methodology

From the first step, we conducted this literature review with an explicit motivation to make every aspect open and transparent to the community. To this end, we developed various outputs as a basis for rigorous interrogation and a strong foundation for objective reflection: the literature review process (see Table 1), the search strategy results (see Appendix A), the coding scheme that we developed over seven iterations (see Table 2), and the concept-centric matrix (see Appendix B). To successfully achieve this open strategy, we scrutinized every decision (step and analysis) in the knowledge that it would be open for the community to interrogate. Drawing from several literature review methodologies (Paré et al., 2015; Webster & Watson, 2002; Wolfswinkel et al., 2013), we followed a four-phase sequential approach: 1) source selection, 2) search strategy, 3) coding schemes, and 4) review papers (see Table 1 for a summary). We explain each phase in more detail over the following sections.

Table 1. Literature Review Methodology

Phase	Action taken	Outcome
1) Selecting the sources	Specified the domain of interest.	Empirical problem-solving studies that use the DSR methodology.
	Identified relevant sources for the specified domain.	Senior Scholars' Basket (of eight) Journals
2) Search strategy	Identified key search terms.	design science, design science research, DSR, design theory, design science approach, action design research, ADR
	Iteration 1: searched each identified source with key search terms	No. of papers: 561
	Iteration 2: reviewed each returned paper and identified ones that contained any of the keywords in their title, abstract, keywords, or body section. Removed papers that 1) lacked relevance to the key search terms, 2) only referenced other papers that used the key search terms.	No. of papers: 229
	Iteration 3: focused on papers that document an empirical study and explicitly state they follow DSR.	No. of papers: 111
3) coding Schemes	Developed a coding scheme over seven iterations to achieve maximum 1) accuracy in describing each DSR instance and 2) consistency in coding across the instances.	See Table 2.
4) Review publications	For added rigor, each paper was coded twice by rotating author pairs among all authors; they resolved conflicts during follow-up review sessions. We documented the results in a concept centric matrix.	Created an extensive concept-centric matrix (see Appendix B)

2.1 Selecting the Sources

We chose the Senior Scholars' basket of eight journals (SSB) as a scoping device as it has been regularly accepted in the past (e.g., Prat et al., 2015), given that researchers have used it extensively to measure productivity in the IS community (Tremblay et al., 2018). Furthermore, in order to set a DSR quality standard, these journals focus on publishing "exemplars" for researchers to emulate and editorials for researchers to follow (see Baskerville et al., 2018; Goes, 2014; Iivari, 2020; Peffers et al., 2018). Furthermore, these journals publish many DSR discussions around aspects such as design theory (see Iivari, 2020). Researchers have argued that the SSB sets an artificial constraint on the IS papers that researchers can draw from (Jennex, 2015); however, in this study, we specifically examine the SSB, which research has shown to influence DSR in the wider IS community (Tremblay et al., 2018), as the exemplar benchmark.

2.2 Search Strategy

First, we identified a list of search terms that related to the domain of interest and used it to search each source to create a publication pool to review. The search terms included "design science", "design science research", "design theory", "design science approach", "action design research", "ADR", and "DSR". Since we focus on how researchers have conducted DSR, we included "action design research" as a search term since authors who conduct ADR may not otherwise refer to design science in their papers. We also purposefully did not add the term "design principles" as one can develop them without conducting DSR. We then searched each SSB journal website with these terms from their inception until December, 2018. We found 561 publications in total. We used the AIS eLibrary for *MIS Quarterly* as its website does not allow one to add multiple search strings.

To determine if each paper pertained to our research objective, we subsequently conducted a more detailed review by opening each paper, searching for the identified terms, and removing papers that 1) lacked relevance to any search terms and 2) only referenced other studies that used the search terms. For example, some papers contained the term "design science" but talked about the IS research landscape in general terms. As a result, we removed 332 papers, which left 229 remaining papers.

Next, since we focus on empirical DSR papers, we reviewed the remaining papers to identify empirical (i.e., studies that explicitly state they conducted DSR) versus non-empirical DSR studies where empirical studies are ones that explicitly state they conduct DSR. The first three authors performed this task. Specifically, they separated the 229 papers into six batches and individually reviewed two batches each. The three researchers consistently met with one another to ensure consistency/agreement (while they agreed highly in some cases, in others, they needed further discussion to reach agreement). As a result, we removed 119 papers, which left 110 remaining papers.

Given that we used each journal website (and AIS eLibrary for *MIS Quarterly*) to search for papers, we also performed our search strategy using the Web of Science to ensure its coverage completeness and replicability. We searched each journal on the Web of Science with the same search terms and compared the results from each search with the papers we had already identified. From this process, we identified one additional empirical DSR paper that we did not identify in the original search, which meant our final sample comprised 119 empirical DSR papers for review.

2.3 Coding Schemes

To maximize accuracy and consistency, we developed a coding scheme over seven iterations to help answer our research questions. To do so, the first, second, and third authors took 12 random papers from the entire pool and reviewed them independently using an initial set of codes. During this process, they found several unsuitable classifications/codes due to their vagueness (e.g., DSR genres and inference type), which led to highly inconsistent analysis output. After validating and triangulating the codes, the three authors applied them across all 111 papers. The coding scheme included:

- The two DSR strategies from Iivari (2015), which we used to understand whether studies identified problems in the literature or practice
- DSR evaluation types from Venable, Pries-Heje, and Baskerville (2016), which we used to understand if studies evaluated their artefacts in a natural or artificial environment
- Theoretical contribution level from Gregor and Hevner (2013), which we used to understand at what theoretical level studies made contributions, and
- Practical impact stages from Nunamaker et al. (2015), which we used to understand at what stage studies used an artefact.

In Table 2, we show the final coding scheme that we used to review the 111 papers and the codes relevance to each research question. Furthermore, we provide additional detail on the codes we used in Sections 3.1.1, 3.2.1, and 3.3.1.

Table 2. Coding Scheme

Code	Guidance	Reference
Guiding reference (RQ1)	Is there a guiding reference explicitly stated as being followed? (Yes, no)	
Evidence of guiding ref. adherence (RQ1)	Is there evidence of the guiding reference being followed? (Yes, no)	
Iteration presented (RQ1)	Are the iterations present? (Yes, no)	
No. of cycles (RQ1)	No. of iterative cycles in the study	
Artefact (RQ1)	Classification of artefact type that emerged during analysis	
DSR strategy (RQ1, RQ2)	1) Problem detailed through literature and past research from which one develops an artefact and evaluates it against a problem instance (problem class to instance implementation) 2) Specific problem that a client experiences from which one develops a solution and generalizes learnings against a problem class (problem instance to generalized learnings).	Iivari (2015)

Table 2. Coding Scheme

Evaluation (RQ1, RQ2)	Naturalistic: natural environment (case study, focus group, participant observation, ethnography, phenomenology, survey (qualitative, quantitative)). Artificial: mathematical/logical proof, lab experiment, role-playing simulation, computer simulation, field experiment.	Venable et al. (2016)
Knowledge contribution level (RQ1, RQ3)	Level 1: situated implementation of the artefact. Instantiations (software products or implemented processes). Instantiations can come in two forms: 1) an instantiation that one implements for real and 2) an instantiation that one implements just for the study and that does not exist beyond the study. Level 2: nascent design theory—knowledge as operational principles/architecture. Constructs, methods, models, design principles, and technological rules. Level 3: well-developed design theory about embedded phenomena. Design theories (mid-range and grand theories)	Gregor & Hevner (2013)
Practical impact stage (RQ1, RQ3)	Stage 1 (proof of concept): establish viability and feasibility of artefact as a solution to the problem. Stage 2 (proof of value): measure an artefact's efficacy and efficiency in solving the problem. Stage 3 (proof of use): create self-sustaining and growing communities of practice around the artefact.	Nunamaker et al. (2015)

2.4 Review Papers

We then used the coding scheme to review the 111 papers. We adopted the open coding technique from Strauss and Corbin (1990) for the review, which researchers have widely applied in conducting content analyses in a literature review (Finney & Corbett, 2007; Goode & Gregor, 2009; Grahlmann et al., 2012; Alhassan et al., 2018). We organized the coding using a concept-centric matrix (see Webster & Watson, 2002) and the predefined codes from Table 2 as concepts.

Since we already initially applied the scheme to a random sample of 12 papers from the entire paper pool, we divided the remaining 99 papers into six batches. We had two authors code each paper to ensure inter-coder reliability and increase the output's accuracy and consistency. The researchers conducted the coding procedures in an iterative fashion in that they reviewed our assigned batches individually and then met to compare their coding for accuracy and consistency. In the cases where researchers disagreed about the coded outputs for a paper, they discussed the matter until they reached consensus. This process ensured that we coded each paper appropriately to fulfill the research objective.

3 Analysis and Findings

In this section, for each research question, we discuss the 1) approach we used to analyze the DSR papers, 2) the findings and key insights that we gained from the analysis, and 3) their implications (see Poeppelbuss et al., 2011). Figure 1 presents the papers that we analyzed over the 26-year period and highlights paper frequency per year. We note the significant increase in publications in 2008, which coincides with two special issues but also emerged shortly after two highly cited DSR methodological papers appeared (i.e., Hevner et al., 2004; Peffers et al., 2007).

