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DESIGN SCIENCE RESEARCH IN PRACTICE: WHAT CAN WE LEARN FROM A LONGITUDINAL ANALYSIS OF THE DEVELOPMENT OF PUBLISHED ARTIFACTS?

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ABSTRACT

Aim/Purpose	To discuss the Design Science Research approach by comparing some of its canons with observed practices in projects in which it is applied, in order to understand and structure it better.
Background	Recent criticisms of the application of the Design Science Research (DSR) approach have pointed out the need to make it more approachable and less confusing to overcome deficiencies such as the unrealistic evaluation.
Methodology	We identified and analyzed 92 articles that presented artifacts developed from DSR projects and another 60 articles with preceding or subsequent actions associated with these 92 projects. We applied the content analysis technique to these 152 articles, enabling the preparation of network diagrams and an analysis of the longitudinal evolution of these projects in terms of activities performed and the types of artifacts involved.

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Contribution	The content analysis of these 152 articles enabled the preparation of network diagrams and an analysis of the longitudinal evolution of these projects in terms of the activities and types of artifacts involved. Evidence was found of a precedence hierarchy among different types of artifacts, as well as nine new opportunities for entry points for the continuity of DSR studies. Only 14% of the DSR artifacts underwent an evaluation by typical end users, characterizing a tenth type of entry point. Regarding the evaluation process, four aspects were identified, which demonstrated that 86% of DSR artifact evaluations are unrealistic.
Findings	We identified and defined a set of attributes that allows a better characterization and structuring of the artifact evaluation process. Analyzing the field data, we inferred a precedence hierarchy for different artifacts types, as well as nine new opportunities for entry points for the continuity of DSR studies.
Recommendations for Practitioners	The four attributes identified for analyzing evaluation processes serve as guidelines for practitioners and researchers to achieve a realistic evaluation of artifacts.
Recommendation for Researchers	The four attributes identified for analyzing evaluation processes serve as guidelines for practitioners and researchers to achieve a realistic evaluation of artifacts.
Impact on Society	The contributions can help editors and reviewers when analyzing scientific knowledge generated from the application of the DSR method.
Future Research	The nine new entry points identified serve as an inspiration for researchers to give continuity to DSR projects.
Keywords	design science, evaluation process, artifact type, entry point, artifact

INTRODUCTION

Design Science Research (DSR) is a recent and mostly unexplored research method and thus continues to be recognized as a minority practice (Wastell, Sauer, & Schmeink, 2009). Researchers dedicated to the study of DSR highlight the need for studies that help to make it "more approachable and less confusing" (Baskerville, Kaul, & Storey, 2015, p. 560). The difficulties apply to all those involved in a DSR project, from its preparation up to its publication, as highlighted by Goes (2014, p. iv): "authors, reviewers, and editors struggle to understand and follow a well-understood formula for writing and reviewing design science articles". There are many controversial and even conflicting aspects in the literature on DSR, mainly in articles that present artifacts developed through the application of this method (from here on referred to as "applied DSR"). There are diverging concepts, even between articles published by the same journal, and also by the same author or research group. These occurrences are also observed in articles published in high impact journals. This scenario is understandable, considering that the DSR approach is recent and still developing.

Throughout this text, we discuss some situations that demonstrate that the issue is not minor local difficulties, but systemic problems of the approach as a whole. To illustrate the controversies of DSR texts, we highlight below some of the definitions of a central and fundamental concept of DSR: the artifact. The most widely accepted and diffused definition of an artifact is that of Hevner, March, Park, and Ram (2004), who identifiy four types of artifacts: construct, model, method, and instantiation. Gregor and Jones (2007, p. 314) presented another interpretation of the text of Hevner et al. (2004), indicating only one type of artifact that is distinct from construct, model and method: "Hevner et al. (2004), see 'constructs, models and methods' as three of the four outputs of design science, with the 'artifact' being the fourth". Meanwhile, Adomavicius, Bockstedt, Gupta, and Kauffman (2008, p. 780) identified five types of artifacts, the four of Hevner et al. (2004) plus "IT artifacts": "Design science research involves the construction and evaluation of IT artifacts, constructs, models, methods, and instantiations." Piirainen, Kolfschoten, and Lukosch (2012, p. 1090) identified five artifacts, the four of Hevner et al. (2004) plus "theory": "When formalized, DSR is about formulating valid prescriptions, design theories, how to develop classes of artifacts (constructs, models, methods, instantiations, or better theories) to fill a certain problem space."

The definitions of artifact given above do not only appear to be confusing, they really are, providing a good portrayal of the current scenario of confusion over DSR described by Baskerville et al. (2015). The definition of an artifact is just one example of the difficulties faced by researchers who seek to understand and apply the DSR approach. In the DSR literature, especially texts associated with applied research, there are many confusing and even contradictory definitions in relation to the precepts of the approach defined in the reference literature on DSR. In many of these articles associated with applied research, the authors desire (or apparently even need) to encompass all four types of artifact cited by Hevner et al. (2004). A systemic vision of a DSR project should understand it as being capable of generating one or more artifacts, using different techniques and activities of the DSR approach, interweaving artifacts and activities at different times, and being able to result in different articles. Thus, for us to be able to describe and explore the possible causes of the sources of incoherence in current texts of studies that practice the DSR method, not only will we find evidence of incoherencies between texts, but we will also explore and discuss precepts of the approach through the most frequently cited texts by researchers on the foundation DSR to present and structure their studies (which we will refer to as reference articles). We will do this by addressing diverse forms of applied DSR, especially exploring the historical paths trodden by DSR projects that resulted in two or more articles.

The identification of incoherencies in the DSR literature is part of the strategy adopted to provide evidence of the contribution of the present study. Locke and Golden-Biddle (1997, p. 1039), when studying the rhetorical practices adopted by researchers to motivate their studies, referred to this strategy as "noncoherent intertextual." In this strategy, aspects such as "major controversy," "non-consensus," "contradictory results," "opposing camps," or "raising questions" are explored. Throughout this article, we will identify incoherencies between the articles that present applied research with the DSR method and the articles of reference that divulge the concepts, techniques, and activities of the DSR method. From this problem situation, we derived the following research goal: to evaluate the observation of some of the research canons for DSR from practical experiences of DSR projects that have already been executed and published. Our secondary goals are to identify aspects that configure incongruences and contradictions, discussing complements to the reference articles in the sense of eliminating these negative aspects of the practice of the DSR method.

