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Abstract:

There has been a concerted effort by Senior Scholars to support the successful adoption and publication of Design Science Research (DSR) in top-ranked Information Systems journals. However, DSR is underperforming, and the support by Senior Scholars in the form of editorials and exemplars have provided confusion as well as clarity. Conducting a descriptive literature review, this study sets out to bring empirical context and insight to the many Senior Scholar discussions on the presentation, implementation, and contributions of DSR. Reviewing 111 articles in the AIS Senior Scholars' Basket the study finds significant transparency issues that have lead to methodological slurring. The study also finds that while DSR has produced research with a strong focus on utility and usefulness, it does so through generalized problems and solutions, which overlooks the messy complexity of real IS problems and the actual use of proposed solutions. Finally, there is little evidence to support a 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.

[Department statements, if appropriate, will be added by the editors. Teaching cases and panel reports will have a statement, which is also added by the editors.]

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1 Introduction

At a time when the IS domain is viewed as being fixated on theory to the point it is an unhealthy obsession, and one of the major challenges facing the field (Dennis, 2019; Hirschheim, 2019), Design Science Research (DSR) is seen as a potential pathway to becoming a driver of leading technology innovation, that balances both rigour and relevance (Baskerville, Baiyere, Gregor, Hevner, & Rossi, 2018). With design being fundamental to IS (March & Storey, 2008), DSR is seen as a natural fit for IS research with recognised attributes that include problem led, artefact creation, a bridge between practice and theory (Holmström, Ketokivi, & Hameri, 2009), and strong potential to balance the rigour and relevance of IS studies (Hevner, 2007).

Furthermore, given that DSR's "raison d'être, (is) the development of artefacts that can be applied as the solution of real-world problems" (Peppers, Tuunanen, & Niehaves, 2018, p.129), its suitability for achieving such a task for the IS community is inherently feasible. Indeed, its recent promotion as the go-to research methodology for IS problem solving is further supported by its positioning "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).

Fostering the adoption of the methodology, many position articles and editorials have provided guidance and support for conducting and positioning DSR studies (c.f. Baskerville, 2008; Baskerville et al., 2018; Baskerville, Kaul, Pries-Heje, & Storey, 2019; March & Storey, 2008; Peppers 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" (Peppers et al., 2018, p.129-130). This indicates that DSR has moved beyond the need for methodological direction but still requires more empirical studies as it evolves and matures within the IS community. Indeed, it is noted that "DSR researchers 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" (Peppers et al., 2018, p.130). However, it is also noted that researchers have found it difficult to publish DSR studies, partly because of the multiple guidelines and partly because of the undifferentiated nature of DSR studies that make them problematic for reviewers (Peppers et al., 2018). Aligned with these observations, there is the view that despite its "pronounced value" for the IS community, there is a lack of DSR empirical studies in highly ranked journals (Baskerville et al., 2018, p.358), notwithstanding three special issues dedicated to publishing exemplars of empirical DSR studies in the Senior Scholars' Basket (SSB): (i) EJIS – 2008, (ii) MISQ – 2008, and (iii) EJIS 2018.

In light of this challenge, this study conducts a descriptive literature review (c.f. Paré, Trudel, Jaana, & Kitsiou, 2015) of all empirical DSR studies published (111 in total) until December 2018 in the Senior Scholars' Basket. Conscious of the existing body of methodological articles and editorials on DSR, this study aims to bring empirical context and insight to the many Senior Scholar discussions on the presentation, implementation, and contributions of DSR. In addition, accompanying this study is an open dataset of the literature analysis and the coding matrix for future studies to leverage and build upon. Finally, the focus of this analysis is bounded within the scope of the following three research questions:

RQ1 – How is Design Science Research presented?

RQ2 – How are Design Science Research studies conducted?

RQ3 – What are the impacts reported in Design Science Research studies?

2 Literature Review Methodology

From the first step, this literature review was conducted with an explicit motivation to make every aspect open and transparent to the community. To this end, a number of outputs have been developed as a basis for rigorous interrogation and a strong foundation for objective reflection. These outputs include: the literature review process (Table 1), the search strategy results (Appendix A), the coding scheme developed over seven iterations (Table 2), and the concept centric matrix (AppendixB – attached to submission). To successfully achieve this open strategy, every decision (step and analysis) was scrutinized 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, Furtmueller, & Wilderom, 2013), this study follows

a four-phase sequential approach: 1. Selecting the Sources; 2. Search Strategy; 3. Coding Schemes; and 4. Review Articles (see Table 1 for a summary). Each phase is explained in more detail over the following sections, starting with 'selecting the sources'.

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 a query of the key search terms	No. of Articles: 561
	Iteration 2: Reviewed each returned article, identifying ones that contain any of the keywords in their "title", "abstract", "keywords", or "body" section. Removed articles that (i) were not relevant to the key search terms, (ii) only referenced other studies that use the key search terms.	No. of Articles: 229
	Iteration 3: Focused on articles that document an empirical study and explicitly state they follow DSR.	No. of Articles: 111
3. Coding Schemes	Developed a coding scheme over seven iterations to achieve maximum (i) accuracy in describing each DSR instance and (ii) consistency in coding across the instances.	See Table 2.
4. Review Articles	For added rigor, each paper was coded by two researchers with any conflicts resolved during follow up review sessions. The results were documented in a concept centric matrix.	Created an extensive Concept Centric Matrix. (Appendix B – attached to submission)

1. Selecting the Sources: The Senior Scholars' Basket (SSB) was chosen as a scoping device as it has been regularly accepted in the past (c.f. Prat, Comyn-Wattiau, & Akoka, 2015), given that the list is used extensively to measure productivity in the IS community (Tremblay, VanderMeer, & Beck, 2018). Furthermore, with the aim of setting a DSR quality standard, these journals focus on publishing 'exemplars' for researchers to emulate and editorials for researchers to follow (c.f. Baskerville et al., 2018; Goes, 2014; livari, 2020; Peffers et al., 2018). Furthermore, it is within these journals that many of the DSR discussions around aspects such as design theory are published (c.f. livari, 2020). It has been argued that the SSB sets an artificial constraint on the selection of sources (Jennex, 2015), however, in the case of this study, it is the above-mentioned exemplar benchmark that we specifically aim to examine, which has been shown to influence the shape of DSR in the wider IS community (Tremblay et al., 2018).

