Nature and Purpose of Conceptual Frameworks in Design Science

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Conceptual frameworks have played significant roles in diverse patterns of inquiry and have significant uses in design science research. However, there is a lack of shared understanding regarding the use of conceptual frameworks in design science. This study addresses the following question: what is the nature and purpose of conceptual frameworks in design science? The question is answered through the literature review method, which is guided by a taxonomy of research question construction in design science. The results highlight at which research stages conceptual frameworks are used, and what purposes they support. From the review, we develop a decision model for using conceptual frameworks in design science.

Keywords: Conceptual Frameworks, Design Science Research, Decision Model.

1 Introduction

Conceptual Frameworks (CFs) are constructs developed by researchers to represent sets of concepts and relationships that express some elements of their research. We use the terms 'represent' to refer to both thinking about something and communicating that thinking to the rest of us, 'concept' and 'relationship' to refer to bits of structured knowledge, and 'construct' to refer to how concepts and relationships are integrated (Antonenko, 2015; Jabareen, 2009).

CFs have been commonly used in several academic fields, such as social sciences, computer science and information systems (IS). In social sciences, CFs are regarded as an essential research tool, helping to align research problems, methods, findings, and contributions (Hughes et al., 2019; Miles et al., 2014; Ravitch & Riggan, 2016). In computer science and IS, CFs have been used to articulate requirements, discuss system architectures, and to represent functions and systems (Pettigrew et al., 2001; Zachman, 1987).

Design Science Research (DSR) is becoming a popular research paradigm in the IS field, investigating the design of novel artifacts (Hevner et al., 2004; Mullarkey & Hevner, 2019). As with other fields, CFs are also common in DSR. For instance, the CF developed by Hevner et al. (2004), which characterizes DSR as three interconnected cycles of design, rigor and relevance, has been

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reused and adapted multiple times (Drechsler & Hevner, 2016; 2004; Thuan et al., 2019). As another example, Kang and Zhou (2019) developed a CF that characterizes a design artifact using a set of service features. However, since DSR involves the construction of a wide range of socio-technical artifacts using different levels of abstraction (Gregor & Hevner, 2013), it is no surprise to see CFs being used in a variety of ways and serving various purposes.

Given the recurrent uses and the importance of CFs in DSR (Iivari, 2020; Nunamaker et al., 1990; Wieringa, 2014), we would expect to find guidelines on how to construct and use them to good effect. However, we have not been able to find such guidance in the related literature. Prior research has mainly focused on generalized views over the research process (Hevner et al., 2004; Hevner & Chatterjee, 2010; Peffers et al., 2007). This research gap may lead researchers to depend more on intuition, spend time figuring out how to communicate their message, or worse, leave the conceptualization effort to readers. Furthermore, excessive pragmatism in using CFs may impede the methodological consolidation of the DSR field around a relevant research tool.

In this study, we investigate the nature and purpose of DSR CFs. Our goal is to develop guidance on what to conceptualize in relation to DSR, avoiding unclear conceptualizations, weak communicative arguments, and uncertainty about how to use CFs throughout the DSR process. This study is organized in two stages. First, based on a literature review, we analyze the use of 54 DSR CFs. With this analysis, we consolidate knowledge about the nature of DSR CFs and advance current understanding about their usage. Second, based on our analysis, we develop a decision model for using DSR CFs, emphasizing the aspects of research design and communication.

2 Background

It seems difficult to discuss CFs without clearly distinguishing them from related concepts. CFs differ from other types of frameworks (e.g., theoretical and research frameworks) because they are focused on the researcher's perspective, conveying an "integrated understanding of issues" related to focal phenomena (Imenda, 2014, p. 189), while theoretical frameworks position the research against the knowledge base, and research frameworks position the research in terms of methodology. CFs differ from theory in the sense they seek theorizing, i.e., forming the discourse (Hassan et al., 2019) and defining the conceptual lens through which the focal phenomena are examined (Niederman & March, 2019).

It is also necessary to clearly differentiate (conceptual) frameworks from (conceptual) models. Both have certain characteristics in common: both are products of qualitative processes of theorization (Jabareen, 2009; Wyssusek, 2006); and both seek to represent concepts related to focal phenomena (Burton-Jones et al., 2017; Jabareen, 2009). However, CFs have certain characteristics that are distinct from conceptual models. Understanding their fundamental distinctions requires looking into the ontological foundations. While frameworks provide "understanding" through an "interpretative approach" (Jabareen, 2009, p. 51), models provide "local theory" (Jonker & Pennink, 2010, p. 44) and "formal representations" of focal phenomena (Hadar & Soffer, 2006, p. 568). As such, models make more direct, bounded and rigorous statements about the world than frameworks. All of these position CFs as a distinctive construct, leading us to investigate CFs *per se*.

In the IS field, CFs have been used in both the hypothetico-deductive and inductive-synthesis patterns of inquiry (Cushing, 1990; Ravitch & Riggan, 2016). Considering the former, researchers often use CFs to justify and link theoretical concepts, testable propositions, hypotheses, variables, data, and validity assessment (Hassan et al., 2019). In the latter pattern, researchers often use CFs to give direction to their studies, defining relevant concepts, establishing a rationale and scaffolding interpretations (Antonenko, 2015). For these reasons, CFs have been recognized as important knowledge artifacts supporting IS research (Cushing, 1990; Iivari, 2007).

As DSR is becoming a popular research paradigm in the IS field (Baskerville et al., 2018; Gill & Hevner, 2013; Hevner et al., 2004; Niederman & March, 2012), we expect similar importance of DSR CFs. Indeed, many DSR studies develop and use CFs as essential components of their research. Some studies use them to organize and justify their research processes (Nunamaker et al., 1990). Others use them to map the existing scientific knowledge related to a study (Iivari, 2007). In other cases, DSR CFs result from the process of mapping existing scientific literature related to a topic of interest (Melville, 2010). All of these suggest the important role of CFs in DSR research.

We look for guidance on how to construct DSR CFs. This looking process raises the question if guidance appropriated from other research fields can be adopted to construct DSR CFs? We would argue 'no' because DSR has been converging towards distinctive patterns of inquiry, which inherently change the nature and uses of CFs. In particular, DSR concerns the design of IS innovations where the knowledge required to develop or apply a design solution is immature (Gregor & Hevner, 2013). As such, we may expect uses of CFs that are more exploratory than, for instance, CFs used in the hypothetico-deductive and inductive-synthesis patterns of inquiry. DSR is also characterized by reflective thinking, where designers must have 'conversations' with technology to identify and explore opportunities, and to study creative solutions to improve the world (Baskerville et al., 2018). Therefore, we may also expect uses of CFs in reflective thinking, or even becoming the end product of DSR. Every DSR project is also research into novel and improved patterns of inquiry and design knowledge contributions, which may be shaped as theory, methods and processes (Baskerville et al., 2018). As such, DSR CFs can take a diversity of roles in supporting theory, methods, processes, and artifact construction. Finally, the process of consuming, integrating and producing knowledge in DSR is also expected to be presented to the stakeholder community (Baskerville & Pries-Heje, 2019; Gregor & Hevner, 2013); and therefore CFs may take a fundamental role in communicating the generated DSR knowledge.