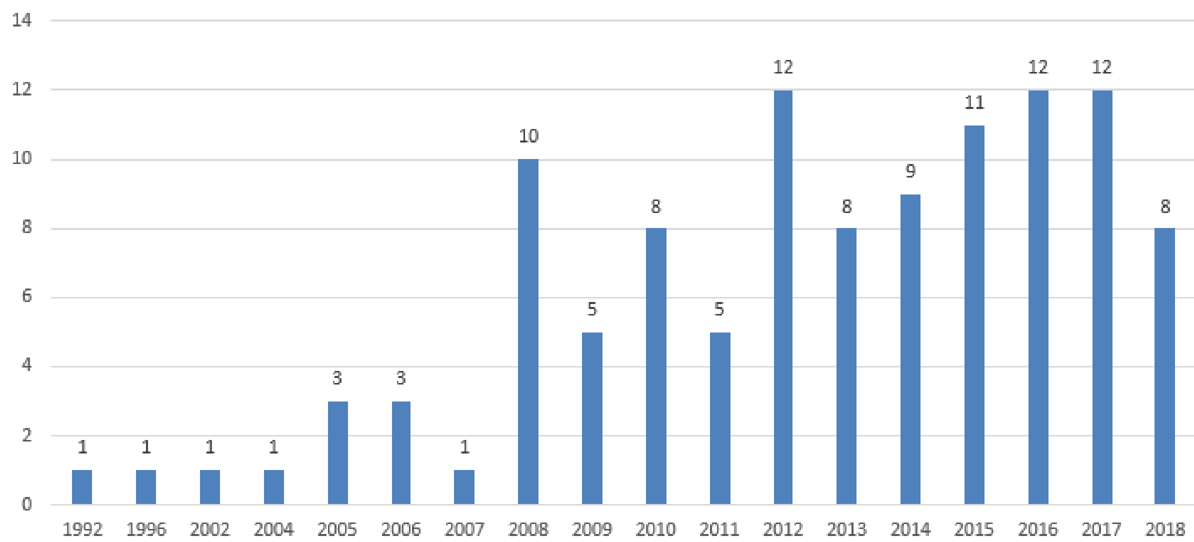

Figure 1.DSR Papers by Year

3.1 RQ 1: How have IS Scholars Presented DSR?

3.1.1 Approach

We coded each empirical paper based on whether it explicitly evidenced seven DSR components. We developed these components iteratively during the third step in the process that we discuss in Section 2. We settled on the final seven components as the most parsimonious components with which we could achieve our objective: 1) problem, 2) artefact, 3) DSR process adherence, 4) iterative design, 5) evaluation, 6) practical impact, and 7) knowledge contribution. To understand DSR presentation, we coded each component for its existence (either yes or no) and grouped them into presentation "styles" (see Table 3 and Table 4). Furthermore, we analyzed DSR process adherence and iterative design given they generated the most variance in presentation style. We further analyze the problem, evaluation, practical impact, and knowledge contribution components when addressing the second and third research questions.

3.1.2 Findings

As Table 3 shows, the empirical problem-solving studies varied in their presentation mostly based on three key components: 1) DSR process adherence, 2) iterative design, and (3) evaluation. These three components align with the core build, iterate, and evaluate (BIE) DSR stages (see Sein & Rossi, 2019).

Table 3. Evidence of DSR Components in Senior Scholars' Basket Papers

	Style 1	Style 2	Style 3	Style 4			Other
Problem	Y	Y	Y	Y	Y	Y	Y
Artefact	Y	Y	Y	Y	Y	Y	Y
DSR process (guiding reference adherence)	N	Y	Y	Y	Y	N	N
Iterative design	N	N	Y	N	N	N	Y
Evaluation	Y	Y	Y	N	N	N	Y
Practical impact	Y	Y	Y	N	Y	Y	Y
Knowledge contribution	Y	Y	Y	Y	Y	Y	Y
Total	66	30	9	2	2	1	1

The most dominant presentation style (Style 1) comprised papers that included all components except for 1) how they adhered to DSR process and 2) how they iteratively designed their artefact(s). The second most dominant style (Style 2) comprised papers that included all aspects except for iterative design. In this style, papers focused mainly on evaluating their artefact(s) and presented the final version with little to no insight into previous iterations or knowledge built along the way (e.g., Kloör et al., 2017). In contrast to the other two styles, Style 3 comprised papers that included all seven components and demonstrated some clearly defined techniques on how to do so (e.g., Ebel et al., 2016). The fact that this style exists highlights the possibility for authors to overcome challenges that journal editorial/publishing guidelines impose (e.g., word and page counts). The final style (Style 4) comprised papers that omitted 1) iterative design and 2) evaluation. For example, Chatterjee et al. (2009) explained how they developed their artefact but did not evaluate it. Müller-Wienbergen et al. (2011) went a step further as they did not evaluate their artefact but instead offered an expository instantiation of it and proposed how one could empirically evaluate it in the future.

Table 4. Papers that Used the Different Styles

Style	Examples
Style1	Cheng et al. (2016), Lang et al. (2015), Kolfschoten & De Vreede (2009), Breuker et al. (2016), VanderMeer et al. (2012), Provost et al. (2015)
Style 2	Kloör et al. (2017), Storey et al. (2008), Currim & Ram (2012),
Style 3	Ebel et al. (2016), Peters et al. (2015), Lycett & Radwan (2018), Spagnoletti et al. (2015)
Style 4	Müller-Wienbergen et al. (2011), Kasper (1996), Walls et al. (1992)

Guiding references: in this study, we do not focus on the view that published DSR research skews towards non-empirical work that focuses on guidelines (Peffers et al., 2018); however, among the 111 papers we analyzed, we found 26 different references that authors explicitly stated as following (e.g., "we conducted our study in line with"), which somewhat supports the assertion that various published DSR guidelines exist. Nonetheless, in further analyzing the guiding references, we found a long-tail distribution: 15 references received only one citation each, while six references made up almost 80 percent of all citations (see Figure 1). At its head, the long tail included the following papers:

1) Hevner et al. (2004), which 47 papers referenced
2) Peffers et al. (2007), which 19 papers referenced, and
3) Sein et al. (2011) and Walls et al. (1992), which eight papers referenced each.

Interestingly, we found that 19 papers did not state a guiding reference. DSR process pluralism also appeared commonly among the SSB papers given that 20 cited more than one guiding reference and numerous others cited three, four, and five guiding references. These results may highlight a natural overlapping in DSR, especially when one views Hevner et al.'s (2004) paper as a set of principles and not a process. Furthermore, we note that all Style 3 papers had only one guiding process.

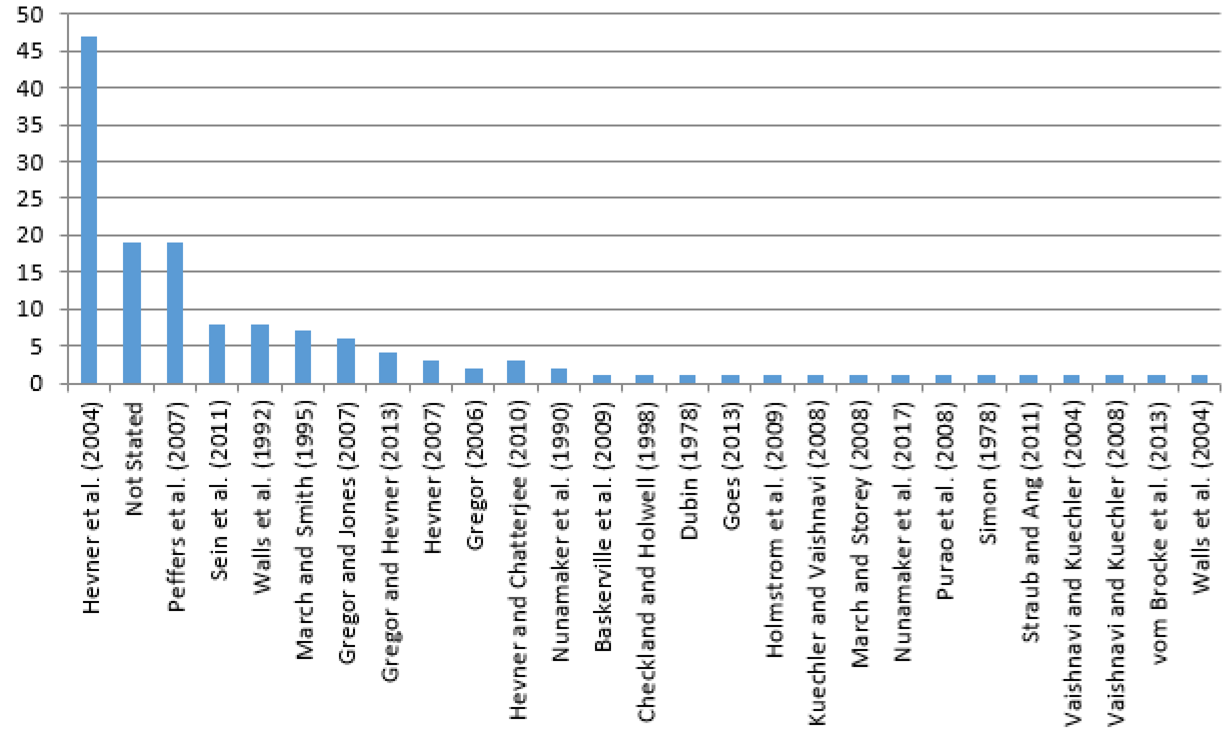

Figure 1.DSR References Used

Presenting DSR adherence: authors presented that they adhered to the DSR process in various ways (see Table 5). Some authors used a DSR process model to structure their paper (as Peffers et al. (2007) suggest). For example, Ebel et al. (2016) (Style 3) note that they adopted action design research (ADR) (see Sein et al., 2011) as the approach for their study and discuss how they understand it. Subsequently, they note that they used each step in this process model to help structure their paper (adherence) starting with the problem formulation followed by an iterative loop between designing, building, and evaluating their artefact.

Table 5. Ways to Present DSR Adherence

DSR adherence presentation	No. of papers	Example
Full paper (authors used the process model to structure the paper)	6	Seidel et al. (2018), Hustad & Olsen (2014), Hariharan et al. (2017)
A section (authors set aside a section or paragraph to outline how they adhered to the process)	17	Mastrogiacomo et al. (2014), Giessmann & Legner (2016)
Visual representation (e.g., figure or table)	20	Spagnoletti et al. (2015), Lycett & Radwan (2018), Storey et al. (2008)

Lycett and Radwan (2018) present a figure that highlights the process model they followed (Kuechler & Vaishnavi, 2008), which directly maps their research to that process model (see Table 5). Peters et al. (2015) and Spagnoletti et al. (2015) followed a similar approach. Interestingly, Storey et al. (2008) followed the seven guidelines from Hevner et al. (2004) and even summarized their contributions to each one in a table, which several other studies replicated. Mastrogiacomo et al. (2014) used a section to explain their adherence, while Giessmann and Legner (2016) used a paper section that includes a figure and a table to explain their adherence. Finally, as a more unique development, Currim and Ram (2012) used an electronic appendix (or external source) to present their guidance.