2. Search Strategy: First, a list of search strings relating to the domain of interest was identified and used to search each source to create a pool of articles to be reviewed. The search strings included: "design science", "design science research", "design theory", "design science approach", "action design research", "ADR", and "DSR". As this study focuses on how DSR is conducted it includes "Action Design Research" as a design research method (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011), and authors who conduct ADR may not otherwise refer to design science in their article. We have also purposefully not added the string "design principles" as they can be developed without conducting DSR. Each SSB journal website was then searched with these strings from their inception until December 2018, where 561 articles were returned (the AIS eLibrary was used for MISQ as their website does not allow for multiple search strings to be added).

To determine if each article is relevant to the research objective, a more detailed review was conducted. This was done by opening each article and searching for the identified strings, and removing articles that (i) were not relevant to any of the search strings, (ii) only referenced other studies that use the search strings.

For example, some articles contained the term “*design science*” but talked about the IS research landscape in general terms. This reduced the pool of articles to 229.

Next, as the focus is on empirical DSR articles, the pool was reviewed for empirical vs non-empirical DSR studies, where empirical studies are ones that explicitly state they are conducting DSR. This was done by three researchers, where six batches of the 229 articles were created, with each batch being individually reviewed by two researchers. Researcher triangulation was a constant aspect of the methodology that involved frequent meetings to ensure consistency/agreement (while there was a high degree of agreement, in some cases, further discussion was necessary to reach an agreement). This resulted in a pool of 110 articles.

Given that each journal website (and AIS eLibrary for MISQ) was used to search for articles, to ensure coverage completeness and replicability of the search strategy, the search strategy was also executed using the Web of Science. Each journal was searched on the Web of Science with the same search strings, and the results of each were compared with the already gathered articles. This resulted in 1 additional empirical DSR article being identified that did not get returned in the original search, giving a total pool of 111 empirical DSR articles to be reviewed.

3.Coding Schemes: To maximize accuracy and consistency, a coding scheme was developed over seven iterations to help answer the research questions outlined earlier. This involved taking a random sample of 12 articles from the pool, with three researchers reviewing them using an initial set of codes. During this process, several classifications/codes were found to be unsuitable due to the vagueness of their definition (e.g. DSR genres and inference type), leading to highly inconsistent analysis output. Having validated and triangulated a range of codes, these well-defined codes and rules were applied across the 111 articles.

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 an artefact is developed and evaluated against a problem instance (problem class to instance implementation) 2. Specific problem experienced by a client from which a solution is developed as well as learnings generalised against a problem class (problem instance to generalised learnings).	(Iivari, 2015)
Evaluation (RQ1, RQ2)	Naturalistic - natural environment (case-study, focus group, participant observation, ethnography, phenomenology, survey (qualitative, quantitative)). Artificial - Mathematical/Logical proof, lab experiment, role-playing simulation, computer simulation, field experiment.	(Venable et al., 2016)
Knowledge Contribution Level (RQ1, RQ3)	Level 1 - Situated implementation of the artefact. Instantiations (software products or implemented processes). There could be two types of instantiations. An instantiation that is implemented for real, or an instantiation that is implemented just for the purpose of the study but doesn't exist outside of the study Level 2 - Nascent design theory—knowledge as operational principles/architecture. Constructs, methods, models, design principles, and technological rules. Level 3 - Well-developed design theory about embedded phenomena. Design theories (mid-range and grand theories)	(Gregor & Hevner, 2013)
Practical Impact Stage (RQ1, RQ3)	Stage 1: Proof-of-concept - establish viability and feasibility of artefact as a solution to the problem Stage 2: Proof-of-value - measure the efficacy and efficiency of artefact in solving the problem Stage 3: Proof-of-use - create self-sustaining and growing communities of practice around the artefact	(Nunamaker et al., 2015)

The coding scheme included the two strategies of DSR by Iivari (2015) to help understand whether studies were identifying problems in the literature or practice; DSR evaluation types by Venable, Pries-Heje, and Baskerville (2016) to understand if studies were evaluating their artefacts in a natural or artificial environment; level of theoretical contribution(s) by Gregor and Hevner (2013) to understand at what level studies were making contributions; and practical impact stages by Nunamaker, Briggs, Derrick, and

Schwabe (2015) to understand at what stage an artefact was being used. Presented in Table 2 is the final coding scheme used to review the 111 articles and the codes relevance to each research question. Furthermore, additional detail on the codes utilized is outlined the approach sections below.

4. Review Articles: The coding scheme was then used to review the pool of 111 articles. We adopted the open coding technique from Strauss and Corbin (1990) for the review, which is widely applied in conducting content analysis as part of a literature review (Finney & Corbett, 2007; Goode & Gregor, 2009; Grahlmann, Helms, Hilhorst, Brinkkemper, & Van Amerongen, 2012; Alhassan, Sammon, & Daly, 2018). We organized the coding using a concept-centric matrix (c.f. Webster & Watson, 2002) where the predefined codes from Table 2 were used as concepts.

Having initially applied the scheme to a random sample of 12 articles from the pool of 111, the other 99 articles were divided into six batches, where two researchers were assigned to each batch. The motivation for having two researchers code each article was to ensure inter-coder reliability and increase the output's accuracy and consistency. The coding procedures were conducted in an iterative fashion, where the researchers reviewed their assigned batches individually, then, met to compare their coding for accuracy and consistency. In the cases where there was disagreement about the coded outputs for an article, discussions to reach a consensus took place. This ensured that each of the 111 articles was coded appropriately to fulfill the research objective.