Some Concepts and Assumptions Associated with DSR

In this study, we adopted the definition of artifact according to Hevner et al. (2004), as did Peffers, Tuunanen, Rothenberger, and Chatterjee (2007), highlighting that these two authors are the most frequently cited in applied DSR studies, as we will observe in the Results section. According to Hevner et al. (2004, p. 77), there can be four types of artifact: "constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems)." The DSR literature does not provide an order of precedence for these four types of artifacts. It only indicates that the instantiation type of artifact must occur for one of the other three kinds. Thus, an instantiation type artifact is never the entry point for a DSR project, and it will always reference a previously developed artifact. The possibilities of entry points for a study, according to the DSR literature, are described below.

Entry Points for DSR Studies

Peffers et al. (2007) proposed a Design Science Research Methodology (DSRM) composed of six activities, with the first four presenting possible entry points for beginning or continuing a DSR study. Therefore, a DSR project can be understood as sequential activities that can be executed by one or more research groups to generate one or more articles. Thus, the entry points for a DSR study can be the input generated by the previous activity of the DSRM that is available, for instance, in the form of an article. Peffers et al. (2007) referred to these processes for beginning or continuing a DSR study as entry points, of which there can be four types:

- problem-centered initiation – identifying and defining the problems to be solved through an artifact, in other words, conceptualizing a problem;
- objective-centered initiation – defining the goal for a solution, by inference, from the definition of the problem and knowledge of what is possible and feasible;
- design and development-centered initiation – projecting and developing the artifact; and
- client/context-centered initiation – demonstrating the use of the artifact to solve one or more instances of the problem.

The four aforementioned entry points are directly associated with the first four activities of the DSRM proposed by Peffers et al. (2007): Problem identification and motivation, Define the objectives for a solution, Design and development, and Demonstration. The fifth activity of the DSRM is Evaluation, which is not considered by Peffers et al. (2007) as an entry point for DSR. This is because Evaluation demands more from researchers in terms of mastery of the artifact and from its community of users, more than is required for the Demonstration activity. It should be remembered that Demonstration is considered an entry point by Peffers et al. (2007), in other words, capable of being executed even by those that were not involved in the previous phase of the Design and development of the artifact. For Evaluation, greater involvement of researchers with the artifact is required, and they must have prior experience with the artifact in previous activities in the DSRM. The complexity involved in executing the Evaluation activity should be highlighted, especially for artifacts that focus on the context of organizations with "bundles of material and cultural properties packaged in some socially recognizable form such as hardware and/or software" (Orlikowski & Iacono, 2001, p. 121). The evaluation of artifacts in DSR is the subject of the following subsection.

Evaluation Process of an Artifact in DSR

Within the context of having the DSR approach as being "more approachable and less confusing" (Baskerville et al., 2015, p. 560), there are some scientific works that focus exclusively on discussing deficiencies and concerns over the process of evaluating artifacts. In this sense, the study conducted by Venable, Pries-Heje, and Baskerville (2016, p. 77) expresses this concern well, declaring that "the extant DSR literature provides insufficient guidance on evaluation to enable Design Science Researchers to effectively design and incorporate evaluation activities into a DSR project that can achieve DSR goals and objectives." Venable et al. defined the "paradigm of the evaluation study" dimension, in which the extreme options are: naturalistic evaluation and artificial evaluation, with only the former adhering to the principles of DSR. The deficiencies of artificial evaluation are well portrayed in Venable et al. (2016, p. 81):

> artificial evaluation involves reductionist abstraction from the natural setting (in order to assure rigour in its assessment of efficacy of the Technology artefact) and is necessarily unrealistic in the sense that it fails to adhere to one or more of the three realities (i.e., unreal users, unreal systems, or unreal problems) of Sun & Kantor (2006).

Of the three realities necessary for the evaluation process – "real users, real problems, and real systems" (Sun & Kantor, 2006, p. 616) – the perspectives of real users and real systems can be structured and analyzed within a user-centered perspective. In the Method section, we will present eight analytical questions on DSR that we developed when thinking of analyzing the evaluation process. The questions are associated with eight codes for the content analysis technique applied to the articles in the sample, with four of them directed at understanding the artifact presented by the DSR study and four codes focusing on the analysis of the reality of the evaluation processes, gauging whether real users were involved in the context of a real system.

Canons Associated with DSR

Interpreting the concepts addressed in this section, we can identify some general canons that are applied to the development of DSR studies. The canons to be adopted as analysis criteria of the sample articles include: a) there are some typical entry points associated with the DSR approach, which are expected to be perceived by researchers when considering DSR as the methodological path to be trodden in these situations; and b) the evaluation of the artifact must occur in the most realistic way possible, with a view to gauging its utility for its intended purpose. These criteria are used again for the discussion of the results.

Relationship Between DSR and Informing Science Transdiscipline

Communication channels in the context of the informational environment are characterized as artifacts because they are human creations used by senders and receivers in a consensual way (Simon, 1996). Regardless of their essence, whether physical or digital, channels essentially contain two groups of actors: the sender/informer, characterized as the one who transmits the content; and the receiver/client, characterized as the recipient of the content. Channel, informer, and client constitute the informing system that is Informing Science's main analysis unit. The informing system is broken down into the informing environment, delivery system, and task completion system (Cohen, 1999). The channel is inserted in the context of the delivery system. A good delivery system should be designed considering the demands of informers and clients, as they are typical channel users. Thus, considering the development of an appropriate communication channel for an informing system encompasses the active involvement of informers and clients in its design and evaluation. Reconciling Informing Science's terminology with the DSR approach, we have (a) the channel of an informing system to be developed and evaluated being considered as an artifact of the DSR and (b) channel informers and clients assuming the role of tester users according to the paradigm of the DSR approach. Thus, there is a very consistent link between the concepts and demands of Informing Science with DSR as an approach to the development and evaluation of artifacts.