Not presenting DSR adherence: as Table 3 shows, the papers in our sample adhered to Style 1 more than any other style (i.e., they included all DSR components except for 1) how they adhered to DSR process and 2) how they iteratively designed their artefact(s)). In fact, among these 66 papers, 18 did not not state the DSR process model they followed but still indicated they conducted a DSR study, which supports Baskerville et al.'s (2018, p. 360) calls for authors to "use a reference process for guidance in performing the [DSR] research".

Referencing a process for guidance manifested in different ways. For example, in their abstract, Fridgen et al. (2016) indicate that they followed a DSR approach, use "design science research" as a keyword, and state that they "rigorously follow[ed] a DSR methodology" (p. 540); however, they do not explicitly state which methodology they applied. Datta, Dutta, Liang, and VanderMeer (2012) state they followed a design science approach but do not refer to a method or DSR at any other point in their paper, nor do Nunamaker et al. (2011). This lack of transparency poses a challenge for the IS community if scholars see this approach to presenting DSR as an exemplar.

We also found instances such as Kolfschoten and De Vreede (2009), who explain that they followed a DSR approach and explain what DSR is but do not mention what process model they applied. Lastly, we found several instances in which authors state that they conducted DSR and cite authors such as Hevner et al. (2004) or Gregor and Hevner (2013) but don not actually state what DSR process model they followed. For example, Breuker et al. (2016, p. 5) state: "This research follows the design science paradigm, and the structure of this paper is based on the design science publication schema that Gregor and Hevner (2013) propose". Similarly, Li et al. (2015, p. 281) also indicate they followed "the design science paradigm" and cite Hevner et al. (2004), but it is not obvious that they followed the guidelines they offer.

Iterative design: as Figure 3 shows, 22 papers explicitly mentioned how many iterations their DSR study included (e.g., Parsons & Wand, 2008; Pries-Heje & Baskerville, 2008; VanderMeer et al., 2012). However, only 10 presented their iterations. Those that did present their iterations did so in the same format as DSR adherence. For example, Spagnoletti et al. (2015) used a figure to represent their design cycles, while Giessmann and Legner (2016) used a table. Peters et al. (2015) used a section to talk through their design cycles and a table to represent the outcomes. Lycett and Radwan (2018) described their design cycles over a number of sections as did Mastrogiacomo et al. (2014). The lack of iterative design appeared most prevalently in Style 2 papers given that they lacked only that component. That is to say, while all Style 2 papers featured evaluation (be it artificial, naturalistic, or both), none showed the design cycles their artefacts went through, and only three indicated how many design cycles they completed. For example, Abbasi et al. (2018) introduced their artefact and then devoted their paper to evaluating it through various experiments but did not show how the artefact evolved or any learning that occurred in these iterations. As such, they failed to show how their artefact emerged—a characteristic DSR process given DSR's iterative nature.

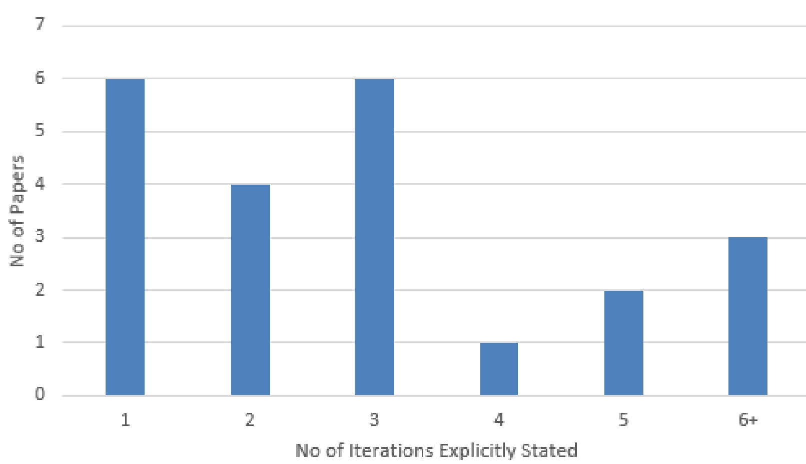

Figure 3. Number of Design Cycles Used in the Study

3.1.3 Discussion

Living up to the promise to solve problems that lead to contributions in both practical and theoretical IS domains, 109 among the 111 papers presented the: 1) problem, 2) artefact, 3) practical impact, and 4) knowledge contribution. In addition, while the fact that Style 3 exists demonstrates that one can present all aspects in a single paper, it appeared relatively infrequently (in only nine papers). The most significant gap in the presentation concerns how authors applied the DSR process and the iterative nature of solving the problem or building the artefact. Across all the papers we analyzed, 101 did not present an iterative design. In terms of IS development, we could describe this poor transparency as a “black box” approach that involves presenting the final artefact and moving straight to evaluation. Indeed, we can view it as normal or best practice to present the research process through an idealized rational process for the reader's benefit (Iivari & Maansaari, 1998; Parnas & Clements, 1986). However, we also included using an appendix (a useful technique to streamline the reader’s experience) in our analysis but found that papers rarely did so. As a result, authors failed to report as much richness as they could have in these cycles and to clearly explain how they arrived at the final artefact. Indeed, Baskerville et al. (2019) refer to a creativity oversight whereby the audience loses out on insights into design decisions that researchers make as they come to understand a problem and build an effective solution. In addition, given the significant differences in the guiding references and, thus, processes that authors followed, when authors omit the specific DSR process they followed, it makes it difficult to replicate the rigor in these studies and produce increasingly better quality DSR. For instance, five papers did not detail their evaluation with the majority of those papers in the proof of concept impact category.

Adherence will always follow a spectrum (e.g., rigid application to innovative freestyle), and, given DSR researchers’ design focus, they will naturally apply that focus to DSR itself. However, if authors do not present their adherence transparently, it lessens the importance of methodological specificity (Baker et al., 1992). Indeed, the evidence above points to DSR method slurring, an issue identified in grounded theory as researchers adopted an arbitrary subset of the method but ultimately did not fulfill its requirements (Stol, Ralph, & Fitzgerald, 2016). The popularity of Hevner et al.’s (2004) paper as a guiding reference indicates this pattern’s prevalence as researchers present a subset of DSR principles as testament to their adherence but fail to incorporate core DSR components. Conversely, our findings could highlight “rational reconstruction” (Pedersen, 2008), a practice in which authors present an idealized design process (Parnas & Clements, 1986) that selectively omits DSR aspects. However, this interpretation overlooks the omitted components’ criticality (e.g., the guiding process itself), which severely stretches the rational construction concept but opens the potential for retrospective methodological reframing. Indeed, in reviewing action research, Avison et al. (2018) pointed out adapting research methods a posteriori and highlighted that scholars specifically reported their work as design science (DS) to enhance the chances that a highly ranked journal would publish their work. For the exemplars published in the SSB this highlights a lack of transparency and tolerance to poor scientific communication in DSR which erodes the rigor, reliability, and repeatability of these studies.

3.2 RQ2: How have IS Scholars Conducted DSR?

3.2.1 Approach

We adopted Iivari’s (2015) Strategy 1 and 2 dichotomy to define the type of DSR strategies that papers in our sample adopted. Strategy 1 describes a process that starts with a problem class, informed by literature and past research, which justifies efforts to develop an artefact (solution). While this strategy does not imply that the problem does not have its roots in practice, it does highlight that one can use past research to generalize the problem. One then implements the resulting artefact against an instance of the problem for evaluation. Strategy 2 begins with a specific problem that a real client experiences (e.g., Sun & Kantor, 2006), which motivates an effort to develop an artefact to solve that specific problem instance. One then generalizes the knowledge that one generates during this process for a wider impact. Furthermore, we analyzed the evaluation type to obtain additional insight into how authors conducted the studies. In line with Venable et al. (2016), we coded two evaluation types: 1) artificial – (mathematical/logical proof, lab experiment, role-playing simulation, computer simulation, field experiment) and 2)) naturalistic (case study, focus group, participant observation, ethnography, phenomenology, and survey (qualitative, quantitative)).

3.2.2 Findings

As we show in Table 6, we classified most DSR papers we examined (96 in total) as Strategy 1. We classified 14 of the remaining 15 papers as Strategy 2. In the final paper (Coenen et al., 2018), the authors explicitly state that they followed both strategies.

Table 6. Design Science Research strategies (Numbers Identify DSR Studies in Appendix B)

	Artificial evaluations	Naturalistic evaluations	Both	None	Total
Strategy 1	**65 papers** (1, 2, 3, 5, 6, 7, 14, 19, 21, 22, 25, 26, 28, 30, 33, 36, 40, 42, 44, 45, 47, 48, 49, 50, 51, 52, 55, 56, 57, 58, 59, 60, 62, 63, 66, 68, 70, 71, 72, 73, 74, 77, 79, 80, 81, 82, 83, 84, 85, 86, 88, 89, 90, 91, 93, 94, 95, 97, 99, 101, 102, 103, 107, 109, 110)	**21 papers** (9, 10, 11, 12, 13, 15, 32, 37, 41, 46, 53, 61, 67, 69, 75, 78, 96, 100, 105, 106, 108)	**6 papers** (23, 35, 38, 54, 64, 98)	**4 papers** (24, 27, 31, 43)	96
Strategy 2	**5 papers** (29, 34, 87, 104, 111)	**7 papers** (8, 16, 17, 18, 20, 76, 92)	**1 paper** (65)	**1 paper** (39)	14
Both			**1 paper** (4)		1

From an evaluation perspective, we found a strong preference towards artificial evaluations over naturalistic (i.e., 70 artificial vs. 28 naturalistic) (see Table 7 for examples). However, this finding does not underestimate the effort that researchers have made in designing evaluations to incorporate realistic characteristics. For instance, Pentland et al. (2017) note that they “elaborately planned [their evaluation] with the goal of increasing realism” (p. 978), and many researchers used simulations, which often build on real-world data (e.g., Piel, Hamann, Koukal, & Breitner, 2017). However, researchers have noted that simulations and real data sets have some limitations. Specifically, Wang et al. (2017) note that simulations will not likely hold up in “real-world” settings (p. 149), and, while some studies did not go beyond simulations (e.g. Soffer, Wand, & Kaner, 2015), they did incorporate real-world data sets. However, as Ghiassi et al. (2016) note, even though real data sets may seem large, they often still have size limitations limited in size.