3 Analysis and Findings

The analysis and findings follow the research questions using the structure of (i) approach, (ii) findings, and (iii) implications (c.f. Poeppelbuss, Niehaves, Simons, & Becker, 2011). The 'approach' describes how the DSR articles were analyzed, while the 'findings' outlines the analysis and resulting key insights. Finally, the potential implications of the 'findings' are detailed. Figure 1 presents the articles analyzed over the 26-year period and highlights the frequency of articles per year. Of note is the significant jump in publications in 2008, which coincides with two special issues but also comes after the publication of two of the most cited DSR methodological articles, as presented in Figure 2 (Hevner, March, Park, & Ram, 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

Figure 1. DSR articles by year

3.1 RQ 1 - How is Design Science Research presented?

3.1.1 Approach

Each empirical article was coded for explicit evidence of seven components of a DSR study. These components were developed iteratively during step three of the process above and were the most parsimonious in achieving the objective. These included: (i) *problem*, (ii) *artefact*, (iii) *DSR process*

adherence, (iv) *iterative design*, (v) *evaluation*, (vi) *practical impact*, and (vii) *knowledge contribution*. To get an understanding of DSR presentation, each component was coded for its existence (either Yes or No) which was grouped into “Styles” of presentation (see Table 3 and Table 4). Furthermore, DSR process adherence and iterative design were further analyzed, given they generate the most variance in terms of styles. The problem, evaluation, practical impact and knowledge contribution were also further analyzed in research question 2 and 3.

3.1.2 Findings

As depicted in Table 3, most variation in the presentation of the empirical problem-solving studies focus on three key aspects: (i) DSR Process Adherence, (ii) Iterative Design, and (iii) Evaluation, which align with the core build, iterate and evaluate (BIE) stages of DSR (c.f. Sein & Rossi, 2019). The most dominant presentation style (Style 1) presents the empirical study without including (i) how the DSR process was adhered to, and (ii) the iterative design of the artefact(s). The second most dominant style (Style 2) includes all aspects except for the iterative design of the artefact(s). In this style, author(s) focus mainly on the evaluation of their artefact (s), where they present the final version with little to no insight into previous iterations or knowledge built along the way (c.f. Kloör, Monhof, Beverungen, & Braäer, 2017). In contrast to the other two styles, Style 3 presents all seven components of a DSR study and demonstrates some clearly defined techniques on how to do so (c.f. Ebel, Bretschneider, & Leimeister, 2016). The existence of this style highlights the possibility of overcoming some of the challenges posed by journal editorial/publishing guidelines (e.g. word and page counts). The final style (Style 4) omits (i) Iterative Design and (ii) Evaluation. For example, Chatterjee, Sarker, and Fuller (2009) explain how their artefact was developed but do not evaluate it. Müller-Wienbergen, Müller, Seidel, and Becker (2011) go a step further as they do not evaluate their artefact but instead offer an expository instantiation of it and propose how it could be empirically evaluated in the future.

Table 3. Evidence of DSR components in Senior Scholars’ Basket articles

	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

Table 4. Examples of articles that use the different styles

Style	Examples
Style1	Cheng, Fu, and Druckenmiller (2016), Lang, Shang, and Vragov (2015), Kolfshoten and De Vreede (2009), Breuker, Matzner, Delfmann, and Becker (2016), VanderMeer, Dutta, and Datta (2012), Provost, Martens, and Murray (2015)
Style 2	Kloör et al. (2017), Storey, Burton-Jones, Sugumaran, and Purao (2008), Currim and Ram (2012),
Style 3	Ebel et al. (2016), Peters, Blohm, and Leimeister (2015), Lycett and Radwan (2018), Spagnoletti, Resca, and Lee (2015),
Style 4	Müller-Wienbergen et al. (2011), Kasper (1996), Walls, Widmeyer, and ElSway (1992)

Guiding References

The view that published DSR research is skewed towards non-empirical work focusing on guidelines (Peffers et al., 2018) is not a focus of this study, however, in the 111 articles analysed, 26 different processes (that were explicitly cited as being followed e.g. 'we conducted our study in line with'), somewhat supports the assertion that a variety of published DSR guidelines exist. Nonetheless, further analysis of the processes referenced reveals that 15 of the references are cited just once, depicting a long-tail of guiding processes, with the top 6 DSR processes making up almost 80% of the citations (see Figure 1). At the head of the longtail is: (i) Hevner et al. (2004) referenced by 47 articles, (ii) Peffers et al. (2007, 2008) referenced by 19 articles, (iii) Sein et al. (2011) referenced by 8 articles, and (iv) Walls et al. (1992) also referenced by 8 articles. What is also interesting is that 19 articles do not state a guiding reference. DSR process pluralism is also common among the SSB articles, with 20 articles citing more than one guiding reference with numerous articles citing 3, 4 and 5 guiding references. This may highlight a natural overlapping in DSR, especially when one views Hevner et al. (2004) as a set of principles and not a process. However, what is interesting to note is that all Style 3 articles have only one guiding process.

Figure 1. DSR references used

Presentation of DSR Adherence

Presenting DSR process adherence can be done in a number of ways (see Table 5). A number of articles use a DSR process model to structure their article (as suggested by Peffers et al. (2007)). For example, Ebel et al. (2016) (Style 3) explain they are adopting action design research (ADR) (c.f. Sein et al., 2011) as the approach for their study and provide their understanding of it; they then use each step in this process model to help structure their article (adherence) starting with the problem formulation; this is followed by the iterative loops of design, build, and evaluate, of their artefact.