These unique aspects suggest a look into the DSR paradigm *per se* rather than rely on guidance from other fields to construct DSR CFs. However, there is limited guidance on how to construct DSR CFs. Prior research has focused on positioning DSR (Hevner, 2007; Hevner et al., 2004), guiding the DSR process (Nunamaker et al., 1990; Peffers et al., 2007, 2018; Venable et al., 2016), and presenting DSR knowledge (Baskerville et al., 2015, 2018; Gregor & Hevner, 2013). This lack of guidance may limit the usage and impact of DSR CFs. In the current study, we address this gap in the literature by analyzing recent publications to synthesize guidelines for using DSR CFs.

3 Analytic Schema for Reviewing the Literature

We develop an analytic schema to guide the literature review on how to construct CFs. For that purpose, we adopt the typology of DSR research questions proposed by Thuan et al. (2019). We recognize strong complementarity between the construction of research questions and the development of CFs, as the former contributes by guiding the research and the latter contributes by organizing and communicating the essential elements of the research. This strong complementary has also been noted by Nunamaker et al. (1990) and Wieringa (2014). With this adoption, the analytic schema identifies the constructs necessary to analyze DSR publications with respect to how researchers develop CFs for addressing the research questions and use them to organize and communicate their studies.

Following Thuan et al. (2019), we consider three stages in the DSR lifecycle: construction, formulation and answer. Construction refers to the initial stage where the researcher seeks to identify opportunities and gaps for contributing to knowledge. Formulation is the stage where the researcher defines the goals and specific research questions. Finally, the answer stage is where the researcher conveys the outcomes of the research. We adopt these stages to analyze where, within the research lifecycle, the researchers position their CFs.

Still following Thuan et al. (2019), we also consider three dimensions of research, which are particular of DSR: way of knowing, way of framing, and way of designing. The way of knowing considers how a DSR study relates to the existing knowledge base, how it contributes new knowledge, and the methods of knowledge inquiry. The way of framing considers how the artifacts generated by a DSR study relate to practice, which involves three aspects (Simon, 1996): requirements to which an artifact must conform to; properties constraining the artifact's identity; and components put together to materialize the artifact. Finally, the way of designing considers how the DSR artifact is realized, which covers several aspects: artifact representation (combining text and other visual elements), design process (the becoming of the artifact), implementation (in specific contexts), use, and evaluation.

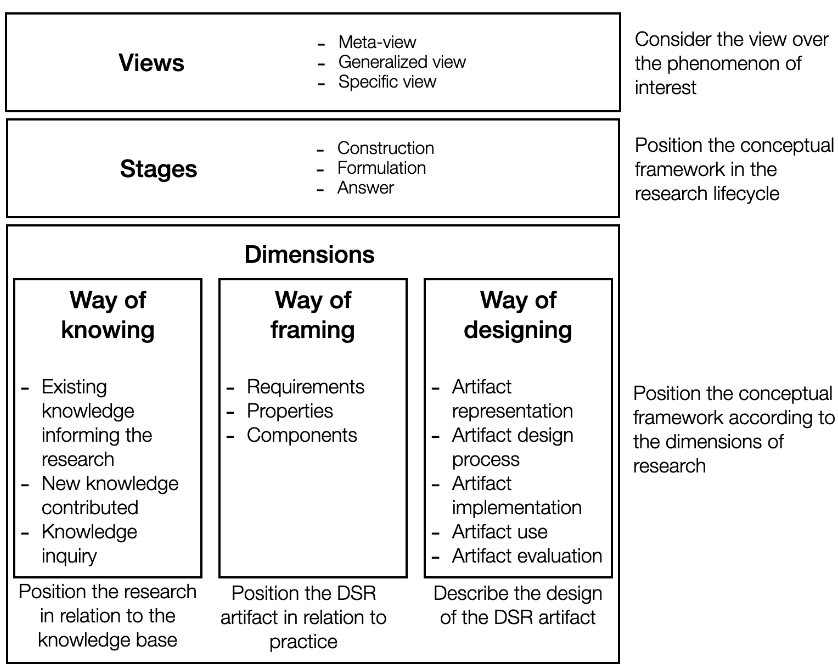

Figure 1. Analytic schema of this study (adapted from Thuan et al. (2019))

This schema helps position a DSR CF in particular research stages; and also helps identify the particular dimensions of research in the DSR domain adopted by the researcher. We note that the schema is open to new dimension of analysis, since DSR CFs have been continually developed and used. In particular, during our analysis of the CFs, we explore a new dimension, which considers the researcher's views about the phenomenon of interest. The realization of the relevance of these views in understanding a CF leads us to add the dimension to our analytic schema. The emerging dimension consists of three different views: meta view (which concerns how to conduct DSR), generalized view (which addresses the design of generalized solutions), and specific view (which concerns the design of specific solutions). With this openness in mind, we use the schema (summarized in Figure 1) to guide our data analysis.

4 Literature Review

We explore the literature on the use of DSR CFs using a descriptive review, seeking to identify trends in the use of DSR CFs by analyzing a representative dataset using both qualitative and quantitative methods (Paré et al., 2015). The literature review is suggested as an appropriate method for analyzing and synthesizing patterns of knowledge (Paré et al., 2015; Templier & Paré, 2015), which in our case equates to patterns of use of CFs by researchers.

We understand certain strengths and weaknesses when analyzing the uses of CFs in DSR publications. On the one hand, by analyzing *uses* of CFs, we cannot examine *impacts* of CFs in research. Assessing the latter would require collecting both the researchers' experiences and the audiences' perceptions. On the other hand, a published CF is a key communicative element of a research project (Antonenko, 2015). Consequently, a review on the uses of CFs provides significant insights on a thoughtful process of research design.

Adopting the literature review method, we use the schema in Figure 1, which helps to constrain the data collection and provides a focus for data analysis (Miles et al., 2014). Following recommendations regarding systematicity in literature reviews (Paré et al., 2016), the adopted procedure is detailed below.

Criteria for inclusion of studies. The definition of explicit criteria for inclusion of studies is essential to ensure systematicity and transparency in reviews (Paré et al., 2016). In our context, a fundamental problem is that, the distinctions between conceptual frameworks and the related constructs are blurred (e.g., Antonenko (2015, p. 56) notes the terms "theoretical framework" and "conceptual framework" are often used interchangeably, and Jabareen (2009, p. 51) notes the current uses of conceptual framework are vague and imprecise) and can therefore generate errors. This problem may lead to the construct identity fallacy, where same/different construct names can refer to same/different phenomena, which may result in low precision and recall when searching the literature (Larsen & Bong, 2016). In particular, we face the complications of excluding relevant CFs from the review, if the search criteria are too narrow, and including inadequate CFs in the review, if the search criteria are too broad.