Table 7. DSR Strategy (Evaluations with Instances)

		Description	Examples
Artificial	Literature analysis	Using literature to validate requirements or concepts embedded in the artefact.	Hariharan et al. (2017)
	Simulation	In situations when one develops innovative method/theory/model artefacts, one needs simulations to create an effective evaluation environment. These simulations often constitute a stepping stone to further evaluations (e.g., Wang 2017).	Brandt et al. (2018), Cascavilla et al. (2018), Soffer et al. (2015)
	Interviews of experts	Interviews on potential usage but they would not have used it.	Adomavicius et al. (2008), D’aubeterre et al. (2008), Babaian et al. (2018)
	Historic/real data sets	Provide more reality but also have limitations and do not know how representative they are.	Xu et al. (2007), Ghiassi et al. (2016), Piel et al. (2017), Pant & Srinivasan (2013)
	Controlled experiments	Experiments that reside near naturalistic evaluations on the spectrum but where, due to the specificity of the aspect being evaluated, one needs to control certain aspects to see a direct impact.	Dang et al. (2012), Pentland et al. (2017), W. Li et al. (2016), Briggs et al. (2013)
Naturalistic	Use in natural environments	Case study on an artefact in use in a real environment that embraces all the complexities of human practice and system integration in real organizations and system implementations.	Datta et al. (2012), Mettler (2018)

Indeed, the artefact type often determines the evaluation type. For many artefacts such as algorithms and models, researchers need to simulate or control evaluations to ensure they can effectively measure performance. Nonetheless, Datta et al. (2012) provide a very good example of how they integrated an approach into a commercial product (naturalistic setting) and evaluated it in a staging environment. Furthermore, Mettler (2018) described their own evaluations as interventions in organizational or naturalistic contexts that inherently embrace "all of the complexities of human practice in real organizations" (Venable et al., 2016, p. 81).

3.2.3 Discussion

Every paper in our sample focused on a practical problem, which highlights a commitment to solve such problems and publish relevant research. Furthermore, the finding demonstrates that the DSR papers in the SSB have focused on solving problems as their core goal. It also highlights that DSR has indeed brought IS researchers closer to practice in solving relevant problems by being more pragmatic and focusing on utility and usefulness rather than an abstract notion of truth (Ågerfalk, 2010; Goles & Hirschheim, 2000). However, the skewed distribution that the sample displayed towards Strategy 1 over Strategy 2 highlights a reluctance to focus on problems with the full complexity of a specific context and its unique characteristics and to explore such problems through a close relationship with the client experiencing the problem. The significant challenge that researchers face when tackling live problems may explain this reluctance—a challenge that may leave them "empty headed" in searching for a solution (Iivari, 2015) but also empty handed when formulating a contribution. Nonetheless, it supports an issue that Alan Hevner identified in DSR, which has struggled to "deal effectively with the messy complexity of real IS problems and avoid the reductionism found in much research that simplifies the problem space to one in which known theories and solutions readily apply" (Rai, 2017). Our findings also tie into the view that DSR overlooks problem analysis compared to other problem-solving methods, such as action research and engaged scholarship, which prescribe empirical problem investigations (Nielsen, 2020). With less importance placed on context specifics and the need to solve specific problems, the outputs from Strategy 1 type studies lack proximity to the real world with a generalized problem and resulting generalized solution. Furthermore, scholars have also mainly overlooked the opportunity to interact with the real-world practice through testing the developed artefacts in naturalistic settings, which would again suggest that the "truly interesting design problems", the ones that cannot be fully anticipated but are "partially designed and partially emergent from the practice" do not play a significant role in DSR (Sein & Rossi, 2019, p. 4). As a result, we have lost out on activity and insight from bottom-up inductive studies, which researchers have seen as a key method for the IS discipline (Goldkuhl, 2004; Sein & Rossi, 2019).

3.3 RQ3: What Impacts have IS DSR Studies Reported?

3.3.1 Approach

To address this question, we leveraged two research-output classifications to code the papers in our sample: 1) knowledge contribution and 2) practical impact. To assess the knowledge contribution, we used Gregor and Hevner's (2013) taxonomy, which highlights three levels of knowledge contribution maturity. Level 1 defines an artefact instantiation as knowledge contribution as the authors note that demonstrating "a novel artifact can be a research contribution that embodies design ideas and theories" even if one has not articulated, formalized, or understood these design principles or ideas (Gregor & Hevner, 2013, p. 314). However, as a knowledge contribution, it also includes key findings about the study's problem domain. Level 2 denotes articulated or formalized embodied constructs, methods, models, and design principles. Finally, Level 3 describes a well-developed design theory (both mid-range and grand). For practical impact, we adopted Nunamaker et al. (2015) taxonomy of IS solutions that deal with problems "for real people with real stakes in the outcomes". The taxonomy incorporates three stages: 1) proof of concept: the research demonstrates the solution's functional feasibility, 2) proof of value: the research demonstrates whether stakeholders can use the solution to create value across various contexts and conditions, and 3) proof of use*:* the research demonstrates that practitioners can successfully create and gain value from their own instances of the generalizable solution.

3.3.2 Findings

As Table 8 shows, among the 111 studies we analyzed, 49 generated an equal knowledge contribution and practical impact. From the remaining studies, 47 generated a higher knowledge contribution than practical impact, while only 15 generated a higher practical impact than knowledge contribution. We also found this 3:1 ratio when assessing Level 3 contributions. Overall, 17 studies (15%) demonstrated a Level 3 knowledge contribution (design theory) versus three studies (3%) that demonstrated a Stage 3 practical impact (proof of use).

Table 9. Impact of DSR Studies (Numbers Identify Papers in the Concept Centric Matrix in Appendix B)

		Knowledge contribution				
		None	Level : artefact instance and key findings	Level 2: nascent theory: constructs, methods, models, design principles, and technological rules	Level 3: design theory	Total
Practical Impact	None			**1 paper** (31)	**1 paper** (24)	**2**
	Stage1: proof of concept		**10 papers** (3, 5, 48, 52, 66, 87, 01, 95, 97, 99)	**29 papers** (1, 2, 7, 10, 11, 12, 13, 15, 16, 20, 32, 39, 46, 55, 58, 67, 68, 69, 70, 71, 75, 77, 82, 93, 85, 100, 108, 109, 110)	**7 papers** (27, 30, 43, 45, 49, 96)	**46**
	Stage 2: proof of value		**12 papers** (6, 14, 23, 25, 26, 72, 88, 89, 90, 98, 104, 107)	**39 papers** (8, 9, 18, 19, 21, 22, 28, 33, 34, 35, 36, 37, 40, 44, 50, 51, 53, 56, 57, 59, 60, 61, 62, 65, 73, 76, 78, 79, 80, 81, 84, 86, 93, 101, 102, 103, 105, 106, 111)	**9 papers** (4, 17, 38, 41, 42, 63, 64, 92, 94)	**60**
	Stage 3: proof of use			**3 papers** (29, 54, 74)		**3**
	Total		**22**	**72**	**17**	

We detail the three papers that achieved the highest practical impact (Stage 3) in Table 9 (i.e., Zahedi et al., 2016; Yang et al., 2012; Boughzala & De Vreede, 2015). Yang et al. (2012) developed an integrated information platform for emergency response management that they "deployed in the real world and used in the 2008 Beijing Olympic Games" (p. 761). As they outline, a strong motivation and detailed need for the platform existed. The requirements, which they validated as part of a two-year industry secondment, provided them with a rich dataset that included over 100 interviews, observations, and workshops in the field. In contrast, Boughzala and De Vreede (2015) focused on addressing an important class of "unsolved problems—assessing the quality of collaboration within and across organizational boundaries" (p. 131). They developed a collaborative maturity model "during a series of focus group meetings with professionals (business unit managers)" (p. 129). Thereafter, they note that "a large multinational automotive firm had a desire to assess the collaboration quality of some of their distributed virtual teams" (p. 142), which highlighted "effective use in the field" (p. 129). Finally, Zahedi et al. (2016) explicitly mentions the impact of their artefact (an augmented virtual doctor office) as "proof of use", which was demonstrated through "experiments with simulated medical sessions (p. 779).

We find spectrum of proof of use demonstrations in the papers interesting. Zahedi et al. (2016) obtained significant input from physicians but used simulated experiments, whereas Yang et al. (2012) and Boughzala and De Vreede (2015) presented real-world adoptions. Furthermore, only Yang et al. (2012) developed an artefact that an organization fully implemented and used, while Boughzala and De Vreede (2015) and Zahedi et al. (2016) set out to solve a problem. In addition, while these papers distinctly indicate (if not explicitly state) proof of use, further supporting evidence for actual use would have strengthened their position.

From a knowledge contribution perspective, 17 papers presented Level 3 contributions. Among those 17 papers, 11 explicitly focused on developing a theory as the artefact. Some also developed prototypes but only as a method to evaluate theory. For example, Li et al. (2015) focused on developing a design theory for market surveillance systems and demonstrating "the effectiveness of this proposed design theory through developing and evaluating a prototype system in the context of a real-world stock exchange market" (p. 279). Similarly, Meth et al. (2015) developed a theory for requirement mining systems and "also implemented a prototype based on this design theory (REMINER)" (p. 799). However, not all papers that explicitly focused on developing theories also developed prototypes; rather, they analyzed existing systems in depth (e.g., Hanseth & Lyytinen, 2010; Spagnoletti et al., 2015). As Spagnoletti et al. (2015) outline, they analyzed the "European digital platform for elderly care assistance" (p. 364) in depth to validate their design theory for digital platforms supporting online communities. As for Hanseth and Lyytinen (2010), they used "the history of Internet exegesis" (p. 1) as a form of theoretical validation.