The conceptual framework employed in the Informing Science transdiscipline works with a procedural perspective through a sender-channel-client lens (Gill & Bhattacherjee, 2009). Thus, the channel artifact always leaves open the possibility of a composition between DSR and the Informing Science transdiscipline. It is important to note that some authors who have worked on the cooperation between Informing Science and DSR, such as Gill (2016), have also highlighted the work of demonstrating and evaluating an artifact as distinct and sequential activities. Within a final step, called "use artifacts", Gill (2016, p.64) identified two work fronts: "design pilot instantiations" and "design release instantiations". Therefore, we would like to highlight that the existing intertexts between Informing Science and DSR are consistent with the foundations used to generate the contributions present in this research.

Research Method

Selection of DSR Articles to Compose the Sample

The articles associated with DSR studies were selected from the Web of Science (WoS) database. The WoS was chosen because it "represents a reasonable cross section of present science by mostly indexing journals considered 'high quality', and it serves equally well to highlight the most visible pieces of literature as any other individual database" (Piirainen et al., 2012, p. 1111). To obtain the highest possible number of scientific articles associated with DSR studies, we made a query adopting the following criteria:

a) for the "Topic" attribute, we used the terms "Design Science" and "Artifact" (or "Artefact");

b) for the "Type of Document" attribute, we used the term "Article;"
c) for the "Language" attribute, we used the term "English."

The query was executed in August of 2018 and resulted in the identification of 156 articles. These articles were first read using a skimming technique (Duggan & Payne, 2009) to identify applied DSR studies. 92 articles (59%) were identified as applied DSR studies. The 64 excluded articles were classified into three categories: (a) 48 theoretical articles focusing on the diffusion of the DSR approach; (b) 13 articles involving variations of the DSR approach, with 11 articles associated with the Action Design Research (ADR) approach and 2 articles associated with the Secondary Design approach; and (c) 3 articles that only cited Design Science, not as an approach, but as a concept.

Adopted Analysis Techniques

The identification of codes and themes for analyzing the texts of the articles followed the precepts of the content analysis technique (Miles & Huberman, 1994). The codes defined for the analysis were divided into two groups: the first encompassed the descriptive data of the artifact; the second involved the data associated with the evaluation of the artifact. These two groups of codes are described in Table 1. To analyze the articles' texts, the researcher triangulation technique (Patton, 1987) was used. For this purpose, the entire article was read and codified at different times by two of the researchers in the team, which was made up of five researchers (the authors of the present study). The results of these analyses were then consolidated by a third researcher. The identification of diverging analyses was resolved by the third researcher, who, if necessary, met with the two researchers to discuss any points of disagreement.

In addition to the content analysis, the word frequency was analyzed to help understand the rhetorical practice employed by the authors of the articles. For this purpose, the NVivo software tool for counting the frequency of words was used. In the results section, we will present the counts, for example, for the words derived from the stems "evaluat" and "demonst" in order to compare the groups of articles: those that evaluated the proposed artifacts, those that demonstrated the artifacts, and those that merely described the artifacts (without evaluation and without demonstration).

Table 1. Codes defined for analyzing the content of the articles

	Code	**Question that guided the analysis of the text of the article**
Description of the artifact	Name of artifact	What name is given to the artifact?
	Function of the artifact	What is the main purpose attributed by the developers to the artifact?
	Typical user	Who are the typical or intended users (if it is an invention)?
	Artifact type [1]	What type of artifact is it? One or more [1] of the following values may be attributed: construct, model, method, or instantiation
Evaluation of the artifact	Use of the artifact	Has the artifact been essentially used with its main function?
	Test user	Was the person that operated the artifact a typical user?
	Use environment	Was the artifact used in the environment where typical users operate?
	Inputs for use	Were data or other resources of the proper environment used for the tests?

[1] There may be multiple values considering that an article can describe a wide-ranging DSR study with the development of more than one artifact associated with the same function, e.g., the proposition of a method and its instantiation in one or more organizations.

Evolutionary History of DSR Projects: Identification of Preceding and Subsequent Articles

To analyze the evolution of DSR studies within the concept of the research project, we sought to identify articles published prior to or after each of the 92 articles associated with applied DSR. These articles should be directly associated with the same logical construction, in other words, with the development of the same technological artifact. For this purpose, we adopted the following strategies:

a) Analysis of the curricula of the authors of each of the 92 articles to identify articles associated with the artifact in question;
b) Analysis of the texts of the 92 articles to identify formally highlighted previous constructions (preceding articles) or articles that could be inferred through the citations that appear throughout the text;
c) Search for the names and acronyms of artifacts in scientific article databases (WoS, Proquest, JStor, EBSCO), social networks of researchers (ResearchGate) and the internet in general (Google Scholar).

The initial preceding and subsequent articles were identified using the following procedures: (a) skimming the article to gauge whether the article with the declared artifact belonged in the sample; if so, (b) the content analysis technique was applied to identify the texts associated with the eight codes described in Table 1. For the articles in the sample with at least one preceding or subsequent article, the evolutionary history of the project was identified through the artifact types involved in each DSR project. From this data, a table was prepared of transitions between types of artifacts that aided the preparation of a diagram of a network analysis summarizing the transitions. These resources allowed an analysis of the frequency of every possible trajectory in the development of research projects using a DSR approach from the perspective of artifact types.

Results

Table 2 presents the description of the publication of the 92 articles in the sample. From the "year of publication" topic for the sample articles, it was found that the growth in the number of DSR publications has been exponential and can be expressed by Equation 1:

$$Q = 1.5e^{(0.20Y)} \quad (1)$$

where

Q = Quantity de papers published in the year, and

Y = Year, where 2007=1

This equation adequately describes the exponential growth of publications (R^2=67.54%), and between Quantity and Year there is a very significant association (p-value: 0.0010). Observing the "subject area and category" of the journals that published the articles (through the Scimago Journal & Country Rank website - https://www.scimagojr.com/index.php), we can affirm that the publications associated with the applied study of the DSR method are concentrated in two fields: Computer Science, 78 articles (85%); and Business Management, eight articles (9%). The six remaining articles were published in 6 different fields: Economics, Environmental Science, Engineering, Multidisciplinary, Nursing, and Social Sciences.