Table 5. Ways of presenting DSR adherence

DSR Adherence Presentation	No. of Articles	Example
Full Article (uses the process model to structure the paper)	6	Seidel, Chandra Kruse, Székely, Gau, and Stieger (2018), Hustad and Olsen (2014), Hariharan et al. (2017)
Article Section (section or paragraph set aside to outline how the process was adhered to)	17	Mastrogiacomo, Missonier, and Bonazzi (2014), Giessmann and Legner (2016)
Visual Representation (e.g figure or table)	20	Spagnoletti et al. (2015), Lycett and Radwan (2018), Storey et al. (2008)

Lycett and Radwan (2018) present a figure in their article that highlights the process model they follow (Kuechler & Vaishnavi, 2008) which directly maps their research to that process model (see Table 5). Peters et al. (2015) and Spagnoletti et al. (2015) follow a similar approach. Interestingly, Storey et al. (2008) follow the seven guidelines offered by Hevner et al. (2004) and went as far as summarizing their contributions to each of these guidelines in a table, which is replicated by several other studies. Mastrogiacomo et al. (2014) use a section to explain their adherence, while Giessmann and Legner (2016) use a paper section that includes a figure and a table to explain their adherence. Finally, an interesting development which was identified in Currim and Ram (2012) is the use of an electronic appendix (or external source) to provide a guidance adherence presentation.

Non-Presentation of DSR Adherence

As seen in Table 3, Style 1 is the most dominant presentation style and consists of the author(s) presenting five of the seven components of a DSR study, such as stating a problem and introducing an artefact but excludes (i) how the DSR process was adhered to, and (ii) the iterative design of the artefact. In fact, 18 of the 66 articles do not state the DSR process model they followed but still indicate they are conducting a DSR study, which supports the call by Baskerville et al. (2018, p.360) to “use a reference process for guidance in performing the research”.

This manifested in a few different ways. For example, Fridgen, König, Häfner, and Sachs (2016) indicate in their abstract that they are following a DSR approach; they add “Design Science Research” as a keyword, and state in their article that they are “Rigorously following a DSR methodology” (p.540) but do not explicitly state which methodology they are applying. Datta, Dutta, Liang, and VanderMeer (2012) state they are following a design science approach but do not refer to a method or DSR, at any other point in their article, as do Nunamaker, Derrick, Elkins, Burgoon, and Patton (2011). This lack of transparency poses a challenge for the IS community, where this approach to presenting DSR could be seen as an exemplar.

There were also instances like Kolfshoten and De Vreede (2009), who explain they are following a DSR approach, explain what DSR is, but don't mention what process model they are applying. Lastly, there are several instances where authors state they are conducting DSR and cite authors like Hevner et al. (2004) or Gregor and Hevner (2013) but don't actually state what DSR process model they follow. 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, X. Li, Sun, Chen, Fung, and Wang (2015, p.281) also indicate they are following “the design science paradigm” and cite Hevner et al. (2004), but it is not obvious that they are following the guidelines they offer.

Iterative Design

As depicted in Figure 3, 22 articles explicitly call out the number of iterations they go through in their DSR study (c.f. Parsons & Wand, 2008; Pries-Heje & Baskerville, 2008; VanderMeer et al., 2012). However, only ten of those present 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) use a table. Peters et al. (2015) use a section to talk through their design cycles and used a table to represent the outcomes. Lycett and Radwan (2018) describe their design cycles over a number of sections, as did Mastrogiacomo et al. (2014). The lack of iterative design is most prevalent in Style 2, given that it's the only component missing. That is to say, while all of them have evaluation (be it artificial, naturalistic, or both), none of them show the design cycles their artefacts went through, while only

three of the ten indicate the number of design cycles they completed. For example, Abbasi, Zhou, Deng, and Zhang (2018) introduce their artefact and then spend the rest of the article evaluating it through a number of experiments but do not show the evolution of the artefact, or any learning that occurred in these iterations. This fails to show the emergence of the artefact that is characteristic of DSR given its iterative nature.

Figure 3. Number of design cycles used in the study

3.1.3 Discussion

Living up to the promise of solving problems that lead to contributions in both practical and theoretical IS fields, 109 of 111 articles present the: (i) problem, (ii) artefact, (iii) practical impact, and (iv) knowledge contribution as part of their study. In addition, while the existence of Style 3 demonstrates it is possible to present all aspects in a single article, its prevalence is relatively small (9 out of 111 articles). The most significant gap in the presentation is how the DSR process was applied and the iterative nature of solving the problem or building the artefact. Across all the articles analyzed, 101 do not present an iterative design. In terms of IS development, this lack of transparency could be described as a “black box” approach that involves presenting the final artefact and moving straight to evaluation. Indeed, this can be viewed 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, the use of appendices (a useful technique to streamline the reader's experience) was also included in our analysis but was rarely used. As a result, much of the richness that could be reported in these cycles is lost while also failing to provide readers with a clear understanding of how the final artefact was arrived at. Indeed, Baskerville et al. (2019) refer to a creativity oversight whereby the audience is losing out on insights into design decisions made by researchers as they get to grips with the problem and build an effective solution. In addition, given the significant differences in processes, the omission of what specific DSR process followed makes it difficult to replicate the rigor within these studies and produce increasing levels of quality DSR. For instance, five articles do not detail their evaluation, of which three indicate a proof-of-concept.

There will always be a necessary spectrum of adherence (e.g. rigid application to innovative freestyle), and given the design focus of DSR researchers it is natural they will apply that focus to DSR itself. However, if not presented transparently, it lessens the importance of methodological specificity (Baker, Wuest, & Stern, 1992). Indeed, the evidence highlighted 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 fulfil the requirements of the method (Stol, Ralph, & Fitzgerald, 2016). The popularity of (Hevner et al., 2004) as a guiding reference indicates the prevalence of this pattern, as researchers present a subset of DSR principles as testament of their adherence but fail to incorporate core components DSR. Conversely, our findings could highlight a practice of ‘rational reconstruction’ (Pedersen, 2008) or presentation of an idealized design process (Parnas & Clements, 1986), which selectively omits aspects of the study. However, this interpretation overlooks the criticality of the components omitted (e.g. the guiding process itself), which severely stretches the concept of rational construction but opens the potential for retrospective

methodological reframing. Indeed, adapting research methods a posteriori was pointed out by Avison et al. (2018) in a review of Action Research. In particular, their research highlighted that scholars specifically reported their work as DS to enhance the possibility of publication in top ranked journals. 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 are Design Science Research studies conducted?