Table 9. Artifacts of Studies that Achieved the Highest-level Impacts

Artefact	Author	Artefact description
Stage 3: practical impact		
System	Yang et al. (2012)	An integrated information platform for emergency response management
System	Zahedi et al. (2016)	An augmented virtual doctor office (AVDO)
Model	Boughzala & De Vreede (2015)	A collaboration maturity model
Level 3: knowledge contribution		
Framework	Siponen et al. (2006)	Secure information systems design framework
Framework	Soffer et al. (2015)	A catalogue of split and merge possibilities
Method	Alspaugh et al. (2010)	An approach for analyzing and modeling FOSS license rights
Model	Zhang et al. (2011)	A model that relates system design to team performance
Model	Mastrogiacomo et al. (2014)	A conceptual model (called Coopilot) to improve real-time coordination in IS projects
Model	McClaren et al. (2011)	MSF measurement model
Theory	Meth et al. (2015)	Design theory for RMS (requirement mining systems)
Theory	Giessmann & Legner (2016)	Design theory for PaaS business models
Theory	Kasper (1996)	A DSS design theory for user calibration
Theory	Walls et al. (1992)	Information system design theory (ISDT)
Theory	Wirenbergen et al. (2011)	A design theory for systems that support convergent and divergent thinking
Theory	Markus et al. (2002)	Emerging knowledge process (EKP)
Theory	Hanseth et al. (2010)	A socio-technical information infrastructure design theory
Theory	Pries-Heje et al. (2008)	Design theory nexus
Theory	Spagnoletti (2015)	A Design theory for digital platforms that support online communities
Theory	Li et al. (2015)	A design theory for market surveillance systems (MSS)
Theory	Coenen et al. (2018)	An information system design theory for the comparatively judging competences

Furthermore, while Coenen et al. (2018) state at the outset they developed a system for assessing "human competences while supporting learning" (p. 248), they did so only as an expository artefact to evaluate competences (a component of the design theory they developed). Markus et al. (2002) followed a similar process but their terminology makes the primary artefact more difficult to define. They created a design theory:

> *While designing and deploying a system for the EKP of organization design. The system was demonstrated through subsequent empirical analysis to be successful in supporting the process. Abstracting from the experience of building this system, we developed an IS design theory for EKP support systems.* (pp. 179-180).

Yet, the system was the naturalistic environment in which the theory was developed and not the primary artefact. Furthermore, among the papers that developed a Level 3 knowledge contributions, six studies developed frameworks and models as their primary artefact and presented their contributions as a design theory. For example, Soffer et al. (2015) presented their framework for conceptualizing routing decisions in business processes as a design theory that they justified by mapping it to Gregor and Jones' (2007) design theory description.

In examining studies with lower-level impacts, we found that projects had twice as much chance to produce a Stage 1 practical impact as their top impact (41% for proof of concept) versus a Level 1 knowledge contribution (20% for artefact implementation). Interestingly, we also found that no paper presented a practical impact with no knowledge contribution; however, the inverse did not hold true. Furthermore, we found two papers that presented no practical impact (Chatterjee et al., 2009; Kasper, 1996). Both these papers lacked an evaluation presentation, made a strong knowledge contribution (a Level 2 or more for both papers), and provided no evidence for or presented a practical impact.

From our analysis, we found that projects achieved Level 2 (65%) and Stage 2 (52%) top-level contributions the most frequently). As a good example, Nunamaker et al. (2011) discuss how they developed an “embodied conversational agent-based kiosk for automated interviewing” and indicate that the artefact reached proof of value. However, they indicate that it remained incomplete and, thus, that they could not establish its proof of use. Accordingly, they suggest the need for more societal and organizational studies to evaluate it. In addition, the model the authors created to “explore the relationship between emotional states and vocal pitch” (p. 41), which emerged as they developed their artefact, demonstrates their Level 2 knowledge contribution.

In summary, the results clearly identify the contribution patterns of IS research problem solving through the lens of DSR as a problem-solving methodology. In particular, we note the 49 studies (44% of total) that generated an equal knowledge contribution and practical impact. However, the remaining 62 papers skewed towards knowledge contributions. Only three papers (3%) presented practitioner proof of use (Stage 3). Given DSR’s highly applied nature, this figure seems arguably low—especially when one compares it to the fact that 17 papers (15%) produced Level 3 design theories.

3.3.3 Discussion

The results that we present above provide significant insight into the editorials around DSR and IS contributions in general. In particular, we provide empirical context to debates on topics such as the obsession or fetish for theory (Dennis, 2019; Hirschheim, 2019; Iivari, 2020) and on positioning DSR research contributions (Baskerville et al., 2018; Gregor & Hevner, 2013). Interestingly, as Table 9 shows, our results do highlight that DSR research has focused more on theoretical contributions in comparison to practical contributions. However, we would expect as much in the SSB even when considering a problem-solving method such as DSR. Furthermore, if we strip back nascent theory to its core components (constructs, methods, models, design principles, and technological rules), the evidence for theory obsession in DSR becomes not as clear. It does, however, point to a labeling issue in DSR with the term “nascent theory” playing a role in legitimizing practical DSR contributions for publication as Iivari (2020) has detailed. Furthermore, given we coded the Level 3 knowledge contributions based on whether authors explicitly called out a design theory as a contribution and given the confusion around what constitutes a design theory (Iivari, 2020), our sample might actually contain fewer Level 3 contributions that what we recorded (which also applies for Stage 3 practical contributions)).

At the other end of the scale, the fact that we identified 22 papers with a Level 1 (artefact instance) contribution raises questions about how these “theory light” (Avison & Malaurent, 2014) papers managed to secure publication in the SSB with such a low knowledge contribution. However, by examining these papers (e.g., Cascavilla et al., 2018; Pentland et al., 2017; Venkates et al., 2017), we found that they often contributed significant results rather than significant theory, which we used as the barometer for assessing knowledge contribution level (Gregor & Hevner, 2013). In retrospect, one could argue that the Gregor and Hevner (2013) taxonomy does not fit our purpose in this study, yet it does embody the theorizing process, which can initially create incomplete explanations that, if given a chance, may become a rich theory (Rivard, 2020). In more recent work, Baskerville et al. (2018) highlighted the significant role that practical impacts/results play in their five positioning perspectives in balancing artifact and theory contributions. However, we cannot easily know whether these positions reduce a reviewer’s urge to reject DSR studies due to a lack of theory (Avison & Malaurent, 2014). As IS academics, we are more attuned to assessing the theoretical strength of research compared to the significance of results associated with a particular problem. Indeed, this difference separates academics from practitioners and consultants (Gregor, 2006), which could explain why we found a high tendency to abstract or theorize results from DSR studies into methods, constructs, design principles, and technological rules. If anything, our study highlights an obsession with theorizing, not theory, which in no way represents a bad thing (especially when studies generate Level 2 contributions). However, we fear that, for the 22 “theory light” papers that the SSB journals accepted in our review, they rejected many more such studies with significant results for having a contribution that did not adhere to the conflicting and overly narrow way in which we define theory (Markus, 2014). Indeed, the lack of DSR papers in top journals echoes such a fear (Baskerville et al., 2018; Goes, 2014; Peffers et al., 2018).

4 Conclusions

Senior Scholars in the IS discipline have made a palpable effort to make DSR a success and mainstay. However, despite these efforts, we found that DSR has not performed as expected given its distinct value for the IS domain (Baskerville et al., 2018). In this study, we survey the DSR landscape in the AIS Senior Scholars' basket of journals to provide empirical context and insight to the many discussions on presenting, implementing, and contributing to DSR. In fulfilling the research objective, we successfully answer our three research questions as we show in Table 10. We discuss the overall conclusions we identified in answering these three questions in Sections 4.1 to 4.3.

Table 10. Answers to Our Research Questions

RQ1: How have IS scholars presented DSR?	We found four different styles for the way in which DSR research in the SSB has presented a DSR study's seven components. Given that only nine papers in our sample presented all seven components, we can see that authors have not comprehensively and transparently presented DSR (e.g., 101 papers did not present an iterative design component).
RQ2: How have IS scholars conducted DSR?	We observed that authors have taken more "academic" approaches to evaluation and reported more artificial evaluations compared to naturalistic evaluations than one might prefer. This finding reflects the many Strategy 1 DSR studies in our sample (96 in total) that began with a problem class as opposed to the 14 papers that began with a problem instance (Strategy 2 DSR studies).
RQ3: What impacts have IS DSR studies reported?	Disappointingly, we found only three papers that showcased the most sophisticated practical impact stage (Stage 3: proof of use), while 17 papers showcased the most sophisticated knowledge contribution level (Level 3: design theory). However, we did not identify any paper that showcased a Stage 3, Level 3 DSR knowledge contribution.

4.1 Theory Obsession

Our analysis highlights the struggles that DSR continues to face in bringing IS research closer to practice while dealing with norms in IS research and publishing in high-quality IS journals. Nevertheless, our study shows that DSR has been successful in focusing on problems in practice, embedding design as a theorizing method, and producing theorized knowledge contributions in the form of practical constructs, methods, models, design principles, and technological rules. Furthermore, it has done so this despite the noted fetishizing and narrow way in which IS research defines theory (Iivari, 2020; Markus, 2014). Indeed, our analysis highlights that, beyond how many authors have superficially labeled their practical contributions as nascent theory as a way to legitimize DSR (Iivari, 2020), little evidence supports an obsession with theory.

4.2 Lack of Transparency

As a key standout from our analysis, we found a lack of methodological transparency in DSR papers, which, at best, leads to black box prototyping and, at worst, methodological slurring. We believe that, without this basic requirement for transparency, providing DSR genres, positioning perspectives, and taxonomies will only serve to fuel additional academic justifications for studies that fail to provide transparency in the first place. Such justifications would lead to further vagaries in deciphering how to conduct and present high-quality DSR and restrict future exemplars. Indeed, increased transparency would highlight how researchers have successfully managed to overcome a significant challenge in DSR: defining a problem and solution, which naturally evolve simultaneously through multiple DSR iterations (Baskerville et al., 2018). Such a methodological transparency request may seem like an impossible task, especially given the limitations that journals place on papers. However, our analysis highlights example papers that have successfully managed the task. Furthermore, we contend that using open science techniques could provide the required bandwidth for researchers to document how they iterated through problems, artefacts, and evaluations (Doyle et al., 2019). In particular, using open science repositories can provide insight into citable and independent DSR project aspects. Open techniques will help authors present DSR studies to overcome restrictions that journals place on their papers, provide significant insight into the seven DSR components, and increase the recognition/citations that their work receives.