Observing the results for the "source of articles" topic in Table 2, it can be seen that the 92 articles were published by 57 journals. In other words, article publication is not concentrated around a few journals. Regarding the country of origin of these studies, in the "Host Country of the Institution of the 1st Autor" dimension, a concentration can be seen involving institutions from three countries: United States of America (17% of the articles), Germany (14%), and Australia (12%). These countries are closely associated with the issue of authorship of the reference works on the DSR method. In the research method section, of the 92 articles in the sample, we observed that the two most cited texts are Peffers et al. (2007), cited in 68 articles (74%), and Hevner et al. (2004), cited in 40 articles (44%). Here, the co-authorships and research partnerships of the first authors of the two main reference works, both American, appear to have collaborated in the dissemination of DSR studies with institutions in Germany and Australia. The researcher Alan Hevner conducted many joint studies with Shirley Gregor (Australian), who is very active in the Australian research community. Likewise, Ken Peffers conducted many studies with Marcus Rothenberger (German), who has a strong history of activity in the German research community. Thus, we wish to provide evidence of the importance of these two reference works, not only in the dissemination of DSR studies by the institutions of several countries, but also as the main means of disseminating precepts and concepts associated with the practice of the DSR approach.

Table 2. Description of the 92 articles in the sample

Topic	**Results**	
Source of Articles (57 journals)	**Number of Articles Published**	**Names of the Journals that Published the Articles**
	7	2 JOURNALS: Decision Support Systems; MIS Quarterly
	4	2 JOURNALS: Business & Information Systems Engineering; European Journal of Information Systems
	3	4 JOURNALS: Information Systems and E-Business Management; Information Systems Frontiers; Journal of Decision Systems; Journal of the Association for Information Systems
	2	9 JOURNALS: Australasian Journal of Information Systems; BMC Medical Informatics and Decision Making; Computers in Human Behavior; Enterprise Information Systems; Enterprise Modelling and Information Systems Architectures: an International Journal; IEEE Access; Information Technology & People; Journal of Enterprise Information Management; Kybernetes
	1	40 JOURNALS: Automation in Construction; Benchmarking; Business Systems Research Journal; Computer Standards & Interfaces; Data Base for Advances in Information Systems; Education and Information Technologies; Electronic Commerce Research and Applications; Government Information Quarterly; Information & Management; Information and Software Technology; Information Research-an International Electronic Journal; Information Systems; Information Technology for Development; International Emergency Nursing; International Journal of Advanced Computer Science and Applications; International Journal of Educational Management; International Journal of Electronic Commerce; International Journal of Information Technology & Decision Making; International Journal of Physical Distribution & Logistics Management; International Journal on Information Technologies and Security; Engineering Economics; Journal of Emerging Technologies in Accounting; Journal of Information & Knowledge Management; Journal of Intellectual Capital; Journal of Internet Services and Applications; Journal of Knowledge Management; Journal of Management Information Systems; Journal of Service Research; Journal of Strategic Information Systems; Journal of Systems and Software; Journal of the American Society for Information Science and Technology; Journal of the Association for Information Science and Technology; Pacific Rim Property Research Journal; South African Journal of Economic and Management Sciences; Springerplus; Sustainability; Telematics and Informatics; Total Quality Management & Business Excellence; Transforming Government- People Process and Policy; Universal Access in the Information Society

Topic	Results			
Year of Publication of the Articles	**Year**	**Number of Articles**	**Year**	**Number of Articles**
	2007	1	2013	5
	2008	7	2014	6
	2009	3	2015	7
	2010	3	2016	12
	2011	2	2017	24
	2012	7	2018	15 [1]

Topic	Articles	Country where the Institution of the 1st Author is Located
Host Country of the Institution of the 1st Autor (30 countries)	16	United States of America
	13	Germany
	11	Australia
	6	Switzerland
	4	South Africa; Portugal
	3	Belgium; Brazil; China; Ireland; Taiwan
	2	Canada; Italy; United Kingdom; Sweden
	1	Austria; Singapore; Korea; Slovenia; Finland; Greece; India; England; Iran; Jamaica; Japan; Malaysia; Poland; Czech Republic; Yemen

[1] Number of articles published between January and August 2018

By counting the frequency of the "artifact type" code attributed to each of the 92 articles in the sample, we identified a total of 136 artifacts developed and presented by these publications. When we classified these artifacts by type, we obtained the following results: 19 artifacts of the construct type, 41 of the model type, 41 of the method type, and 35 of the instantiation type. The following frequencies of artifacts per article were observed: 56 of the 92 articles in the sample (61%) developed and presented 1 artifact; 33 articles (36%) developed and presented 2 artifacts; 6 articles (7%) developed and presented 3 artifacts, and 1 article had no artifacts. It should be highlighted that, as expected, the most frequent situation was the development and presentation of one artifact per article. Imagining the challenges of creation, the ontological challenges of presentation, and epistemological challenges of evaluation, it can be imagined how extremely challenging it would be to develop and present more than one artifact per article.

The search for preceding or subsequent articles resulted in the identification of 60 articles associated with 57 of the 92 articles in the sample, in other words, 57 (62%) applied DSR studies with a history of two or more associated articles. To analyze the sequencing of the types of artifacts produced by the 57 articles in the sample for which a preceding and/or subsequent article was identified, referred to here as DSR projects, we prepared Table 3, which summarizes the transitions between the types of artifacts found in the articles. Table 3 has the data necessary to assemble the network analysis diagram and should be read as follows: the type of artifact in the line was succeeded by the development of the type of artifact described in the column. The values of the diagram were obtained by the transitions between artifacts identified in 47 articles of the sample that presented only preceding articles, seven articles in the sample that presented only subsequent articles, and three articles in the sample that presented both preceding and subsequent articles. It is important to note in Table 3 that only the upper diagonal of the diagram is filled, showing a linear trajectory of development between the types of artifacts in the following order: construct, model, method, and instantiation. The decreasing values for the outdegree column also corroborate this statement. In this sense, the construct type artifact is the entity with the highest potential to generate other artifacts, as it indicates 32 transitions (research continuity) for the development of other artifacts. At the other end is the instantiation type artifact, a terminal artifact in terms of a DSR project.

