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# The Research Method we Need or Deserve? A Literature Review of the Design Science Research Landscape

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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.

This manuscript underwent peer review. It was received 4/10/2020 and was with the authors for 16 months for three revisions. Tuure Tuunanen served as Associate Editor.

# 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)<br>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)).<br>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.<br>Level 2: nascent design theory—knowledge as operational principles/architecture. Constructs, methods, models, design principles, and technological rules.<br>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.<br>Stage 2 (proof of value): measure an artefact's efficacy and efficiency in solving the problem.<br>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).

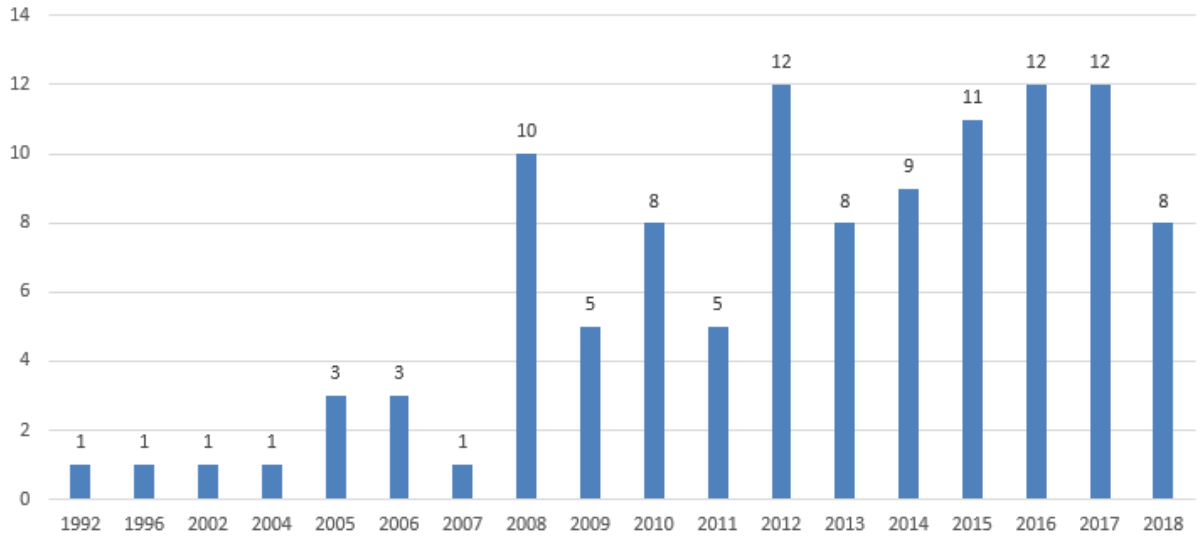


**Figure 1.DSR Papers by Year**

## 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.

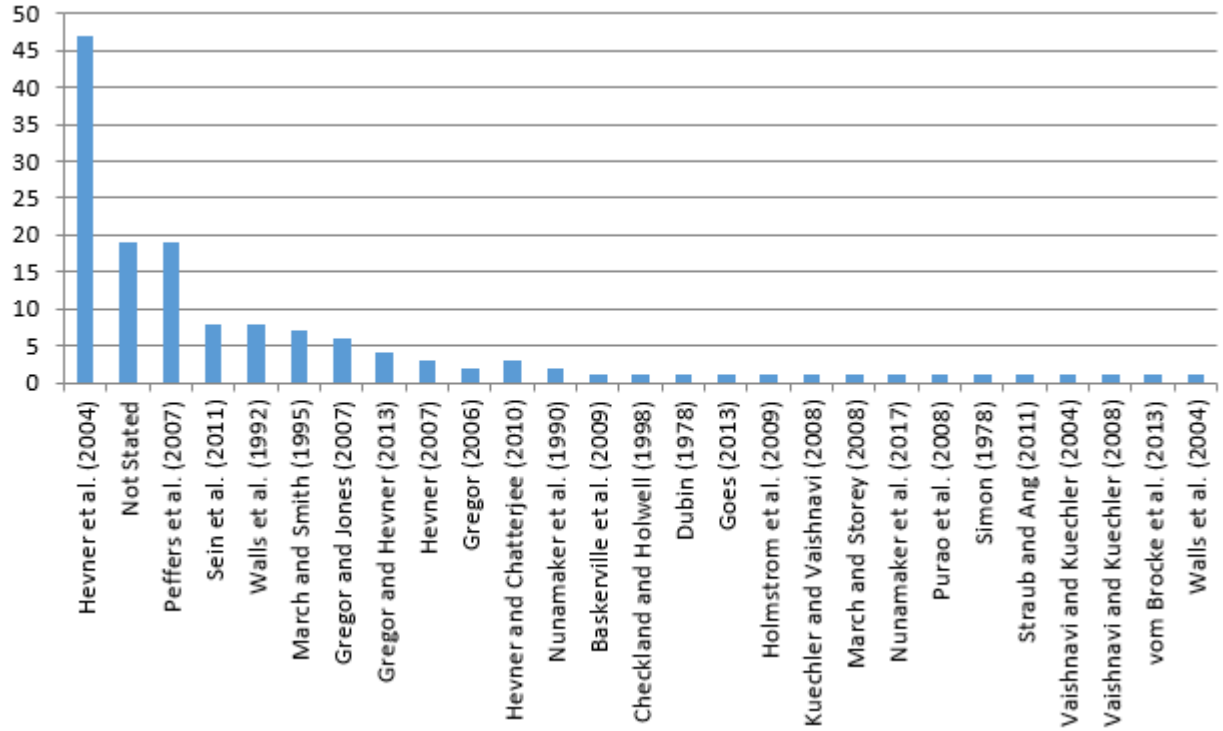


**Figure 1.DSR References Used**

**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.

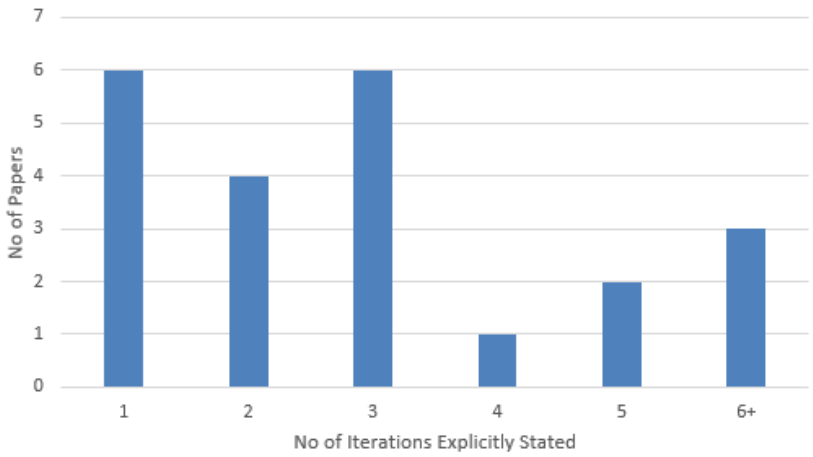


**Figure 3. Number of Design Cycles Used in the Study**

### 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**<br>(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**<br>(9, 10, 11, 12, 13, 15, 32, 37, 41, 46, 53, 61, 67, 69, 75, 78, 96, 100, 105, 106, 108) | **6 papers**<br>(23, 35, 38, 54, 64, 98) | **4 papers**<br>(24, 27, 31, 43) | 96 |
| **Strategy 2** | **5 papers**<br>(29, 34, 87, 104, 111) | **7 papers**<br>(8, 16, 17, 18, 20, 76, 92) | **1 paper**<br>(65) | **1 paper**<br>(39) | 14 |
| **Both** | | | **1 paper**<br>(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)<br>Hevner & Chatterjee (2010)<br>Peffers et al. (2007) |
| 4 | Level 3 | Yes | Stage 2: proof of value | Other | 2 | Sein et al. (2011)<br>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)<br>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)<br>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)<br>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)<br>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)<br>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)<br>Hevner & Chatterjee (2010)<br>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)<br>March & Smith (1995)<br>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)<br>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)<br>Peffers et al. (2007) |