4.3 Problem and Impact Abstraction

Our study demonstrates that DSR has brought IS research(ers) closer to practice by focusing on practical problems and developing solutions in the form of IS artefacts. However, we need to ask not if DSR brings

IS research(ers) closer to practice but by how much and if it needs to go further. Strategy 1 type DSR—which typically comprises generalized problems that authors detail through literature, evaluate artificially, and deductively theorize—dominates the studies we analyzed. In essence, the investigation has an abstract nature by design and, thus, engages with real-world contexts and messy problems to a limited degree. We may have found so many Strategy 1 papers because 1) IS research places little value on empirically exploring and defining IS problems (Nielsen, 2020), 2) practitioners lack guidelines to engage in DSR (Nagle et al., 2017), or 3) IS researchers lack the business and technical capabilities to directly engage with practice for which Lacity et al. (2021) have developed an alternative approach in action principles.

In addition, the limited number of studies that demonstrate proof of use highlights a potential for researchers to make more progress in this area. While our theoretical contributions have become more practical, we still do not know about their use and impact. One can find strong merit in the argument that no journal wants to publish the outcome of 100 uses or, indeed, to wait two to three years to see what results from using an artefact in the world. However, proof of use represents a hugely significant milestone and indicates real impact, one that becomes much more immediate if researchers directly engage with practice. With this statement, we do not mean to trivialize proof of concept and proof of value contributions but to highlight the need to present proof of use, which not only demonstrates real impact but lessens extent to which practitioners need to interpret/understand DSR papers and adopt/adapt DSR generalized solutions (Nunamaker et al., 2015). Furthermore, it targets a specific problem in research relevance (i.e., that almost no managers turn to academic journals for advice on how to improve practices) (Rynes et al., 2001; Shapiro & Kirkman, 2018). Demonstrating such impact could again benefit from open science techniques (such as archiving artefacts in open repositories) that enables researchers to capture proof of use impact by recording practitioner and academic engagement with DSR artefacts after publication.

5 Future Research

In line with our objective to provide empirical context and insight to the many Senior Scholar discussions on presenting, implementing, and contributing to DSR, we also provide the IS community with the opportunity to reflect on the shape DSR has taken and decide how our community wants to address more relevant and impactful real-world problems in the future. Indeed, we hope our research will provide the basis for further analyses and insights to support IS researchers, editors, reviewers, supervisors, and practitioners. In this spirit, we provide our literature analysis data to support future DSR editorials and position pieces in Appendix B (we also have made it available on the Open Science Framework; please contact us for the link). By further using our open dataset, researchers may examine DSR studies from sources beyond the SSB. Indeed, we note that we did not target studies that authors conducted in the DSR spirit without explicitly mentioning DSR. We would encourage researchers to build on our analysis to uncover and examine such studies.

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Appendix A: Search Strategy

Table A1. Search Strategy

Senior Scholars' basket	**Search**	**Iteration 1: # of papers returned in search**	**Iteration 2: # of papers related to DSR**	**Iteration 3: # of DSR papers to review**
European Journal of Information Systems	*EJIS* website	97	54	15
Information Systems Journal	*ISJ* Website	51	14	7
Information Systems Research	ISR website	45	16	10
Journal of the Association for Information Systems	*JAIS* website	85	44	19
Journal of Information Technology	*JIT* website	55	14	4
Journal of Management Information Systems	*JMIS* website	77	38	28
Journal of Strategic Information Systems	*JSIS* website	24	5	3
MIS Quarterly	AIS eLibrary	127	43	24
Total		561	228	110
Web of Science			**Additional DSR papers identified**	**Additional empirical DSR papers**
European Journal of Information Systems	Web of science	40	0	0
Information Systems Journal	Web of science	11	0	0
Information Systems Research	Web of science	10	0	0
Journal of the Association for Information Systems	Web of science	42	0	0
Journal of Information Technology	Web of science	9	0	0
Journal of Management Information Systems	Web of science	21	0	0
Journal of Strategic Information Systems	Web of science	8	0	0
MIS Quarterly	Web of science	42	1	1
Total		183	1	1
Complete search	Web of Science			
	Total	562	229	111

Appendix B: Concept Centric Matrix

Table B1. Concept Matrix

Paper no.	Paper		Strategy*	Artefact	Guiding reference	Evidence of process adherence
1	*EJIS*	Babaian et al. (2018)	1	System	Yes	Yes
2	*EJIS*	Brandt et al. (2018)	1	Model	No	No
3	*EJIS*	Cascavilla et al. (2018)	1	System	Yes	No
4	*EJIS*	Coenen et al. (2018)	Both	Theory	Yes	No
5	*EJIS*	Collins et al. (2010)	1	Approach	Yes	No
6	*EJIS*	D'Aubeterre et al. (2008)	1	Approach	Yes	No
7	*EJIS*	Dietz et al. (2012)	1	Methodology	Yes	Yes
8	*EJIS*	Gregor et al. (2014)	2	Methodology	Yes	Yes
9	*EJIS*	Klor et al. (2017)	1	System	Yes	Yes
10	*EJIS*	Nickerson et al. (2013)	1	Method	Yes	No
11	*EJIS*	Oetzel et al. (2014)	1	Methodology	Yes	No
12	*EJIS*	Puschamnn et al. (2005)	1	Model	Yes	Yes
13	*EJIS*	Seidel et al. (2017)	1	Methodology	Yes	Yes
14	*EJIS*	Umapathy et al. (2008)	1	System	Yes	No
15	*ISJ*	Arnott (2006)	1	Model	Yes	Yes
16	*ISJ*	Ebel et al. (2016)	2	System	Yes	Yes
17	*ISJ*	Giessmann et al. (2016)	2	Theory	Yes	Yes
18	*ISJ*	Hustad et al. (2014)	2	Framework	Yes	Yes
19	*ISJ*	Lycett et al. (2018)	1	Model	Yes	Yes
20	*ISJ*	Mettler (2018)	2	Methodology	Yes	No
21	*ISR*	Adomavicius et al. (2005)	1	Approach	Yes	Yes
22	*ISR*	Currim et al. (2012)	1	Framework	Yes	Yes
23	*ISR*	Datta et al. (2012)	1	System	No	No
24	*ISR*	Kasper (1996)	1	Theory	Yes	Yes
25	*ISR*	Pant et al. (2013)	1	System	Yes	No
26	*ISR*	Storey et al. (2008)	1	Methodology	Yes	Yes
27	*ISR*	Walls et al. (1992)	1	Theory	Yes	Yes
28	*ISR*	Wang et al. (2017)	1	Algorithm	No	No
29	*ISR*	Yang et al. (2012)	2	System	No	No
30	*JAIS*	Alspaugh et al. (2010)	1	Method	Yes	No
31	*JAIS*	Chatterjee et al. (2009)	1	Model	Yes	Yes
32	*JAIS*	D'Aubeterre et al. (2008)	1	Approach	Yes	Yes
33	*JAIS*	Druckenmiller et al. (2009)	1	System	Yes	Yes
34	*JAIS*	Fridgen et al. (2016)	2	Algorithm	No	No
35	*JAIS*	Hariharan et al. (2015)	1	System	Yes	Yes
36	*JAIS*	John et al. (2016)	1	Approach	Yes	Yes
37	*JAIS*	Lukyanenko et al. (2017)	1	Methodology	No	No
38	*JAIS*	Meth et al. (2015)	1	System	Yes	Yes
39	*JAIS*	Mittlemann (2009)	2	Process	No	No

Table B1. Concept Matrix

40	*JAIS*	Nan et al. (2009)	1	Model	Yes	No
41	*JAIS*	Siponen et al. (2006)	1	Framework	Yes	Yes
42	*JAIS*	Soffer et al. (2015)	1	Framework	No	No
43	*JAIS*	Wirenbergen et al. (2011)	1	Theory	Yes	Yes
44	*JAIS*	Xu et al. (2007)	1	Method	Yes	Yes
45	*JAIS*	Zhang et al. (2011)	1	Model	Yes	Yes
46	*JIT*	Amrit et al. (2010)	1	Method	Yes	No
47	*JIT*	Hanseth et al. (2010)	1	Theory	Yes	Yes
48	*JIT*	Koschmider et al. (2010)	1	System	Yes	No
49	*JIT*	Spagnoletti (2015)	1	Theory	Yes	Yes
50	*JMIS*	Abbasi et al. (2015)	1	Method	Yes	No
51	*JMIS*	Astor et al. (2013)	1	System	Yes	No
52	*JMIS*	Bendahan et al. (2005)	1	System	Yes	No
53	*JMIS*	Bittner et al. (2014)	1	System	Yes	Yes
54	*JMIS*	Boughzala et al. (2015)	1	Model	Yes	No
55	*JMIS*	Briggs et al. (2013)	1	System	Yes	No
56	*JMIS*	Carmel et al. (2010)	1	Model	No	No
57	*JMIS*	Cheng et al. (2016)	1	Process	Yes	No
58	*JMIS*	Choi et al. (2010)	1	System	Yes	No
59	*JMIS*	Dang et al. (2012)	1	System	No	No
60	*JMIS*	Ghiassi et al. (2016)	1	Approach	No	No
61	*JMIS*	Kolfschoten et al. (2009)	1	Approach	No	No
62	*JMIS*	Li et al. (2016)	1	System	Yes	No
63	*JMIS*	Li et al. (2015)	1	Theory	No	No
64	*JMIS*	Mastrogiacomo et al. (2014)	1	Model	Yes	Yes
65	*JMIS*	Nunamaker et al. (2011)	2	System	No	No
66	*JMIS*	Pentland et al. (2017)	1	System	Yes	Yes
67	*JMIS*	Peters et al. (2015)	1	Framework	Yes	Yes
68	*JMIS*	Piel et al. (2017)	1	Model	No	No
69	*JMIS*	Shao et al. (2006)	1	Procedure	No	No
70	*JMIS*	Twyman et al. (2014)	1	System	Yes	Yes
71	*JMIS*	Twyman et al. (2015)	1	System	No	No
72	*JMIS*	Vlas et al. (2012)	1	System	Yes	No
73	*JMIS*	Yang et al. (2012)	1	System	Yes	No
74	*JMIS*	Zahedi et al. (2016)	1	System	Yes	No
75	*JSIS*	Kolkowska et al. (2016)	1	Method	Yes	Yes
76	*JSIS*	Spagnoletti et al. (2015)	2	Model	Yes	Yes
77	*MISQ*	Abbasi et al. (2008)	1	Framework	Yes	Yes
78	*MISQ*	Abbasi et al. (2018)	1	Framework	Yes	No
79	*MISQ*	Abbasi et al. (2012)	1	Framework	Yes	No
80	*MISQ*	Abbasi et al. (2010)	1	System	Yes	No
81	*MISQ*	Adipat et al. (2011)	1	System	Yes	No
82	*MISQ*	Adomavicius et al. (2008)	1	Methodology	Yes	No