3.2.1 Approach

We adopt the livari (2015) dichotomy of: (i) Strategy 1, and (ii) Strategy 2 to define the type of DSR strategies undertaken. Strategy 1 describes a process that starts with a problem class, informed by literature and past research, which justifies the development of an artefact (solution). This does not imply that the problem is not rooted in practice but does highlight an availability of past research to generalize the problem. The resulting artefact is then implemented against an instance of the problem for evaluation. For Strategy 2, the starting point is a specific problem currently experienced by a real client (c.f. Sun & Kantor, 2006), which motivates the development of an artefact to solve that specific problem instance. The knowledge that is generated during this process is generalized for a wider impact. Furthermore, the type of evaluation is analyzed in order to give additional insight into how the studies were conducted. In line with Venable et al. (2016), two types of evaluation are coded: (i) artificial - mathematical/logical proof, lab experiment, role-playing simulation, computer simulation, field experiment, and (ii) naturalistic - completed in the natural/real environment that embraces all of the complexities of human practice in real organisations (case-study, focus group, participant observation, ethnography, phenomenology, survey (qualitative, quantitative)).

3.2.2 Findings

Depicted in Table 6, the majority of DSR projects analyzed (96 in total) are classed as Strategy 1. These are studies that begin by defining a problem class and use DSR to build an artefact that is evaluated against a chosen instance of that problem. Problems are sourced from literature, inferencing is deductive, and a real-world client is not necessarily associated. Out of the remaining 15 projects, 14 are classed as Strategy 2 and begin with a description of a problem instance that a real-world client faces and builds an artefact to solve that particular instance, generalizing the emergent/inductive knowledge gained throughout the problem-solving process. The first Strategy 2 article identified is that of Markus, Majchrzak, and Gasser (2002), with the strategy later popularized by Sein et al. (2011), after which 12 can be identified. Of the 111, only one article failed to fall into one of the two strategies. This article, Coenen et al. (2018), explicitly states that it follows both strategies.

Table 6. Design Science Research strategies (numbers identify DSR articles in the data file attached)

	Artificial Evaluations	Naturalistic evaluations	Both	None	Total
Strategy 1	65 articles (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 articles (9,10,11,12,13,15,32,37,41,46,53,61,67,69,75,78,96,100, 105, 106,108)	6 articles (23,35,38,54,64,98)	4 articles (24,27,31,43)	96
Strategy 2	5 articles (29,34,87,104,111)	7 articles (8,16,17,18,20,76, 92)	1 article (65)	1 article (39)	14
Both			1 article (4)		1

From an evaluation perspective, there is a strong preference towards artificial evaluations over naturalistic with a count of 70 artificial to 28 naturalistic (see Table 7 for examples). However, this is not to underestimate the efforts by researchers in designing evaluations to incorporate realistic characteristics. For instance, Pentland, Twyman, Burgoon, Nunamaker Jr, and Diller (2017) note their evaluation was “elaborately planned with the goal of increasing realism” (p. 978), and many researchers used simulations, which are often based on real-world data (c.f. Piel, Hamann, Koukal, & Breitner, 2017). However, researchers have noted the limitation of simulations and real data sets. Specifically, Wang, Ipeirotis, and Provost (2017) note

that simulations are unlikely to hold up in “real-world” settings (p. 149), and while a number of studies don’t go beyond simulations (c.f. Soffer, Wand, & Kaner, 2015), they go on to incorporate real-world data sets. However, as called out by Ghiassi, Zimbira, and Lee (2016), even though real data sets may seem large, they are still often 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	Given the nature of the innovative method/theoretical/model artefacts developed, simulations are needed to create an effective evaluation environment. These simulations are often a stepping-stone to further evaluations. (c.f. Wang 2017).	Brandt, Feuerriegel, and Neumann (2018), (Cascavilla, Conti, Schwartz, & Yahav, 2018), Soffer et al. (2015)
	Interviews of experts	Interviews on potential usage but they would not have used it.	Adomavicius, Bockstedt, Gupta, and Kauffman (2008), D'aubeterre, Singh, and Iyer (2008), Babaian, Xu, and Lucas (2018)
	Historic/real data sets	Provide more reality but also have limitations and don't know how representative they are.	Xu, Wang, Li, and Chau (2007), Ghiassi et al. (2016), Piel et al. (2017), Pant and Srinivasan (2013)
	Controlled experiments	These are the close end of the spectrum to naturalistic evaluations, but due to the specificity of the aspect being evaluated, a number of aspects need to be controlled to see a direct impact.	Dang et al. (2012), Pentland et al. (2017), W. Li, Chen, and Nunamaker Jr (2016), Briggs, Kolfshoten, de Vreede, Lukosch, and Albrecht (2013)
	Use in natural environments	Case study of 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 type of evaluations are often determined by the type of artefact. For many artefacts such as algorithms and models, evaluations need to be simulated or controlled to ensure effective measurement of performance. Nonetheless, Datta et al. (2012) provide a very good example of how an approach is integrated into a commercial product (naturalistic setting) and evaluated in a staging environment. Furthermore, as noted by Mettler (2018), their evaluations were seen as interventions in organizational or naturalistic contexts that inherently embraces “all of the complexities of human practice in real organisations” (Venable et al., 2016, p.81).

3.2.3 Discussion

Every article in the review focuses on a practical problem, highlighting a commitment to solve such problems and publish relevant research. This demonstrates that the underlying goal of being problem-led is very much at the core of the articles being published in the SSB. It also highlights that DSR is indeed bringing 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 of studies between Strategy 1 and 2 highlights a reluctance to focus on problems with the full complexity of a specific context, encompassing unique characteristics, explored through a close relationship with the client experiencing the problem. Such reluctance may be explained by the significant challenge that researchers face when tackling live problems. 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 identified issue in DSR which is struggling 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" (Alan Hevner in 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 are distanced from the real-world with a generalized problem and resulting generalized solution. The opportunity to interact with the real-world practice through testing the developed artefacts in naturalistic settings is also mainly overlooked. This 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). The result is a loss of activity and insight from bottom-up inductive studies, which have been seen as a key method for IS (Goldkuhl, 2004; Sein & Rossi, 2019).