For this review, we select studies that fulfill all of the following criteria:

- Explicitly concern design science research in the study, either in the context of fundamental (theory and methodology) or applied (design, construction and evaluation of artifacts) research;
- Explicitly communicate constructs developed by the authors of the study to express some elements of their research;
- Explicitly use the term 'conceptual framework' to characterize the proposed constructs.

We recognize these criteria are overly cautious. For instance, we exclude constructs proposed by Peffer et al. (2007) and Mullarkey and Hevner (2019), because they are classified as models, even though they could be classified as frameworks. On the other hand, by limiting the review to these criteria we 1) avoid operationalizing very blurred and error prone rules for discriminating conceptual frameworks from other constructs[1]; and we 2) rely on the contextual knowledge and good reasoning of the researchers (and anonymous reviewers), who may have had good reasons for deciding to use (and accept) the term 'conceptual framework' for classifying their constructs[2].

Finally, we also note that our study does not involve a systematic literature review, in the sense that we do not seek to appraise and synthesize the research landscape in a quantitative manner (Paré et al., 2016). Instead, we use quantitative results to identify and analyze trends in the selected data set.

Search strategy. We searched DSR papers proposing CFs in the AIS electronic Library (AISeL). The choice was based on the perception that AISeL is a high-quality database hosting representative DSR papers. The search used two keyword phrases: 'design science' and 'conceptual framework'. The search was restricted to papers published after the seminal paper by Hevner et al. (2004), which arguably is a milestone in the DSR field. This search yielded 204 full text papers.

Screening process. This stage further refined the search results by checking in more detail the inclusion criteria discussed above. Papers that did not meet one criterion were removed from the selection. For practical reasons, we also omitted non-English papers. As a result, 29 papers satisfied our criteria.

Forward and backward search. Forward and backward searches avoid excessive constraints to the review, especially in multidisciplinary fields such as IS (Webster & Watson, 2002). We followed recommended procedures (Levy & Ellis, 2006) to check for cited and citing (using Google Scholar) CFs to identify omissions. The missing CFs were then screened according to the process mentioned above. This step further added 16 papers to the pool.

Data extraction and analysis. To extract data in a systematic way, we developed a coding sheet that operationalizes the schema in Figure 1. The coding sheet was applied to each CF. The definitions in Section 3 guided the data extraction. To ensure the inter-coder reliability, we used two coders

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[1] Jonker and Penning (2010) propose a long list of rules to distinguish conceptual frameworks from maps and models, but more rules would be necessary to distinguish them from other constructs; and they would have to be clearer to be operationalized.

[2] A study of the researchers' reasoning when deciding to classify a construct as theory, framework, model or any other label seems interesting but is beyond our scope.

(Kitchenham, 2007). Both coders independently conducted the coding procedure and differences were discussed until a consensus was reached. When coding, we kept our minds open for new codes to explore different usages and characteristics of DSR CFs. The coding sheet allowed for an ‘other’ option in all categories. Later, the new codes were integrated in our schema.

Data extraction and analysis were done multiple times, as the applicability of our schema was first tested and then applied with increased detail, which resulted in several adjustments. In particular, we added the views adopted by the researcher as a dimension of analysis. Another iterative adjustment to the schema, was the addition of knowledge inquiry in the way of knowing dimension. This element emerged from the ‘other’ options in the coding sheet. More explanations and justifications of these adaptations are discussed next.

Synthesis. This stage synthesized the characteristics of DSR CFs, which involved three steps. First, we reviewed the extracted data in relation to the selected codes. Second, we calculated descriptive statistics of the coding dimensions, which provided us with an indication about their popularity in the dataset. We finally summarized the findings for richer understanding and explanations.

5 Data Analysis

5.1 General profile of the dataset

Of the 45 considered papers, 42% are journal articles and 58% are papers in conference proceedings (Table 1). We note that a variety of journals and conferences have published DSR CFs. In the journal category, MIS Quarterly is at the top of the list. In the conference category, the Americas Conference on Information Systems (AMCIS), is the top conference publishing DSR CFs.

Table 1. Number of papers by outlet

Publication Outlet	# papers
Journals	
MIS Quarterly	5
Communications of the Association for Information Systems	3
Business & Information Systems Engineering	3
Journal of the Association for Information Systems	2
Enterprise Modelling and Information Systems Architectures	1
Scandinavian Journal of Information Systems	1
International Journal of Accounting information systems	1
Technology Analysis & Strategic Management	1
Pacific Asia Journal of the Association for Information Systems	1
Transactions on Management Information Systems	1
Conferences	
Americas Conference on Information Systems	10

International Conference on Design Science Research in Information Systems and Technology	6
International Conference on Information Systems	5
Hawaii International Conference on System Sciences	3
European Conference on Information Systems	2
Total	45

While most papers in our dataset have a single CF, seven papers contain two CFs, and one paper contains three CFs. As a result, from the 45 papers, 54 CFs are identified and analyzed (Appendix A).

5.2 General analysis of DSR CFs

We now report our research findings about the DSR CF nature, focusing on three aspects: views adopted by researchers, positions in the research lifecycle, and dimensions of research. We will use reviewed CFs for illustration purposes.

Views adopted by researchers. We note that the views dimension has emerged during the coding process. While iteratively coding the dataset, we observed that some DSR CFs expressed different views about the phenomenon of interest: meta, generalized, and specific. Table 2 (left) summarizes the views found in the dataset.

Table 2. Distribution of CFs according to views adopted by the researcher (left) and stages of research (right)

View	# papers
Meta	16
Generalized	22
Specific	16

Stage	# papers
Construction	14
Formulation	1
Answer	39

Regarding the meta view, sixteen researchers used CFs to discuss fundamental concepts that define DSR as a distinctive research paradigm. Therefore, this kind of CF takes a meta view over artifact design. For instance, the CF in Figure 2 highlights that DSR artifacts result from (and are used by) a process of scientific inquiry, which generates (and uses) abstract and situational knowledge (Herwix & Rosenkranz, 2018).

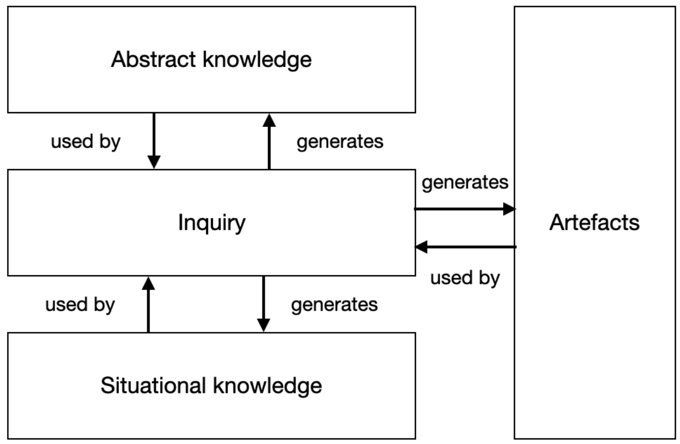

Figure 2. CF adopting a meta view over artifact design, which emphasizes knowledge use and generation (adapted from Herwix and Rosenkrantz (2018))

We also found several papers using CFs to propose generalized solutions to categories of problems. For instance, the CF in Figure 3 describes a method for the systematic architecting of modular services using principles of modularity (Dörbecker & Böhmann, 2015). With this generalized view, CFs can be reused and applied to a category of artifacts that address recurring problems. On the other hand, we also found papers using CFs to characterize a particular solution artifact. For instance, the CF in Figure 4 describes the architecture of a support system for project managers to understand project performance (Marzoughi & Arthanari, 2016). With this specific view, CFs are normally applied to a particular artifact addressing a particular problem for a particular organization.