Table 3. Transitions between the types of artifacts observed in the articles associated with the 57 analyzed DSR projects

	Construct	Model	Method	Instantiation	Outdegree
Construct	1	8	13	10	32
Model	-	8	2	2	12
Method	-	-	2	2	4
Instantiation	-	-	-	-	0
Indegree	1	16	17	14	48

With regard to the analysis of the evaluation of the artifact, from the content analysis of the codes described in Table 1, it was found that this process actually occurred in only 13 of the 92 articles in the sample (14%). The following was found: 53 articles (58%) showed an effective use of the artifact, with the code "use of the artifact" as a source; 27 articles (29%) were operated by their typical professionals, with a comparison of the content identified for the "typical user" and "test user" codes as a source; 37 articles (40%) were used in the typical environment use of these professionals, with "use environment" as a source; and 40 articles (43%) involved data and other inputs from the environment itself, with the "inputs for use" code as their source. For the 79 articles in which no evaluation process was observed, 11 of these only described the artifact, with no evidence of specific actions to indicate the occurrence of the evaluation or demonstration of the artifact. Thus, we have 68 articles that performed some kind of test of the artifact, despite not having adequately met the requirements of at least one of the four analysis codes.

When we compared the rhetoric of the 13 articles that underwent an evaluation process with the 68 articles that, despite not having met the requirements of the four analysis codes, presented a test of the artifact, we observed a significant difference at the level of significance of 0.05 regarding the average presence of the "evaluat" stems. The 13 articles that underwent the evaluation process had an average of 18.69 terms, while the other 68 articles had an average of 30.74 terms (t-test, one-sided p-value=0.0355). This seems to show that in the articles in which the evaluation process did not occur, respecting the four codes, the authors placed even greater emphasis on the evaluation process.

DISCUSSION

Longitudinal research identified 60 articles (50 preceding and ten subsequent) associated with 57 articles or DSR study projects. An examination of the corpus of texts of these 117 articles, through the content analysis technique that used the eight codes described in Table 1, allowed us to identify two types of evolution of the continuity of the DSR projects: the first associated with the evolution of the artifact in question, spanning new activities, e.g., the first article describes the artifact and the second presents the tests (evaluation process) of this artifact; the second associated with the evolution of the DSR project, encompassing a second artifact associated with the artifact that was the object of the first article, e.g., the first article presents and demonstrates a method type artifact and the second presents an instantiation type artifact (new artifact) of the method, in other words, of the first artifact.

This broader longitudinal perspective of considering and analyzing DSR projects rather than articles in isolation afforded us a better understanding of the practice associated with DSR projects. This information allowed us to address the proposed objective of this work: to discuss the DSR canons through practical experiences of DSR projects. In this section, we break the discussions down into two topics: "entry points for the continuity of DSR studies" and "artifact evaluation process." In these subsections, we identify incongruent aspects of the practice observed in relation to the DSR canons, developing and discussing content that is complementary to the reference articles in the sense of helping to provide evidence and eliminating these negative aspects of the practice of the DSR method. In other words, we seek to meet the secondary goals outlined in the Introduction.

Entry Points for the Continuity of DSR Studies

Table 3 was developed from the trajectory of DSR projects that involved two or more articles. It shows an analysis perspective of conducting and sequencing these projects based on the artifacts involved. Considering the data in Table 3, it was possible to prepare a diagram of networks (network analysis) that shows a representation of the actions that occurred over time in research projects conducted in accordance with the DSR approach. This network diagram is in the central part of Figure 1, highlighted with a grey background. We decided to include the information from the network analysis within a context of a process diagram to characterize an adapted version of the DSRM proposed by Peffers et al. (2007) regarding the issue of "entry points" for DSR. Our idea is to characterize that there are other perspectives of entry points for DSR studies in addition to those identified by Peffers et al. (2007, p. 71): "problem-centered initiation, an objective-centered initiation, a design and development-centered initiation, and a client/context-centered initiation" (defined in the section on "Entry Points for DSR Studies"). The network diagram shows that there is a precedence hierarchy for the four types of artifacts, respectively: construct, model, method, and instantiation.

Peffers et al. (2007, p. 74) highlighted the importance of entry points not only for DSR but for the practice of scientific research as a whole: "Another interesting problem is that of the research entry point. We demonstrated that there are multiple possible entry points for DS research. Of course, this issue is not unique to DS Research." Identifying other entry points is important in the sense of providing researchers with a better understanding of possible paths to follow to continue research. The longitudinal analysis of the 57 DSR projects that were given continuity beyond one article had nine opportunities for entry points for the continuity of DSR studies:

I. To improve a construct type artifact, one occurrence was observed (co-co);
II. To improve a model type artifact, eight occurrences were observed (mo-mo);
III. To improve a method type artifact, two occurrences were observed (me-me);
IV. From a construct type artifact, develop a model type artifact, eight occurrences were observed (co-mo);
V. From a construct type artifact, develop a method type artifact, 13 occurrences were observed (co-me);
VI. From a construct type artifact, develop an instantiation type artifact, ten occurrences were observed (co-in);
VII. From a model type artifact, develop a method type artifact, two occurrences were observed (mo-me);
VIII. From a model type artifact, develop an instantiation type artifact, two occurrences were observed (mo-in);
IX. From a method type artifact, develop an instantiation type artifact, two occurrences were observed (me-in).