Table B1. Concept Matrix

83	*MISQ*	Albert et al. (2004)	1	Framework	Yes	Yes
84	*MISQ*	Breuker et al. (2016)	1	Method	No	No
85	*MISQ*	Chau et al. (2012)	1	Framework	Yes	Yes
86	*MISQ*	Chen et al. (2013)	1	Model	Yes	No
87	*MISQ*	Chou et al. (2014)	2	System	Yes	No
88	*MISQ*	Lau et al. (2012)	1	System	Yes	No
89	*MISQ*	Lee et al. (2008)	1	Method	Yes	Yes
90	*MISQ*	Lin et al. (2017)	1	Approach	Yes	No
91	*MISQ*	Loock et al. (2013)	1	System	Yes	No
92	*MISQ*	Markus et al. (2002)	2	Theory	Yes	No
93	*MISQ*	Martens et al. (2014)	1	Algorithm	Yes	No
94	*MISQ*	McClaren et al. (2011)	1	Model	Yes	No
95	*MISQ*	Parsons et al. (2008)	1	Model	Yes	No
96	*MISQ*	Pries-Heje et al. (2008)	1	Theory	Yes	No
97	*MISQ*	Reinecke et al. (2013)	1	System	Yes	Yes
98	*MISQ*	Vandermeer et al. (2012)	1	System	Yes	No
99	*MISQ*	Venkatesh et al. (2017)	1	System	Yes	Yes
100	*EJIS*	Rosenkranz et al. (2016)	1	System	Yes	No
101	*MISQ*	Larsen et al. (2016)	1	System	Yes	Yes
102	*MISQ*	Guo et al. (2017)	1	System	Yes	No
103	*JSIS*	Narman et al. (2013)	1	Method	Yes	No
104	*JMIS*	Shi et al. (2017)	2	Approach	Yes	No
105	*JMIS*	Keith et al. (2014)	1	Methodology	Yes	No
106	*JMIS*	Kitchens et al. (2018)	1	Method	No	No
107	*JAIS*	Roussinov et al. (2008)	1	System	Yes	No
108	*JAIS*	Schmeil et al. (2012)	1	Framework	Yes	No
109	*JAIS*	Lang et al. (2015)	1	Model	Yes	No
110	*ISR*	Provost et al. (2015)	1	Model	No	No
111	*ISJ*	Giesbrecht et al. (2017)	2	System	Yes	Yes

* 1 = class of problem to instance implementation, 2 = problem instance to generalization

Table B1. Concept Matrix (Cont.)

Paper no.	Type of evidence for adherence	Iteration presented	No of cycles	Cycle count	Evaluation (Y/N)	Evaluation type	Theoretical contribution
1	Figure	No	No	N/A	Yes	Artificial	Yes
2	None	No	No	N/A	Yes	Artificial	Yes
3	None	No	No	N/A	Yes	Artificial	Yes
4	None	Yes	Yes	5	Yes	Both	Yes
5	None	No	No	N/A	Yes	Artificial	Yes
6	None	No	No	N/A	Yes	Artificial	Yes
7	Paper Section	No	No	N/A	Yes	Artificial	Yes
8	Table	No	Yes	3	Yes	Naturalistic	Yes
9	Table	No	No	N/A	Yes	Naturalistic	Yes
10	None	No	No	N/A	Yes	Naturalistic	Yes
11	None	No	Yes	1	Yes	Naturalistic	Yes
12	Figure	No	No	N/A	Yes	Naturalistic	Yes
13	Whole paper	Yes	Yes	3	Yes	Naturalistic	Yes
14	None	No	No	N/A	Yes	Artificial	Yes
15	Figure	No	No	N/A	Yes	Naturalistic	Yes
16	Whole paper	Yes	Yes	2	Yes	Naturalistic	Yes
17	Paper section	Yes	Yes	2	Yes	Naturalistic	Yes
18	Whole paper	Yes	Yes	4	Yes	Naturalistic	Yes
19	Figure	Yes	Yes	2	Yes	Artificial	Yes
20	None	No	No	N/A	Yes	Naturalistic	Yes
21	Paper Section	No	No	N/A	Yes	Artificial	Yes
22	Table	No	No	N/A	Yes	Artificial	Yes
23	None	No	No	N/A	Yes	Both	Yes
24	Whole paper	No	No	N/A	No	None	Yes
25	None	No	No	N/A	Yes	Artificial	Yes
26	Table	No	No	N/A	Yes	Artificial	Yes
27	Figure	No	No	N/A	No	None	Yes
28	None	No	No	N/A	Yes	Artificial	Yes
29	None	No	No	N/A	Yes	Artificial	Yes
30	None	No	No	N/A	Yes	Artificial	Yes
31	Paper section	No	No	N/A	No	None	Yes
32	Table	No	No	N/A	Yes	Naturalistic	Yes
33	Paper section	No	No	N/A	Yes	Artificial	Yes
34	None	No	No	N/A	Yes	Artificial	Yes
35	Whole paper	Yes	Yes	3	Yes	Both	Yes
36	Table	No	No	N/A	Yes	Artificial	Yes
37	None	No	No	N/A	Yes	Naturalistic	Yes
38	Table	No	Yes	2	Yes	Both	Yes
39	None	No	No	N/A	No	None	Yes
40	None	No	No	N/A	Yes	Artificial	Yes
41	Paper section	No	Yes	3	Yes	Naturalistic	Yes
42	None	No	No	N/A	Yes	Artificial	Yes

Table B1. Concept Matrix (Cont.)

43	Whole paper	No	No	N/A	No	None	Yes
44	Paper section	No	No	N/A	Yes	Artificial	Yes
45	Table	No	No	N/A	Yes	Artificial	Yes
46	None	No	No	N/A	Yes	Naturalistic	Yes
47	Table	No	No	N/A	Yes	Artificial	Yes
48	None	No	No	N/A	Yes	Artificial	Yes
49	Figure	No	No	N/A	Yes	Artificial	Yes
50	None	No	No	N/A	Yes	Artificial	Yes
51	None	No	No	N/A	Yes	Artificial	Yes
52	None	No	No	N/A	Yes	Artificial	Yes
53	Paper section	No	Yes	6	Yes	Naturalistic	Yes
54	None	No	No	N/A	Yes	Both	Yes
55	None	No	Yes	10+	Yes	Artificial	Yes
56	None	No	No	N/A	Yes	Artificial	Yes
57	None	No	No	N/A	Yes	Artificial	Yes
58	None	No	No	N/A	Yes	Artificial	Yes
59	None	No	No	N/A	Yes	Artificial	Yes
60	None	No	No	N/A	Yes	Artificial	Yes
61	None	No	No	N/A	Yes	Naturalistic	Yes
62	None	No	No	N/A	Yes	Artificial	Yes
63	None	No	No	N/A	Yes	Artificial	Yes
64	Paper section	Yes	Yes	3	Yes	Both	Yes
65	None	No	No	N/A	Yes	Both	Yes
66	Paper section	No	No	N/A	Yes	Artificial	Yes
67	Figure	Yes	Yes	3	Yes	Naturalistic	Yes
68	None	No	No	N/A	Yes	Artificial	Yes
69	None	No	No	N/A	Yes	Naturalistic	Yes
70	Paper section	No	No	N/A	Yes	Artificial	Yes
71	None	No	No	N/A	Yes	Artificial	Yes
72	None	No	No	N/A	Yes	Artificial	Yes
73	None	No	No	N/A	Yes	Artificial	Yes
74	None	No	No	N/A	Yes	Artificial	Yes
75	Paper section	No	Yes	6	Yes	Naturalistic	Yes
76	Figure	Yes	Yes	5	Yes	Naturalistic	Yes
77	Table	No	No	N/A	Yes	Artificial	Yes
78	None	No	No	N/A	Yes	Naturalistic	Yes
79	None	No	No	N/A	Yes	Artificial	Yes
80	None	No	No	N/A	Yes	Artificial	Yes
81	None	No	No	N/A	Yes	Artificial	Yes
82	None	No	No	N/A	Yes	Artificial	Yes
83	Paper section	No	No	N/A	Yes	Artificial	Yes
84	None	No	No	N/A	Yes	Artificial	Yes
85	Paper section	No	No	N/A	Yes	Artificial	Yes

Table B1. Concept Matrix (Cont.)

86	None	No	No	N/A	Yes	Artificial	Yes
87	None	No	No	N/A	Yes	Artificial	Yes
88	None	No	No	N/A	Yes	Artificial	Yes
89	Paper section	No	No	N/A	Yes	Artificial	Yes
90	None	No	No	N/A	Yes	Artificial	Yes
91	None	No	No	N/A	Yes	Artificial	Yes
92	None	No	No	N/A	Yes	Naturalistic	Yes
93	None	No	No	N/A	Yes	Artificial	Yes
94	None	No	No	N/A	Yes	Artificial	Yes
95	None	No	Yes	1	Yes	Artificial	Yes
96	None	No	Yes	1	Yes	Naturalistic	Yes
97	Figure	No	Yes	1	Yes	Artificial	Yes
98	None	No	Yes	1	Yes	Both	Yes
99	Paper section	No	No	N/A	Yes	Artificial	Yes
100	None	No	No	N/A	Yes	Naturalistic	Yes
101	Table	No	No	N/A	Yes	Artificial	Yes
102	None	No	No	N/A	Yes	Artificial	Yes
103	None	No	No	N/A	Yes	Artificial	Yes
104	None	No	No	N/A	Yes	Artificial	Yes
105	None	No	No	N/A	Yes	Naturalistic	Yes
106	None	No	No	N/A	Yes	Naturalistic	Yes
107	None	No	No	N/A	Yes	Artificial	Yes
108	None	No	Yes	1	Yes	Naturalistic	Yes
109	None	No	No	N/A	Yes	Artificial	Yes
110	None	No	No	N/A	Yes	Artificial	Yes
111	Paper section	No	No	N/A	Yes	Artificial	Yes

Table B1. Concept Matrix (Cont.)