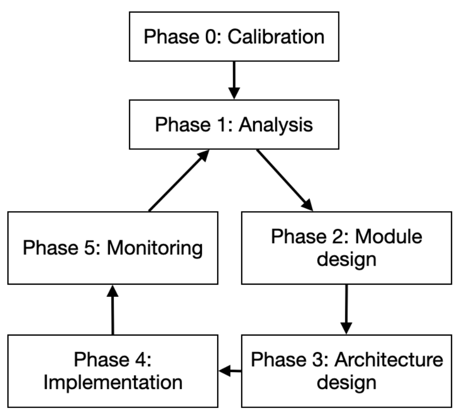

Figure 3. CF adopting a generalized view over the design of a category of artifacts, which emphasizes the design process (adapted from Dörbecker and Böhmann (2015))

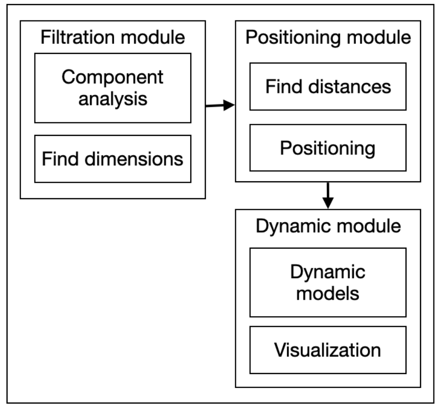

Figure 4. CF adopting a specific view over the design of a particular artifact, which emphasizes logical architecture (adapted from (Marzoughi & Arthanari, 2016))

Regarding the distributions of the CF views in the dataset, we found a good number of CFs in each view (Table 2, left). The salience of the generalized view reflects an important tenet of DSR, which is to offer generalized solutions to categories of problems (Peffers et al., 2018). We find the high number of CFs taking a meta view interesting. This may reflect the still emerging theoretical and methodological scaffolding of the domain, where researchers continue developing fundamental concepts (Iivari, 2020). This understanding is also supported by a detailed analysis of the way of knowing dimension. In the way of knowing, concepts such as genres of inquiry, types of knowledge contributions, and theorizing modes are all related to the meta level and all contribute to extend our understanding of DSR in the knowledge dimension (Baskerville et al., 2015).

Positions in the research lifecycle. Table 2 (right) shows the distribution of CFs across the research lifecycle. We identified a robust majority of CFs in the answer stage, where CFs characterize output artifacts and conceptualize research outputs. Further, we find affinities between DSR CFs and grounded theory, where researchers organize their findings in the form of a CF (Green, 2014). This suggests a *pivotal role of CFs in explaining knowledge contributions*. Such positioning contrasts with other research paradigms. For instance, CFs in qualitative research help mapping and guiding the inquiry, but then knowledge is summarized in other ways, such as hypotheses testing (Green, 2014; Miles et al., 2014).

As most CFs in our dataset concern the answer and construction stages, we now further illustrate these two types of CFs. The CFs in Figures 3 and 4 concern the answer stage. In both cases, the researchers used CFs to characterize the conceptual outputs of their research, which identify and systematize a set of design elements and their interdependencies. In the construction stage, CFs help to identify research opportunities. For instance, the CF in Figure 5 concerns the construction stage. It defines a set of dimensions of analysis used to review papers related to management control systems, which helps to map the related literature and research opportunities (Marx et al., 2012).

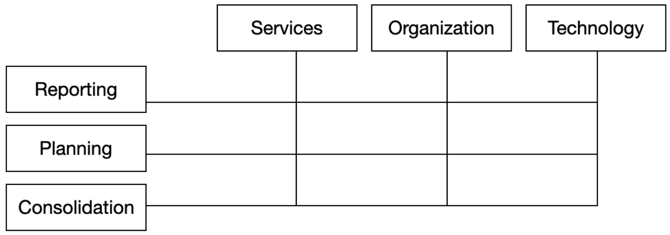

Figure 5. CF addressing the construction stage, which identifies a set of dimensions of analysis (adapted from Marx et al. (2012))

Dimensions of research. Table 3 shows the distribution of CFs across way of knowing, way of framing, and way of designing. The distribution highlights the dominance of the way of designing (Table 3, right); and within this dimension, the design process takes the lead. This suggests an *important role of CFs in explaining the adopted research methods* (Peffers et al., 2007). For instance, the CF in Figure 6 describes the method adopted for assessing the quality and customer satisfaction with healthcare providers using data collected from social media (Albarrak & Li, 2018).

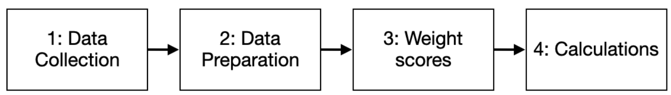

Figure 6. CF describing an artifact design method, which identifies a set of research steps (adapted from Albarrak and Li (2018))

Artifact representation also takes a preeminent role overall. This suggests an interesting contrast with other views over IS, which usually seek to more formally and faithfully represent the artifact using models (Recker et al., 2019; Wand & Weber, 2002) rather than just making sense of the artifact using CFs (Jabareen, 2009). The CF in Figure 4 provides an architectural representation of a system designed to benchmark project performance (Marzoughi & Arthanari, 2016). It highlights the conceptual structure of the developed system without showing details of the actual software implementation.

Table 3. Distribution of CFs according to dimensions of research

Way of knowing	# papers
Existing knowledge	7
New knowledge	7
Other	5
Total	19

Way of framing	# papers
Requirements	3
Properties	9
Components	11
Other	0
Total	23

Way of designing	# papers
Artifact representation	14
Artifact design process	18
Artifact implementation	5
Artifact use	4
Artifact evaluation	9
Other	0
Total	50

In Table 3 (left), the smaller number of CFs addressing the way of knowing is somewhat surprising. Even though there is a current trend towards emphasizing knowledge contributions in DSR, in particular in the form of design theory (Baskerville et al., 2018; Iivari, 2020), the review results reveal a different picture. This could reflect the emerging nature of DSR, where researchers may still be developing ways to convey design knowledge (Gregor et al., 2020). The CF in Figure 2 concerns the way of knowing, highlighting the relationships between scientific inquiry and knowledge generation and use (Herwix & Rosenkranz, 2018).