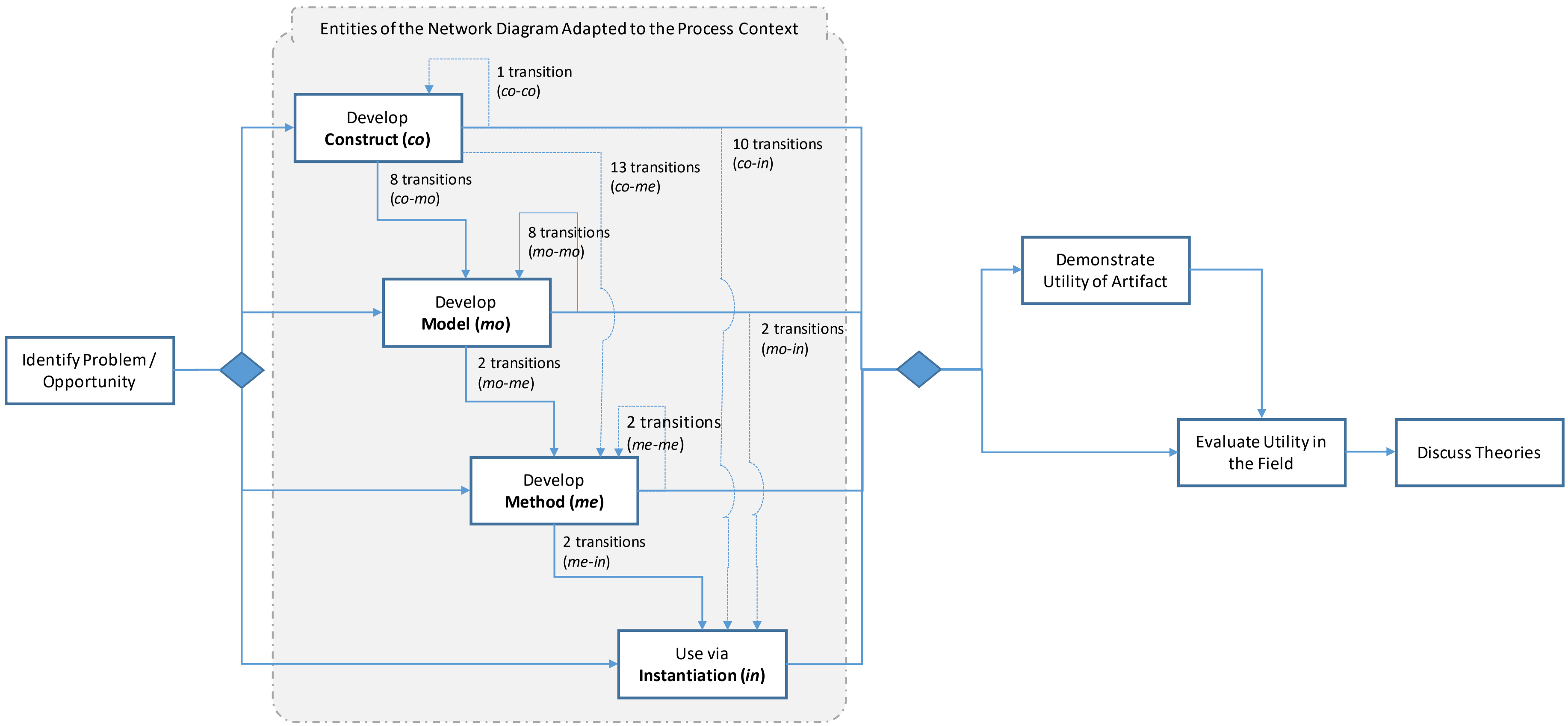

Figure 1. DSR method in the longitudinal perspective of a research project

The longitudinal perception of DSR, encompassing one or more artifacts described in one or more articles, leads to benefits for the scientific community. The first is helping to identify research opportunities, with the latest type of published artifact as a starting point. Continuity may occur through an improved artifact of the same type, or also considering the other types of artifacts that are downstream from the current one, in accordance with the sequence described in Figure 1. Thus, the explanation of the link between artifacts can be understood as a source of information transfer to help identify research problems. Another benefit lies in helping to improve understanding of the DSR approach, enabling the solution of a point of incongruence observed between the DSR canons and DSR in practice. In the 92 articles in the sample, associated with applied DSR, it was observed that, in some articles, the researchers and authors understood that research conducted using the DSR approach should generate all four types of artifact: construct, model, method and instantiation. In the following paragraphs, we will present and analyze two articles from the sample that presented this kind of incongruence.

The high number of artifacts indicated often results from the aggregation of artifacts developed with the artifacts used to support this development. An example is the article Flory, Osei-Bryson, and Thomas (2017), which developed two artifacts and, for this purpose, used two other artifacts that already existed. However, the text of Flory et al. (2017, p. 21) indicates that four new artifacts were created in their research:

> [...] our theoretical contributions include novel design science (DS) artifacts of four types: (1) construct: review quality analysis as an automated approach to help consumers make sense of online reviews; (2) model: the architecture of the IUSR Analyzer; (3) method: the DPSO-KM and RURanking algorithms; (4) instantiation: the IUSR Analyzer prototype.

Likewise, the article of An and Kim (2018, p. 3) has a very wide-ranging and ambitious text in terms of types of artifacts developed in their study:

> This study therefore adds to the knowledge base by providing foundational elements such as constructs (definitions, frameworks, and applications), a model (classification model), a method (analysis), and instantiations (applications).

It would be ideal if researchers clearly indicated the types of artifacts developed in their research, pointing out those that can be developed later, in other words, opportunities for the continuity of the research project. In the article by Genemo, Miah, and McAndrew (2016, p. 11), there is a highly illustrative declaration in this respect:

> At this stage the development will concentrate on building constructs and model artefacts. Once the development, building and evaluation of the two artefacts are established, the research will progress to the next artefacts - methods and instantiations- development and building.

ARTIFACT EVALUATION PROCESS

When comparing the DSR approach epistemologically with other approaches, it is very common to cite and contrast the "build-and-evaluate" phases of the design cycle (Hevner et al., 2004) with the "justify-and-theorize" phases of the other approaches (Baskerville et al., 2015). Declaring that evaluation is one of the two central phases of the DSR cycle demonstrates the epistemological importance of the evaluation process of artifacts within the DSR approach. This process should help to answer a fundamental question of the DSR approach regarding the proposed artifact: "how well does it work?" (March & Smith, 1995, p. 258). Due to the importance of analyzing the utility of the artifact with regard to the DSR approach, we understood that it was necessary to execute it as fully and effectively as possible. Considering that only 14% of DSR projects actually evaluated the artifact, it configures a context of effective opportunity for the continuity of DSR projects from the perspective of activities for execution.

From this perception, we developed the questions associated with the four codes to analyze the evaluation process described in Table 1: use of the artifact, test user, use environment, and inputs for use. With these questions, we wish not only to identify the articles that effectively evaluated their artifacts, but especially understand how the evaluation process is conducted in applied DSR projects. As in the previous subsection, we will identify incongruent aspects of the practice observed in the 92 sample articles regarding the DSR canons associated with the evaluation process. For each contradictory aspect identified in the sample, we will discuss other examples from the sample that may be considered totally correct and in coherence with the DSR canons. Thus, as in the previous subsection, our aim in this part of the text is equally complementary to the reference articles in the sense of helping to pinpoint and eliminate negative aspects identified in the practice of the DSR method.