Paper no.	Theoretical contribution level	Practical impact	Practical impact level	Styles	No. of guiding refs	Guiding references
1	Level 2	Yes	Stage 1: proof of concept	Style 2	2	Hevner et al. (2004), Peffers et al. (2007)
2	Level 2	Yes	Stage 1: proof of concept	Style 1	0	Not stated
3	Level 1	Yes	Stage 1: proof of concept	Style 1	3	Hevner et al. (2004) Hevner & Chatterjee (2010) Peffers et al. (2007)
4	Level 3	Yes	Stage 2: proof of value	Other	2	Sein et al. (2011) Peffers et al. (2007)
5	Level 1	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
6	Level 1	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
7	Level 2	Yes	Stage 1: proof of concept	Style 2	1	Peffers et al. (2007)
8	Level 2	Yes	Stage 2: proof of value	Style 2	1	Sein et al. (2011)
9	Level 2	Yes	Stage 2: proof of value	Style 2	1	Peffers et al. (2007)
10	Level 2	Yes	Stage 1: proof of concept	Style 1	1	March & Smith (1995)
11	Level 2	Yes	Stage 1: proof of concept	Style 1	3	Hevner et al. (2004), Gregor (2006), Hevner (2007)
12	Level 2	Yes	Stage 1: proof of concept	Style 2	2	Checkland & Holwell (1998) March & Smith (1995)
13	Level 2	Yes	Stage 1: proof of concept	Style 3	1	Peffers et al. (2007)
14	Level 1	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
15	Level 2	Yes	Stage 1: proof of concept	Style 2	1	Vaishnavi & Kuechler (2004)
16	Level 2	Yes	Stage 1: proof of concept	Style 3	1	Sein et al. (2011)
17	Level 3	Yes	Stage 2: proof of value	Style 3	1	Sein et al. (2011)
18	Level 2	Yes	Stage 2: proof of value	Style 3	1	Sein et al. (2011)
19	Level 2	Yes	Stage 2: proof of value	Style 3	1	Kuechler & Vaishnavi (2008)
20	Level 2	Yes	Stage 1: proof of concept	Style 1	1	Sein et al. (2011)
21	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
22	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
23	Level 1	Yes	Stage 2: proof of value	Style 1	0	Not stated
24	Level 3	No	None	Style 4	1	Walls et al. (1992)
25	Level 1	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
26	Level 1	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
27	Level 3	Yes	Stage 1: proof of concept	Style 4	2	Dubin (1978) Simon (1976)
28	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
29	Level 2	Yes	Stage 3: proof of use	Style 1	0	Not stated
30	Level 3	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
31	Level 2	No	None	Style 4	1	Walls et al. (1992)
32	Level 2	Yes	Stage 1: proof of concept	Style 2	2	Hevner et al. (2004) Walls et al. (1992)
33	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
34	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
35	Level 2	Yes	Stage 2: proof of value	Style 3	1	Peffers et al. (2007)

Table B1. Concept Matrix (Cont.)

36	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
37	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
38	Level 3	Yes	Stage 2: proof of value	Style 2	2	Hevner et al. (2004) March & Smith (1995)
39	Level 2	Yes	Stage 1: proof of concept	Style 4	0	Not stated
40	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
41	Level 3	Yes	Stage 2: proof of value	Style 2	1	Walls et al. (1992)
42	Level 3	Yes	Stage 2: proof of value	Style 1	0	Not stated
43	Level 3	Yes	Stage 1: proof of concept	Style 4	1	Gregor & Jones (2007)
44	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
45	Level 3	Yes	Stage 1: proof of concept	Style 2	1	Gregor & Jones (2007)
46	Level 2	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
47	Level 3	Yes	Stage 1: proof of concept	Style 2	2	Walls et al. (1992) Walls et al. (2004)
48	Level 1	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
49	Level 3	Yes	Stage 1: proof of concept	Style 2	1	Gregor & Jones (2007)
50	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
51	Level 2	Yes	Stage 2: proof of value	Style 1	1	vom Brocke et al. (2013)
52	Level 1	Yes	Stage 1: proof of concept	Style 1	1	March & Smith (1995)
53	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner (2007)
54	Level 2	Yes	Stage 3: proof of use	Style 1	3	Hevner et al. (2004) Hevner & Chatterjee (2010) March & Smith (1995)
55	Level 2	Yes	Stage 1: proof of concept	Style 1	1	Hevner & Chatterjee (2010)
56	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
57	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
58	Level 2	Yes	Stage 1: proof of concept	Style 1	3	Hevner et al. (2004) March & Smith (1995) Peffers et al. (2007)
59	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
60	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
61	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
62	Level 2	Yes	Stage 2: proof of value	Style 1	1	Nunamaker et al. (1990)
63	Level 3	Yes	Stage 2: proof of value	Style 1	0	Not stated
64	Level 3	Yes	Stage 2: proof of value	Style 3	1	Holmström et al. (2009)
65	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
66	Level 1	Yes	Stage 1: proof of concept	Style 2	1	Nunamaker et al. (2017)
67	Level 2	Yes	Stage 1: proof of concept	Style 3	1	Hevner (2007)
68	Level 2	Yes	Stage 1: proof of concept	Style 1	0	Not stated
69	Level 2	Yes	Stage 1: proof of concept	Style 1	0	Not stated
70	Level 2	Yes	Stage 1: proof of concept	Style 2	2	Peffers et al. (2007) Hevner et al. (2004)
71	Level 2	Yes	Stage 1: proof of concept	Style 1	0	Not stated
72	Level 1	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
73	Level 2	Yes	Stage 2: proof of value	Style 1	2	Hevner et al. (2004) Peffers et al. (2007)

Table B1. Concept Matrix (Cont.)

74	Level 2	Yes	Stage 3: proof of use	Style 1	3	Gregor & Jones (2007) Gregor & Hevner (2013) Nunamaker et al. (1990)
75	Level 2	Yes	Stage 1: proof of concept	Style 2	1	Peffers et al. (2007)
76	Level 2	Yes	Stage 2: proof of value	Style 3	1	Sein et al. (2011)
77	Level 2	Yes	Stage 1: proof of concept	Style 2	1	Walls et al. (1992)
78	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
79	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
80	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
81	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
82	Level 2	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
83	Level 2	Yes	Stage 1: proof of concept	Style 2	1	Hevner et al. (2004)
84	Level 2	Yes	Stage 2: proof of value	Style 1	1	Not stated
85	Level 2	Yes	Stage 1: proof of concept	Style 2	1	Hevner et al. (2004)
86	Level 2	Yes	Stage 2: proof of value	Style 1	3	Hevner et al. (2004) Peffers et al. (2007) Purao et al. (2008)
87	Level 1	Yes	Stage 1: proof of concept	Style 1	1	Peffers et al. (2007)
88	Level 1	Yes	Stage 2: proof of value	Style 1	3	Hevner et al. (2004) March & Storey (2008) Peffers et al. (2007)
89	Level 1	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
90	Level 1	Yes	Stage 2: proof of value	Style 1	2	Gregor & Hevner (2013) Hevner et al. (2004)
91	Level 1	Yes	Stage 1: proof of concept	Style 1	1	Peffers et al. (2007)
92	Level 3	Yes	Stage 3: proof of value	Style 1	1	Walls et al. (1992)
93	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
94	Level 3	Yes	Stage 2: proof of value	Style 1	1	Baskerville et al. (2009)
95	Level 1	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
96	Level 3	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)
97	Level 1	Yes	Stage 1: proof of concept	Style 2	1	Peffers et al. (2007)
98	Level 1	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
99	Level 1	Yes	Stage 1: proof of concept	Style 2	1	Gregor & Jones (2007)
100	Level 2	Yes	Stage 1: proof of concept	Style 1	1	Vaishnavi & Kuechler (2008)
101	Level 2	Yes	Stage 2: proof of value	Style 2	1	Hevner et al. (2004)
102	Level 2	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
103	Level 2	Yes	Stage 2: proof of value	Style 1	2	Walls et al. (1992) Gregor & Jones (2007)
104	Level 1	Yes	Stage 2: proof of value	Style 1	4	Gregor & Hevner (2013) Peffers et al. (2007) Straub & Ang (2011) Hevner et al. (2004)
105	Level 2	Yes	Stage 2: proof of value	Style 1	1	Peffers et al. (2007)
106	Level 2	Yes	Stage 2: proof of value	Style 1	0	Not stated
107	Level 1	Yes	Stage 2: proof of value	Style 1	1	Hevner et al. (2004)
108	Level 2	Yes	Stage 1: proof of concept	Style 1	1	Hevner et al. (2004)

Table B1. Concept Matrix (Cont.)

109	Level 2	Yes	Stage 1: proof of concept	Style 1	5	March & Smith (1995) Hevner et al. (2004) Gregor (2006) Peffers et al. (2007) Goes (2014)
110	Level 2	Yes	Stage 1: proof of concept	Style 1	0	Not stated
111	Level 2	Yes	Stage 2: proof of value	Style 2	1	Sein et al. (2011)

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David Sammon is a Professor of Information Systems who operates according to the principle that “if you can’t draw it, you don’t understand it!” In more recent times, his applied research interests are focusing on seeing the opportunity in data through the use of relational data modeling. He is also co-Founder of the Data Value Innovation Group, helping organizations to deliver value from their data through data value mapping. The Data Value Map (http://datavaluemap.com) is a visual discursive template for building shared understanding around data initiatives.