**Table B1. Concept Matrix (Cont.)**

| | | | | | | |
|---|---|---|---|---|---|---|
| 74 | Level 2 | Yes | Stage 3: proof of use | Style 1 | 3 | Gregor & Jones (2007)<br>Gregor & Hevner (2013)<br>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)<br>Peffers et al. (2007)<br>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)<br>March & Storey (2008)<br>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)<br>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)<br>Gregor & Jones (2007) |
| 104 | Level 1 | Yes | Stage 2: proof of value | Style 1 | 4 | Gregor & Hevner (2013)<br>Peffers et al. (2007)<br>Straub & Ang (2011)<br>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)<br>Hevner et al. (2004)<br>Gregor (2006)<br>Peffers et al. (2007)<br>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) |

## About the Authors

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**Cathal Doyle** is a lecturer in Information Systems at the School of Information Management, Wellington School of Business and Government. His research covers: design science research (DSR); technology and learning; and open science. He contribute to these areas from a foundational perspective which includes looking at how to improve the relevance of DSR, especially in making it available to IS professionals, and how IS researchers can introduce open science practices to their research.

**Ibrahim Mohammed Alhassan** is an Assistant Professor of Business Information Systems specializing in data governance planning and implementation, with more than 14 years of wide-range experience in managing several digital transformation projects in the banking and other sectors. Interested in digital marketing as well as implementation of e-business models. Academically, he has published several publications on data governance activities and implementation in leading journals.

**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.

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