Still in the way of knowing, we note an interesting point, where we categorized five CFs in the 'other' category. These cases relate to genres of inquiry (Akoka et al., 2017; Baskerville et al., 2015) and theorizing modes (Drechsler & Hevner, 2018), and suggest new approaches to build and accumulate knowledge in DSR. This reinforces the perception that researchers are still developing essential ways to generate and communicate about design knowledge. We therefore recognize that, in addition to existing and new knowledge, there should be another defining aspect of the way of knowing: the methods, approaches and genres of inquiring into existing and new knowledge. For that reason, we added 'knowledge inquiry' to our analytic schema (Figure 1).

In Table 3 (middle), the CFs we found addressing the way of framing predominantly characterize the properties and components of designed artifacts. For instance, the CF in Figure 7 concerns the way of framing, identifying a set of components and relationships shaping the researcher's mindset when designing knowledge management solutions for communities of practice (Dinter et al., 2016).

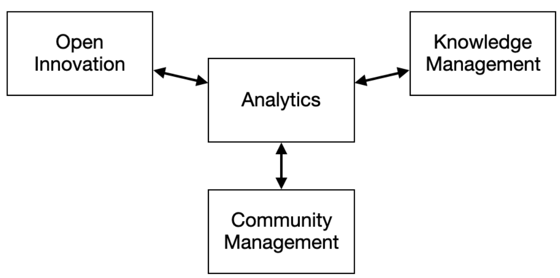

Figure 7. CF addressing the way of framing, which identifies a set of elements of interest to the researcher (adapted from Dinter et al. (2016))

5.3 Detailed analysis

In this section, we further analyze the characteristics of DSR CFs. As noted, a CF can be analyzed according to three aspects: views, stages, and dimensions of research. We now analyze combinations of these aspects to uncover relationships between them.

Table 4. Distribution of CFs according to view and dimensions of research

View \ Dimension	Way of knowing	Way of framing	Way of designing
Meta	13	10	18
Generalized	3	10	17
Specific	2	3	15

Considering the distribution of CFs according to the views adopted by the researcher and dimensions of research (Table 4), the meta view takes the lead, showing a strong relationship with the way of designing. Tables 5, 6, and 7 further analyze the three dimensions in details.

5.3.1 DSR CFs according to views and dimensions of research

View versus way of knowing. The distribution of CFs according to the view adopted by the researcher and the categories pertaining to the way of knowing (Table 5) shows stronger relationships between the meta view and, almost equally, existing knowledge, new knowledge and knowledge inquiry. Based on these relationships, we suggest that *CFs in the meta view should be regarded as a form of theorizing*: the process of creating theories in DSR (Alturki & Gable, 2014).

Table 5. Distribution of CFs according to view and way of knowing

View \ Way of knowing	Existing knowledge	New knowledge	Knowledge inquiry (other)
Meta	5	5	4
Generalized	1	1	1
Specific	1	1	0

Theorizing in DSR articulates purpose with principles and expositions (Gregor & Jones, 2007). CFs can help put together these elements at the meta level. For instance, the CF in Figure 8 typifies DSR knowledge at the meta level using two dimensions: knowledge goal (design or science) and knowledge scope (abstract or situational). These types then support theorizing about the nature of design knowledge contributed by DSR studies (Akoka et al., 2017).

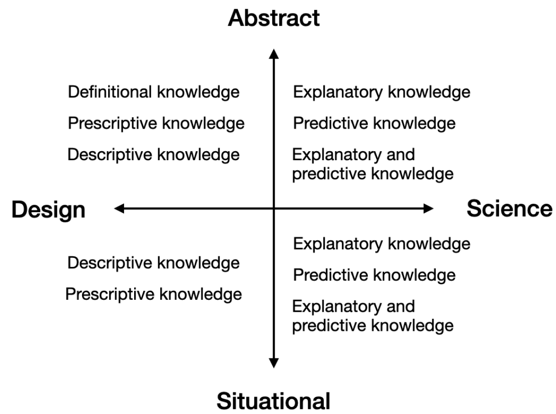

Figure 8. CF as a form of theorizing, which emphasizes knowledge dimensions (adapted from Akoka et al. (2017))

View versus way of framing. The distribution of CFs according to the view adopted by the researcher and the categories pertaining to the way of framing can also be enlightening (Table 6). We note the strong relationships between all aspects of the way of framing and the meta and generalized views. This could be interpreted as utilizing CFs in another form of theorizing. As noted earlier, theorizing may concern the way of knowing, suggesting ways of inquiring and generating knowledge. However, at both the meta and generalized levels, theorizing may also consider the way of framing, contributing to *theorizing about the requirements, properties and components of DSR artifacts*. For instance, the CF in Figure 2 theorizes that DSR inquiry (a component of the way of framing) uses and generates artifacts based on the use and generation of abstract and situational knowledge (Herwix & Rosenkranz, 2018).

Table 6. Distribution of CFs according to view and way of framing

Way of framing / View	Requirements	Properties	Components
Meta	1	5	4
Generalized	2	4	6
Specific	0	1	2

We also observe the lack of relationships between the specific view and the requirements and properties of DSR artifacts, accompanied by a weak relationship with components. This is surprising, as we would expect that researchers would use CFs to frame the DSR artifact. Based on Table 6, we cannot explain this surprise. However, by looking in more detail at the data, we suggest that DSR researchers are still discussing the fundamental aspects of framing and how it is distinct from knowing and designing.

Perhaps not a surprise is the weak utilization of CFs regarding the specific view and DSR artifact components. After all, CFs tend to organize concepts according to abstract concepts and worldviews rather than concrete prescriptions of realized artifacts (Green, 2014). In the latter case, other constructs such as architectural, functional and data models can be used instead. On the other hand, this may also signal a *specialization of DSR CFs in providing higher forms of abstraction about artifacts* (e.g., meta requirements and forms of inquiry) rather than concrete forms (e.g., system architectures and data models). Figure 7 provides such an example, where the CF is more focused on the form of inquiry about the artifact than the artifact itself.

View versus way of designing. Table 7 summarizes the distribution of CFs according to the view adopted by the researcher and the categories of the way of designing. We note the strong relationship between the specific view and artifact representation. This suggests that *many researchers utilize CFs to represent DSR artifacts*. Compared to previous uses in theorizing about DSR and DSR artifacts, this approach reveals a more pragmatic use of CFs, which is centered on how DSR artifacts are designed, implemented and used. For instance, the CF in Figure 4 shows the design components of a specific system (Marzoughi & Arthanari, 2016).

Table 7. Distribution of CFs according to view and way of designing

Way of designing / View	Artifact representation	Artifact design process	Artifact implementation	Artifact use	Artifact evaluation
Meta	1	6	2	2	7
Generalized	4	7	2	2	2
Specific	9	5	1	0	0

The consideration for the artifact design process also takes a preeminent role and is almost evenly distributed across the three views. This also highlights the *relevance of CFs regarding research methods*, where researchers seek to rigorously explain how the DSR artifact is researched, often in relation to known methodologies (Peffers et al., 2007). For instance, the CF in Figure 9, which is adapted from (Ostrowski et al., 2011), shows rigorous adherence to the DSR methodology proposed by Peffers at al. (2007).