Aspects associated with the test users of the artifact

Many of the 92 applied DSR projects that we analyzed involved typical users only to gather their opinions after a demonstration of the artifact. Therefore, it is important to note not only whether typical users were identified and their involvement, but also the type of involvement they had with the use of the artifact. In pragmatic terms, this means observing whether the test user, the one who used and tested the artifact, is the same as the typical user for whom the artifact was initially intended. It is important to recall the data presented in the results section: only in 27 articles (29%) were the proposed artifacts operated by typical users. The use of the artifact by test users who were not typical users was identified in only a few articles as a limitation of the study, as shown in Table 4.

One of the risks to the evaluation process is not involving typical users in testing the artifact, replacing them with others that are more easily available to the researchers, test users of convenience to the researcher. As many DSR artifact developers are associated with universities, a highly recurring situation is the involvement of researchers' students in the process of evaluating artifacts. Owing to the constant contact between a researcher professor and his students and the hierarchical relationship between them, involving students in the testing of artifacts is a quick and easily implemented process. Bono and McNamara (2011, p. 658), when discussing aspects related to the mismatch between the research question and design, pointed out the involvement of "students with limited work experience to participate in experimental research" as an epistemological deficiency. In the case of DSR, the testing of artifacts by students is also an important limitation, considering that students usually have a very different profile from that of the professionals for whom the artifact was projected.

It was also observed that the practitioners of an artifact are not always characterized as a specific group of professionals, as some artifacts can meet the needs of several groups of professionals. For example, De Sordi, Meireles, and de Oliveira (2016) describe an artifact intended for people who edit (include, exclude, and alter) extensive texts and are prone to a lack of cohesion between the sets of texts in their documents. The proposed artifact is recommended for "workers developing extensive texts, such as auditors, consultants, analysts, lawyers, researchers, and writers, as well as workers who analyze, select, and read such texts, including editors, managers, judges, researchers, and scriptwriters" (De Sordi et al., 2016, p. 911). The evaluation process in the article of De Sordi et al. (2016) involved different types of professionals who edited different types of extensive documents: books, consulting reports, dissertations, research reports, and theses. In these situations, it is important to clearly define the class of the problem and mention the main collectives of users who can benefit from using the artifact.

Table 4. Excerpts from texts associated with the limitations regarding the test users

Article:	Umapathy, Purao, and Barton (2008)
Name of the artifact:	Designing enterprise integration solutions (p. 518)
Function of the artifact:	A design artifact that embeds a methodology for assisting designers in developing integration solutions based on design strategies represented in integration patterns (p. 525)
Typical user of the artifact:	USER ENTERPRISE INTEGRATION PROFESSIONAL ─ The second pre-requisite for developing effective enterprise integration solutions is the expertise that the enterprise integration professional brings to the project. (p. 519)
Test user of the artifact:	USER STUDENT ─ The subjects were recruited from a pool of students enrolled in an 'Advanced Enterprise Integration' course (p. 523)
Identified limitation:	As a result, our sample does, at least to some extent, represent individuals who will become enterprise integration professionals. (p. 525)
Article:	Sarnikar and Deokar (2017)
Name of the artifact:	Design Approach for Process-based Knowledge Management Systems (p. 1)
Function of the artifact:	In this research, the artifact is the novel design process for developing PKM [Process-based Knowledge Management] systems. (p. 6)
Typical user of the artifact:	USER SYSTEM ANALYST ─ We contribute to practice by creating artifacts that can readily be used by systems analysts and an approach (p. 30)
Test user of the artifact:	USER STUDENT ─ The participants were 14 students in a graduate knowledge management class who had completed a basic overview of knowledge management concepts and knowledge management processes. (p. 26)
Identified limitation:	One limitation of this study is the small sample size of the feasibility study used to evaluate the ease of use and utility of our approach. (p. 30)

For some artifacts, it is not always easy to identify and define typical users, even for the developers who are proposing the artifact. This is especially true in the case of invention type artifacts: new solutions for new problems (Gregor & Hevner, 2013). In this context, where everything is new, it is not always possible to define very clearly who the agent is that will operationalize the artifact. Given that inventions are rare events and that most artifacts are improvements of existing artifacts (Gregor & Hevner, 2014), the target public of an artifact is expected to be clearly defined for the vast majority of applied DSR projects. In one-off situations, when artifacts are classified as inventions, we are more likely to see a further demonstration of the artifact than an evaluation. This is because the target audience is very often uncertain or even unknown. A point in question is the invention presented in the article of Cascavilla, Conti, Schwartz, and Yahav (2018) – a system for Detecting Unintentional Information Leakers (DUIL artifact). The text does not refer to a specific group of professionals as typical users, but rather possible user organizations: public, private, and social organizations. The second last section of the article of Cascavilla et al. (2018), before the Discussion section, coherently labels the actions performed during the project as Demonstration instead of Evaluation.

Aspects associated with the use environment for testing the artifact

Considering that "the goal of design-science research is utility" that "seeks to create what is effective" (Hevner et al., 2004, p. 80), the effectiveness of the artifact lies in its use in an ideal environment. The ideal use environment is understood as the most common and preferred place for typical users. If the evaluation process identifies the use of an artifact in a place other than the natural use environment of the typical user, we should highlight this aspect as a limitation of the study. Table 5 includes excerpts from texts of some of the 92 articles in the sample that highlight as a limitation the use and testing of the proposed artifact in a use environment other than the natural one.