3.3 RQ3 - What are the impacts reported in Design Science Research studies?

3.3.1 Approach

Our coding leverages two classifications of research output: (i) knowledge contribution, and (ii) practical impact. To assess the knowledge contribution, we utilize the taxonomy put forward by Gregor and Hevner (2013), which highlights three levels of knowledge contribution maturity. Level 1, defines an artefact instantiation as knowledge contribution as the authors note that "*demonstration of a novel artifact can be a research contribution that embodies design ideas and theories*" even if these design principles or ideas have not been articulated, formalized or understood (Gregor & Hevner, 2013, p 314). However, as a knowledge contribution, it also includes key findings about the problem domain of the study. Level 2, denotes the articulation or formalization of the embodied constructs, methods, models, and design principles. Finally, Level 3 describes a well-developed design theory (both mid-range and grand). For practical impact, Nunamaker et al. (2015) taxonomy of IS solutions that deal with problems "*for real people with real stakes in the outcomes*" is adopted. The taxonomy incorporates three stages: (i) *proof-of-concept*: the research demonstrates the functional feasibility of the solution, (ii) *proof-of-value*: where researchers demonstrate if stakeholders can use the solution to create value across a variety of contexts and conditions, and (iii) *proof-of-use*: study demonstrates that practitioners can successfully create and gain value from their own instances of the generalizable solution.

3.3.2 Findings

As depicted in Table 8, of the 111 studies analyzed, 49 presented equal coverage of knowledge contribution and practical impact. From the remaining studies, 47 generated higher knowledge contribution than practical impact, while only 15 created higher practical impact than knowledge contribution. This 3:1 ratio is replicated when assessing Level 3 contributions. Overall, 17 studies (15%) demonstrated they had attained Level 3 knowledge contribution (Design Theory) versus 3 studies (3%) for Stage 3 practical impact (proof-of-use).

Table 8. Impact of DSR studies (numbers identify articles in the concept centric matrix associated with this submission)

		Knowledge Contribution				
		None	Level 1- 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 article (31)	1 article (24)	2
	Stage1 – proof of concept		10 articles (3,5, 48, 52,66, 87, 91, 95, 97, 99)	29 articles (1,2,7,10,11,12,13, 15,16,20,32, 39,46,55,58,67,68,69,70,71,75,77,82,83,85, 100,108,109,110)	7 articles (27,30, 43,45,47, 49, 96)	46
	Stage 2 – proof of value		12 articles (6, 14, 23,25,26,72,88,89, 90, 98,104,107)	39 articles (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, 76,78,79,80,81,84,86,93,101,102,103,105,1 06,111)	9 articles (4,17, 38,41, 42,63, 64, 92,94)	60
	Stage 3 – proof of use			3 articles (29,54,74)		3
	Total		22	72	17	

The three articles that achieved the highest practical impact (Stage 3) include Zahedi, Walia, and Jain (2016), Yang, Su, and Yuan (2012), and Boughzala and De Vreede (2015), which are detailed in Table 9. Yang et al. (2012) developed an integrated information platform for emergency response management which was “*deployed in the real world and used in the 2008 Beijing Olympic Games*” (p. 761). As outlined in the study, there was a strong motivation and detailed need for the platform. The requirements, which were validated as part of a two-year industry secondment provided a very rich dataset that included over 100 interviews, observations and workshops in the field. In contrast, for Boughzala and De Vreede (2015), the focus was 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, the article notes, “*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). The third paper Zahedi et al. (2016) explicitly calls out the “proof-of-use” of an augmented virtual doctor office (AVDO) “*collected through experiments with simulated medical sessions using AVDO*” (p. 779). What is interesting is the spectrum of proof-of-use demonstrations in the articles. For Zahedi et al. (2016), there is a significant input from physicians, however, the experiments are simulated while the other two articles presented real-world adoptions. Furthermore, only one had the purpose of being fully implemented and utilized by an organization (Yang et al., 2012), while the other two set out to solve a problem. In addition, while these articles 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 articles present Level-3 contributions. Of these articles, 11 explicitly set out to develop a theory as the artefact. A number of these articles also develop prototypes but only as a method of evaluating the theory. For example, X. Li et al. (2015), set out to develop a design theory for market surveillance systems and demonstrates “*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, Mueller, and Maedche (2015), develop a theory for requirement mining systems and “*also implemented a prototype based on this design theory (REMINER)*” (p. 799). However, not all articles that explicitly set out to develop theories also developed prototypes, but instead use in-depth analysis of existing systems (c.f. Hanseth & Lyytinen, 2010; Spagnoletti et al., 2015). As outlined in Spagnoletti et al. (2015), an “*in-depth analysis of an European digital platform for elderly care assistance*” (p. 364) is used to validate their design theory for digital platforms supporting online communities. In the case of Hanseth and Lyytinen (2010), “*the history of Internet exegesis*” (p. 1) was used as a form of theoretical validation.

Furthermore, while Coenen et al. (2018), state at the outset they developed a system for “*assessment of human competences while supporting learning*” (p.248), it's only as an expository artefact in relation to their information system design theory for the comparative judgement of competences. Markus et al. (2002), follow a similar process, but the use of 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*” (p. 179-180). Yet, the system was the naturalistic environment in which the theory was developed and not the primary artefact. Furthermore, of the articles that led to Level 3 knowledge contributions, six studies developed frameworks and models as their primary artefact and were presented as a level 3 design theory. Indeed Soffer et al. (2015) present their framework for conceptualizing routing decisions in business processes as a design theory justified by mapping it to Gregor and Jones' (2007) design theory description.