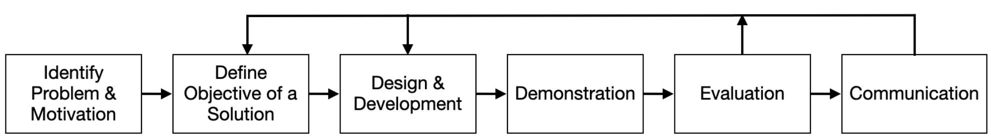

Figure 9. CF as a way to show methodological rigor. This CF (adapted from Ostrowski et al. (2011)) highlights adherence to the DSR methodology proposed by Peffers et al. (2007)

5.3.2 CFs according to stages and dimensions of research

The distribution of CFs according to the stage of research and way of designing shows a strong relationship between answer and way of designing (Table 8). That is, *many CFs are used to explain how a DSR artifact has been designed in addressing the DSR enquiry* rather than outlined against the environment where the artifact is used, and the knowledge supporting or justifying the artifact design. For instance, the CF in Figure 3, which describes a method for designing modular services, emphasizes the systematic and iterative logic of artifact design using a combination of highly cohesive phases (Dörbecker & Böhmann, 2015).

Table 8. Distribution of CFs according to stage and way of designing

Dimension Stage	Way of knowing	Way of framing	Way of designing
Construction	6	9	10
Formulation	0	1	0
Answer	13	12	39

Once again, we find strong affinities between DSR CFs and what happens in grounded theory research, where the CF is the primary output of the research (Green, 2014). This suggests that *CFs are an important vehicle for theorizing about DSR artifact*s, even though theorizing about DSR artifacts may take a variety of forms, including the ways of knowing, framing and designing, but with an emphasis on the way of designing.

5.4 Consolidation and further reflections

In the above sections, we have drawn a series of observations regarding how DSR CFs are used by researchers (using text emphasis on the most relevant ones). We now consolidate and reflect about these observations. One relevant aspect that emerges is that many DSR CFs are used to support different forms of theorizing: 1) using CFs to theorize about DSR, where CFs provide explanations about DSR, articulating design concepts with the process of inquiring about artifacts, and the becoming of artifacts; and 2) using CFs to theorize about the DSR artifact as a conceptual output, where CFs provide higher forms of abstraction and schemes for articulating requirements, properties and components.

Another salient aspect is that many DSR CFs are created to synthesize the new knowledge contributions of a study, rather than positioning the study according to existing knowledge. That is, many DSR CFs promote framing at the end rather than framing at the beginning of a study.

Finally, we also observe that many DSR CFs are used in reflective thinking, helping researchers to think about and communicate how artifacts are designed, implemented and used, which are central to the logic of discovery in the tradition of pragmatism (Shepherd & Suddaby, 2017), although not using the more traditional testing of hypotheses (Hassan et al., 2019). All in all, it seems DSR CFs are relevant for both DSR theorization and praxis (Popper, 1972).

6 Decision Model for Using Conceptual Frameworks

Our analysis above highlights a variety of roles and usage patterns of DSR CFs. To make this knowledge more actionable, we elaborate on a decision model which synthesizes our main observations and provides guidance on how to use CFs. The decision model is not intended to be prescriptive. Instead, it consolidates major trends found in our review.

Our analysis shows that stage of research, view adopted by the researcher, and dimensions of research, help characterize CFs at the most abstract level. We therefore consider the decision model as a combination of these three main decisions (Figure 10). Since the decision regarding stage of research is more matter-of-fact than the others, we suggest it as a starting point; and since the view of researcher is more up-front than the dimensions of research, we suggest it should be addressed next, leaving the dimensions of research to the end.

Figure 10. Decision stages for using DSR CFs

Next, we consider the detailed decision model. The first decision starts with a simple question considering the current stage of the research (based on Table 2, right-hand side). As Table 2 indicates lack of evidence regarding the use of CFs in the formulation stage, we do not include that stage in the decision model. Consequently, the model (Figure 11) includes the two alternatives of construction (identifying opportunities for knowledge contributions) and answer (explaining the outcomes of research), which lead to branches A and B, respectively. We suggest that researchers wishing to address both stages of research should create two CFs, one following the A branch and the other following the B branch. Such an approach may contribute to communicating the intended purposes of their CFs more clearly.

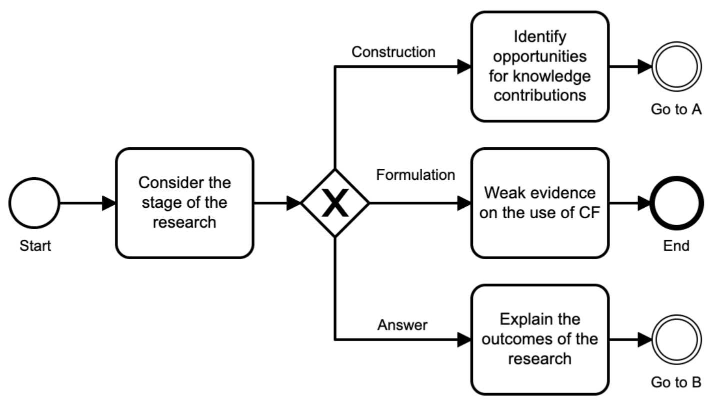

Figure 11. Decisions regarding the stage of the research

The A branch concerns the opportunities for knowledge contributions (Figure 12). The decision model then moves to an intermediate stage, which requires the researcher to adopt a view over the research (based on Table 2, left-hand side). Table 2 suggests three views, meta, generalized, and specific, which we include in the decision model.

The meta view situates the theoretical understanding of DSR and may address three aspects in parallel: design knowledge, meta properties and components, and methods of knowledge inquiry. Our review shows that existing CFs have been, broadly speaking, equally divided between these three categories (Table 3, left). Regarding the generalized view, which concerns the characterization of DSR methods and artifacts, decisions should consider both the design process and the aspects of framing related to properties and components of artifacts. Since weak evidence was found in relation to requirements (Table 5), this element is not considered in the decision model in relation to the generalized view. Finally, regarding the specific view, decisions should consider the design process and artifact representation, as they appeared as more relevant in the literature (Table 6). For each branch in the decision model, we end up identifying the major goals of the CF and providing some example CFs (Figure 12).

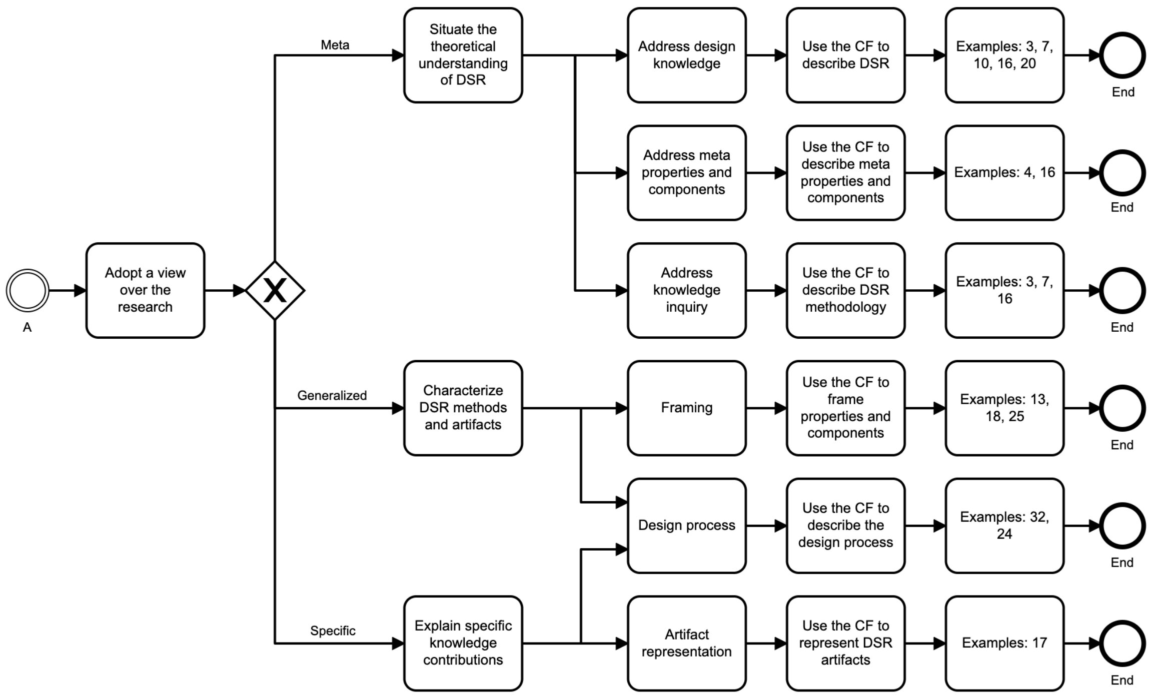

Figure 12. Branch considering knowledge contributions (refer to Appendix A for the examples)

The B branch concerns the explanation of outcomes of research. The decision model then moves to an intermediate stage, which requires the researcher to adopt a view over the research (based on Table 2, left-hand side). Once again, Table 2 suggests three views, meta, generalized, and specific, which we include in the decision model. The meta view extends the theoretical understanding of DSR and may, once again, address three aspects in parallel: design knowledge, meta properties and components, and methods of knowledge inquiry. The generalized view concerns explaining a generalized design. Decisions should consider both the design process and the aspects of framing related to properties and components. Finally, regarding the specific view, the decision should consider the design process and artifact representation. For each branch in the decision model, we also end up identifying the major goals of the CF and providing some example CFs (Figure 13).

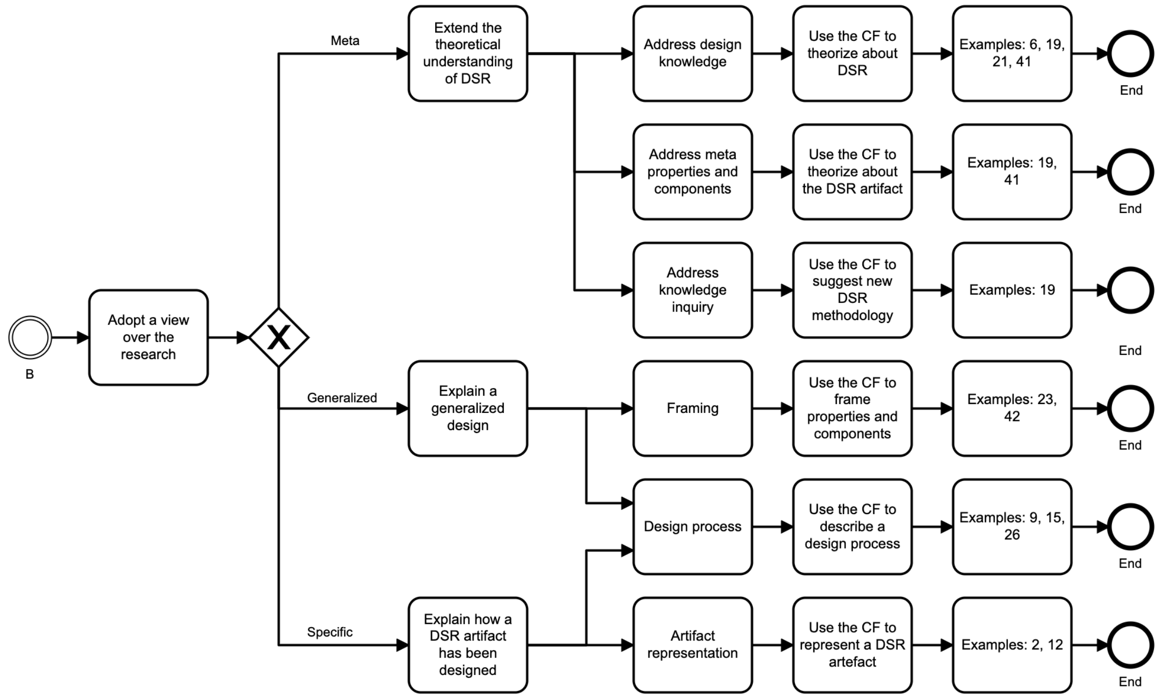

Figure 13. Branch considering outcomes of research (refer to Appendix A for the examples)

Overall, the decision model identifies the three main stages and twelve different uses of DSR CFs. For each use, we identify exemplary references (Figures 12 and 13). Therefore, the decision model can be used in two different ways. First, at an abstract level, the model suggests three main decisions that researchers should address to clarify the nature and purpose of their CFs. Our analytic schema (Figure 1) can then be used to support the clarification. Second, at a detailed level, the decision model can be used to define the nature of the CFs and identify examples that fit with the researchers' specific purpose. These examples provide reference points for the use of CFs in DSR research.

7 Discussion and Conclusions

The nature and roles of CFs in general research is well understood by methodologists (Bordage, 2009; Cushing, 1990; Wilson et al., 2010). In certain fields, e.g., qualitative research, methodologists provide specific recommendations on the use of CFs (Jabareen, 2009; Miles & Huberman, 1994; Rocco & Plakhotnik, 2009). In this study, we highlight a variety of roles that CFs have been playing in DSR. We find significant intersections and differences between DSR CFs and their counterparts in other fields. The way of knowing dimension of research highlights the intersections. CFs falling into this category contribute to an understanding of how studies relate to existing knowledge, contribute new knowledge, and inquire about knowledge. This role is similar to CF roles in other social science fields (Antonenko, 2015; Lindgreen et al., 2021; Ravitch & Riggan, 2016). In this manner, DSR CFs help bridge the DSR paradigm with the wider research landscape, as they focus on knowledge in general.