Examining studies with lower-level impacts, projects are twice as likely to produce a Stage 1 practical impact as its top impact (41% - proof-of-concept) versus Level 1 knowledge contribution (20% - artefact implementation). It is also interesting to note that no paper presents a practical impact with no knowledge contribution, however, the same is not true of the inverse. While small in number, there are two articles that present no practical impact (Chatterjee et al., 2009; Kasper, 1996). What is common between both these articles is the lack of evaluation presentation, a strong knowledge contribution (both articles getting a Level 2 or more), and no evidence/presentation of practical impact.

Table 9. Artifacts of studies that achieve 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 and 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 modelling 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's (requirement mining systems)
Theory	Giessmann et al. (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 (MSSs)
Theory	Coenen et al. (2018)	An information system design theory for the comparative judgement of competences

From our analysis Level 2 and Stage 2 are the most likely top-level contributions achieved for projects, with 65% Level 2 knowledge contributions and 52% demonstrating proof-of-value (Stage 2). A good example of this type is Nunamaker et al. (2011), an article that presents the development of an “*embodied conversational agent-based kiosk for automated interviewing*”. The article indicates the artefact has reached proof-of-value, but it is not fully completed and that the proof-of-use is “*unknowable at this point, and societal and organizational studies will need to be more completely evaluated*” (p. 26). In addition, its Level 2 knowledge contribution is demonstrated by the model created to “*explore the relationship between emotional states and vocal pitch*” (p. 41), which emerged through the development of the artefact.

In summary, the results clearly identify the contribution patterns of IS research problem solving through the lens of DSR as a problem-solving methodology. Of note is the 44% of studies that have equal levels in both practical impact and knowledge contributions. However, of the remaining 56%, there is a skewed focus towards knowledge contributions. Only 3% of artefacts demonstrate proof-of-use (Stage 3) by practitioners. Given the highly applied nature of DSR, this figure is arguably low, especially when it is compared to the 15% of projects that produce Level 3 design theories.

3.3.3 Discussion

The results outlined above provide significant insight into the editorials around DSR and IS contributions in general. In particular, we provide empirical context to debates such as the obsession or fetish for theory (Dennis, 2019; Hirschheim, 2019; livari, 2020) and positioning of DSR research contributions (Baskerville et al., 2018; Gregor & Hevner, 2013). It is interesting to note that if we assess knowledge contribution under the headings of Level 1 – artefact instance, Level 2 – nascent theory, Level 3 – design theory, our results do highlight more of a focus on theoretical contributions in comparison to practical contributions. However, this would be expected in SSB even within the context of a problem-solving method. Furthermore, if we strip back the label of nascent theory to its core components (constructs, methods, models, design principles, and technological rules), the evidence for theory obsession in DSR is not as clear. It does however point to a labelling issue in DSR, with the term ‘nascent theory’ playing a role in legitimizing practical DSR contributions for publication, as detailed by livari (2020). Furthermore, having coded the Level 3 knowledge contributions on the basis of authors explicitly calling out a design theory as a contribution, there is a possibility that given the confusion around what constitutes a design theory (livari, 2020), the number of Level 3 contributions is lower than what we recorded (as is also the case for Stage 3 practical contributions).

At the other end of the scale, the existence of 22 articles in the SSB with a Level 1 (artefact instance) contribution highlights an interesting dataset. Indeed, one could ask how these “theory light” (D. Avison & Malaurent, 2014) articles were even published with such a low knowledge contribution. However, examining these articles (c.f. Cascavilla et al., 2018; Pentland et al., 2017; Venkatesh, Aloysius, Hoehle, & Burton, 2017), it is possible to identify a contribution of significant results versus a contribution of significant theory, the latter being the barometer for assessing the level of knowledge contributions (Gregor & Hevner, 2013). In retrospect, it could be argued that the Gregor and Hevner (2013) taxonomy is not fit for purpose in our study, yet it does embody the process of theorizing, which can initially create incomplete explanations and, if given a chance, may attain the status of a rich theory (Rivard, 2020). More recent work by Baskerville et al. (2018) does highlight the significance of practical impacts/results in their five positioning perspectives to balance artifact and theory contributions. However, whether these positions reduce a reviewer's urge to reject DSR studies due to a lack of theory (D. Avison & Malaurent, 2014) is hard to know. As IS academics, we are more attuned to assessing the theoretical strength of research versus the significance of results associated with a particular problem. It is this very thing that separates academics from practitioners and consultants (Gregor, 2006). This could explain the results in our study, which demonstrates a high tendency to abstract or theorize the results of DSR studies into methods, constructs, design principles, and technological rules. If anything, our study highlights an obsession with theorizing, not theory. This is in no way a bad thing, especially when the output are at Level 2, but the fear is that for the 22 articles that got accepted in our review, many more theory-light studies with significant results were rejected for having a contribution that did not fit our conflicting and overly narrow definition of theory (Markus, 2014) and deemed more suitable for a field report and not a top ranked journal article. A fear that is called out by the lack of DSR articles in top journals (Baskerville et al., 2018; Goes, 2014; Peffers et al., 2018).

4 Conclusions

Within IS, there is a palpable effort to make DSR a success and mainstay of IS research. However, despite multiple efforts by senior scholars, Design Science Research is not performing as expected given its distinct value for the IS domain (Baskerville et al., 2018). This study set out to survey the DSR landscape in the AIS Senior Scholars' Basket to provide empirical context and insight to the many Senior Scholar discussions on the presentation, implementation, and contributions of DSR. In fulfilling the research objective we have successfully answered the three research questions as follows. In answering RQ1 (How is Design Science Research presented?) we have found that there are four presentation styles used to present various combinations of the seven components of a DSR study. While only nine of the 111 articles reviewed, present all seven components of the DSR study, it is clear that a comprehensive and transparent presentation of DSR across the SSB journals has not been achieved (e.g. 101 articles do not present an iterative design component). In answering RQ2 (How are Design Science Research studies conducted?) we have observed that approaches to evaluation are more “academic” in nature than might be preferred, where more artificial evaluations are reported as compared to naturalistic evaluations. This reflects the significant volume of Strategy 1 DSR studies (96 in total) that start with a problem class, as opposed to the 14 articles that start with a problem instance (Strategy 2 DSR studies). Finally, in answering RQ3 (What are the impacts reported in Design Science Research studies?) we highlighted that disappointingly only three articles showcase the most sophisticated stage of practical impact (Stage 3 – Proof of Use), while 17 articles showcase the most

sophisticated level of knowledge contribution (Level 3 – Design Theory). However, none of the 111 articles showcased a Stage 3, Level 3 DSR study.