On the other hand, the way of framing and way of designing dimensions highlight the differential aspects of DSR CFs from other fields. In particular, CFs in the way of framing category help the problematization of research using a discourse that is unique to DSR, i.e., articulating requirements, properties and design components, instead of defining hypotheses and variables, as often found in general research (Hassan et al., 2019). CFs in the way of designing also contribute to highlight the distinctive outputs of DSR knowledge, i.e., artifact knowledge, which combines representation, design, implementation, and use. Together, our research underlines the variety of uses of CFs in the DSR field. These include problematizing, positioning the research, organizing the inquiry process, representing DSR artifacts, and explaining design processes. As such, we regard CFs as a very flexible tool in DSR research.

Furthermore, in many instances of DSR, CFs have also been the main research contributions, in the form of design theorizing. In particular, we find it interesting that CFs can be used in different forms of theorizing:

- **Meta-theorizing**, where researchers are mainly interested in *situating* or *extending* the theoretical understanding of the DSR paradigm. Examples of situating and extending CFs are Baskerville et al. (2015), which positions DSR studies according to different types of knowledge, and Hevner et al. (2004), which proposes a CF for conducting DSR.
- **Generalized theorizing**, which addresses a fundamental concern of DSR, which is to develop generalized *methods and artifacts*, or to explain generalized *designs*. An example of the former is a CF for valuing IT (Töhönen et al., 2020); and an example of the latter is a CF for service architectures (Dörbecker & Böhmann, 2015).
- **Local theorizing** (Jonker & Pennink, 2010), in situations where researchers explain specific *knowledge contributions* or explain how DSR *artifacts* have been designed. An example of the former is a CF for aligning big-data projects with organizational strategy (Lakoju & Serrano, 2017); and an example of the latter is a CF for a navigational support system (Marzoughi & Arthanari, 2016).

This range of possibilities extends CFs beyond acting as flexible tools, to also being flexible constructs, which can stand *per se*, as theorizing artifacts. Our classification scheme helps classify such theorizing artifacts, considering the views, stages and dimensions of research selected by researchers for theorizing.

We suggest that future work should draw from knowledge developed in grounded theory to consolidate the CF as a distinctive, theoretically sound, and generally acceptable research tool in DSR. Further research should also inquire about the ontological and theoretical foundations of DSR CFs, regarded as theorizing artifacts. Further research is also necessary to inquire more in-depth about the intrinsic and extrinsic properties of DSR CFs, so that researchers, besides having access to a collection of examples, may also understand the essential properties of DSR CFs. Finally, it would be interesting to empirically evaluate the proposed decision model.

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A Reviewed Frameworks

Table A. List of reviewed frameworks

#	Reference	Page	Name
1	(Abbasi & Chen, 2008)	816	A design framework for CMC text analysis
2	(Abbasi & Chen, 2008)	822	CyberGate system design
3	(Akoka et al., 2017)	205	Integrated evaluation framework
4	(Albani et al., 2016)	8	Conceptual framework for analyzing the essential concepts and building blocks of EE methodologies
5	(Albarrak & Li, 2018)	3342	The quality and customer satisfaction health accessibility framework
6	(Barquet et al., 2017)	405	PDSA framework
7	(Baskerville et al., 2015)	550	The genres of inquiry framework
8	(Becker et al., 2008)	9	Framework to evaluate IT artifacts
9	(Bell & Nusir, 2017)	2545	G2C e-service co-design framework
10	(Betzing, 2018)	5	Perspectives on customer data with regard to different levels of analysis and beneficiaries
11	(Chung & Sundaram, 2018)	2971	SHARPP games framework
12	(Chung & Sundaram, 2018)	2973	SHARPP games architecture
13	(Dinter et al., 2016)	4	Conceptual framework for the VCOP

14	(Dinter et al., 2016)	5	Conceptual data model
15	(Dörbecker & Böhmann, 2015)	8	FAMouS – Framework for architecting modular services
16	(Drechsler & Hevner, 2018)	89	A unified perspective on knowledge utilization, production, and contribution in IS DSR
17	(Goeken & Patas, 2010)	180	Framework to structure empirical research in RE
18	(Henningsson et al., 2010)	783	A preliminary RDT framework
19	(Herwix & Rosenkranz, 2018)	58	The scientific inquiry framework
20	(Herzog et al., 2015)	7	A conceptual framework for ESS evaluation
21	(Hevner et al., 2004)	80	IS research framework
22	(Horita et al., 2014)	5	Conceptual framework
23	(Hsieh & Yuan, 2010)	8	The conceptual framework of designing excellent service experiences
24	(Lakoju & Serrano, 2017)	2	SAVI-BIGD
25	(Marx et al., 2012)	197	Conceptual MCS framework
26	(Marzoughi & Arthanari, 2016)	3	Generic framework for a navigational support system
27	(Marzoughi & Arthanari, 2016)	5	Architecture and case model of a navigational support system
28	(Melville, 2010)	6	Belief-action-outcome (BAO) framework
29	(Mettler et al., 2014)	232	Proposed evaluation framework
30	(Monteiro et al., 2016)	3	iCBT framework
31	(Monteiro et al., 2016)	5	Conceptual framework for iCBT
32	(Ostrowski & Helfert, 2012)	3	The reference model
33	(Ostrowski et al., 2011)	351	A conceptual framework for meta-design
34	(Pries-Heje et al., 2008)	7	Strategic DSR evaluation framework
35	(Rizk & Elragal, 2012)	3	A framework for extracting semantic trajectory patterns (Sem-TP)
36	(Russell et al., 2018)	7	Digital-Privacy transformation “Gap-Map”
37	(Studer & Leimstoll, 2015)	12	Meta-Model: model of the MCAF
38	(Studer & Leimstoll, 2015)	14	MCAF formally modelled in BPMN with expanded sub-processes
39	(Studer & Leimstoll, 2015)	15	MCAF’s high-level key process areas overview including maturity levels
40	(Timm & Sandkuhl, 2018)	10	A framework for R-CO reuse
41	(Venable, 2006)	17	Activity framework for design science research
42	(Venkatesh et al., 2017)	93	Conceptual framework
43	(Vodanovich et al., 2014)	11	Conceptual framework to guide the design of Wikis for youth well-being
44	(Volland & Eurich, 2014)	6	ICT-enabled value creation for community pharmacies
45	(Volland & Eurich, 2014)	11	Overview of prototype system architecture
46	(Widiyatmoko et al., 2017)	8	Global task coordination (GTC) framework
47	(Bork et al., 2019)	681	The Digital Product Design Framework
48	(Töhönen et al., 2020)	9	Conceptual Framework with three perspectives for valuing IT
49	(Margherita et al., 2020)	6	Framework of Organizational Agility Development
50	(Daras et al., 2019)	361	SDSS development workflow
51	(Daras et al., 2019)	363	SDSS architecture and development toolkit
52	(Goldkuhl & Karlsson, 2020)	1248	ME-DS Process Model
53	(Kang & Zhou, 2019)	5	A hierarchical framework of product features and two illustrations
54	(Widjaja & Gregory, 2020)	670	Heuristic Theorizing Framework