In answering the three research questions we have arrived at the following overall conclusions.

4.1 Theory Obsession

Our analysis highlights the struggles 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 within practice, embedding design as a method of theorizing, and producing theorized knowledge contributions in the form of practical constructs, methods, models, design principles, and technological rules. Furthermore, it does this despite the noted fetishizing and narrow definition of theory in IS research (Iivari, 2020; Markus, 2014). Indeed, our analysis highlights that beyond a superficial labelling of theoretical contributions as a possible form of legitimizing DSR (Iivari, 2020), there is little evidence to suggest an obsession with theory.

4.2 Lack of Transparency

A key standout from our analysis is the lack of methodological transparency in DSR articles, which at best leads to blackbox prototyping and, at worst methodological slurring. It is our stance that without this basic requirement of transparency, the provision of genres, positioning perspectives, and taxonomies of DSR will only serve to fuel additional academic justifications for studies that fail to provide transparency in the first place. This 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 the significant DSR challenge of defining a problem and solution, both of which evolve through multiple iterations of simultaneous construction of a problem space and a solution space, both of which grow in completeness while evolving through multiple DSR iterations (Baskerville et al., 2018). Such a methodological transparency request of IS researchers may seem like an impossible task, especially within the limits of a journal article. However, our analysis highlights examples of articles that have successfully managed the task. Furthermore, we contend that the use of open science techniques could provide the required bandwidth for researchers to document iterations of problems, artefacts, and evaluations (Doyle, Luczak-Roesch, & Mittal, 2019). In particular, the utilisation of open science repositories can provide a level of insight into aspects of DSR projects that are citable and independent of a final published article. Open techniques will aid the presentation of DSR studies to overcome the confines of a journal article, provide significant insight into the seven components of DSR methods applied, and enable the potential for increased recognition/citation of work undertaken in a DSR project.

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, the key question is 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 dominates the studies analysed, which typically consists of generalized problems, detailed through literature, evaluated artificially, and deductively theorized. In essence, it is an abstracted investigation by design that has limited engagement with real-world contexts and messy problems. This may be a result of the lack of value placed on empirical problem definition or problematization in IS research as noted by Nielsen (2020), the lack of guidelines to enable practitioners to engage in DSR (Nagle, Sammon, & Doyle, 2017), or a consequence of the lack of business and technical capabilities required by IS researchers to directly engage with practice, to which Lacity, Willcocks, and Gozman (2021) have developed an alternative approach in action principles.

In addition, the limited amount of studies that demonstrate proof-of-use highlights there is potential for more progress to be made. While our theoretical contributions have become more practical, their use and impact are still unknown. There is strong merit in the argument that no journal wants to publish the outcome of 100 uses or indeed willing to wait 2-3 years to see the outcome of real uses of an artefact. However, proof-of-use is a hugely significant milestone and an indication of real impact, one that is much more immediate if directly engaging with practice. This does not trivialize proof-of-concept and proof-of-value contributions but highlights the significance of presenting proof-of-use, which not only demonstrates real impact but lessens the level of interpretation needed by practitioners to adopt/adapt DSR generalized solutions (Nunamaker et al., 2015). Furthermore, it targets a specific problem in research relevance which is that almost no managers turn to academic journals for advice on how to improve practices (Rynes, Bartunek, & Daft, 2001; Shapiro

& Kirkman, 2018). The format of such impact demonstration could again benefit from open science techniques (such as archiving artefacts in open repositories) that allow the capture of proof-of-use that is directly accessed from the DSR article post-publication.

5 Future Research

In line with our objective to provide empirical context and insight to the many Senior Scholar discussions on the presentation, implementation, and contributions of DSR, the study also provides 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 analysis and insights to support IS researchers, editors, reviewers, supervisors, and practitioners. In this spirit, we linked our literature analysis data to support future DSR editorials and position pieces. Through further use of our open dataset, researchers may examine other sources of DSR studies outside of the SSB and address a specific limitation of our study; for example, those journals categorised under 'Information Management' in the Chartered Association of Business Schools (CABS) list, along with the major IS conferences listed in the AIS eLibrary. Indeed, we note that studies done in the spirit of DSR without explicitly mentioning DSR were not targeted in our work. We would encourage researchers to build on our analysis to uncover and examine such studies.

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Appendix A: Search Strategy

		Iteration 1: # of Articles Returned in Search	Iteration 2: # of Articles related to DSR	Iteration 3: # of DSR Articles to Review
Senior Scholars' Basket				
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 articles identified	Additional empirical DSR articles
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

See link for matrix <https://osf.io/5p3td/> (DOI 10.17605/OSF.IO/5P3TD)

About the Authors

Tadhg Nagle is a Lecturer (Business Information Systems) at Cork University Business School (CUBS), University College Cork (UCC), and associate faculty at the Irish Management Institute (IMI). Specialising in the business value of data. Tadhg has created several tools and techniques (such as the Data Value Map – <http://datavaluemap.com>) to aid organisations in getting the most out of data assets. He has also developed a brand of applied research (Practitioner Design Science Research) that arms practitioners with a simple and scientific methodology in solving wicked problems.

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 contributes 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.

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 modelling. He is also co-Founder of the Data Value Innovation Group, helping organisations 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.

Ibrahim Mohammed Alhassan is an Assistant Professor of Business Information Systems specialising 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, published several articles in leading journals focusing on data governance activities and implementation.

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