Table 5. Excerpts from texts regarding limitations of the use environment of an artifact

Article:	Venkatesh, Aloysius, Hoehle, and Burton (2017)
Name of the artifact:	Shopping assistance artifacts (p. 1)
Function of the artifact:	Help in-store customer (i.e., shopper) purchase decisions with auto-ID scanning functions that provide product descriptions and customer product reviews. (p. 2)
Use environment:	The retail store laboratory was designed to appear similar to a retail store in its layout and was set up as a mock storefront for "Acme Products" (p. 15)
Identified limitation:	We conducted our experiment in a laboratory environment including a relatively small store front offering a limited number of product options. When major retailers begin to enable mobile RFID applications in their stores, future research could replicate our work in an actual store environment in which shoppers purchase products. A test in the field could examine the ecological validity of our conclusions (p. 24).
Article:	Lim, Mostafa, and Park (2017)
Name of the artifact:	A tourist mobile application called "EATJOY" (p. 2)
Function of the artifact:	The application helps to revive the famous Japanese "Omotenashi" culture which means "Japanese style of providing hospitality" (p. 2) [...] exploring tourists' sustainable values of experiences and local staffs' behaviors (p. 1)
Use environment:	a test site was made similar to a local restaurant setting (p. 15)
Identified limitation:	However, there are some limitations in this study. [...] Second, while the observations were taken from real-life study fields, the utility test was made in artificial conditions as a lab experiment (p. 18)

All 92 articles from the sample were identified as being of an intangible nature: construct, model, method, or instantiation of logical abstractions. Broadening this analysis to articles from the initial selection, of the 156 articles prior to exclusions, only one article of a physical nature was found: a "laptop trolley" used in hospital environments to help healthcare professionals to access patients' data (Weeding & Dawson, 2012). Thus, as expected, in the fields of Computer Science and Business Management (94% of the articles in the sample) artifacts of an intangible nature are predominant. Regarding the use environment of these artifacts, there is more variation, with some depending exclusively on the virtual environment, others on the physical environment and others on both the virtual and physical environment. The two artifacts described in Table 5 were conceived for scenarios to help their typical users in the field. In other words, typical users must be in specific use environments. For instance, the artifact in the article of Venkatesh et al. (2017) helps shoppers to access information and analytical reviews of products when they are in the shopping environment, with the product in their hands:

> mobile applications that will help in-store customer (i.e., shopper) purchase decisions with auto-ID scanning functions that provide product descriptions and customer product reviews (Venkatesh et al., 2017, p. 2).

Very similar to the artifact in the article of Venkatesh et al. (2017), the artifact described in the article of Flory et al. (2017) is also intended to aid consumers during the purchase process by analyzing customer product reviews posted on the internet. The artifact in the article of Venkatesh et al. (2017) is intended to provide information on physical products, while that of Flory et al. (2017) focuses on the sale of services. Whereas the reviews on the artifact in the article of Flory et al. (2017) can be accessed and used from any environment, that of the article of Venkatesh et al. (2017) requires the customer to have the product in his hands, in other words, to be preferentially in the store at the point of sale. For the artifact in the article of Venkatesh et al. (2017) to access customer reviews, the user's handheld device must be equipped with a barcode scanner or RFID reader to identify the product. Thus, the artifact in the article of Venkatesh et al. (2017) is dependent on a specific environment for a realistic evaluation process, while the artifact in the article of Flory et al. (2017) can be evaluated irrespective of physical location. It should be observed that even an intangible artifact may have requirements regarding the ideal test environment. Thus, the use environment of the artifact by the test users must be considered important when it comes to analyzing the quality of the evaluation process.

Aspects associated with the inputs used to test the artifact

In addition to observing the location where the artifact is used, and the person who operates it, an analysis of the inputs that enable it to function (normally data in the case of intangible artifacts) is equally important to the effectiveness of the evaluation process. The inputs must be obtained directly for the context of the use environment. In other words, they need to be realistic. An example is the article of Marques et al. (2017), which focuses on monitoring nurses' hand hygiene (HH) procedures. The evaluation process of the artifact required the gather of data on the (i) movements of 24 nurses in an Intensive Care Unit and (ii) use of equipment for the nurses' HH. The data were gathered using beacon sensors and broadcast using Bluetooth technology installed at the entry points of each environment or close to patients, as well as the devices available for HH. The mobile devices of every nurse captured these signals from the beacons and transmitted them to a server that updated the data and made them available for a hospital gamification system. The game is based on the comparative information on the nurses, showing which came closest to meeting the HH demands during their shift. Thus, the game became one of the hospital's means of monitoring HH compliance.

Providing realistic inputs is not always a trivial activity, especially when there are many concomitant challenges, such as those associated with a DSR project: having creative insight (new solution and/or new problem), conceiving the logical architecture of the artifact, developing the physical project of the artifact, implementing the artifact and using it for the purpose of evaluation, in other words, in a real context (typical user operating it in its typical use environment, involving data and other natural inputs of the work environment). In some of the articles in the sample, the researchers stated the limitation of the evaluation process in terms of restrictions associated with the quality of the inputs (data) used, according to the excerpts of the texts highlighted in Table 6.

Restrictions associated with input data can exist for different reasons. The restriction in the article of Wimmer, Yoon, and Sugumaran (2016) is associated with the low diversity of sources, in this case, few sources in relation to the context of reality. The restriction in the article by Nussbaumer, Matter, Porta, and Schwabe (2012) is associated with the alternative source (students), which is different from the one used in real life (investors). In many of the articles in the sample, we observed caveats in relation to the use of fictitious data from case studies and databases available in scientific repositories, as well as the use of masses of test data generated from specific tools for this purpose. In all of these situations, the problem lies in the differences between the data used in the evaluation process and data from the natural use environment that will provide the inputs for the effective use of the artifact.

In this section, we observe another form of the use of students becoming a source of bias in applied DSR. In addition to using them to replace the typical professionals who should use the artifact, as shown in "Aspects associated with the test users of the artifact, in this subsection we observed the use of students as investors, in other words, in the role of the typical client of the artifact to be manipulated by the professional (advisor). Thus, the interaction of students with artifact tests during the evaluation process should be observed very carefully. This situation will only make sense in certain contexts, such as the evaluation process of artifacts intended for the field of education. This arrangement of involving students in the evaluation of artifacts was observed in the articles of McNaughton, Rao, and Mansingh (2017), Krakauer, Serra, and de Almeida (2017) and De Sordi et al. (2016).

Table 6. Excerpts from texts regarding limitations on inputs to operate an artifact

Article:	Wimmer et al. (2016)
Name of the artifact:	Multi-Agent Privacy Preserving for Medical Data (MAPP4MD) (p. 2)
Function:	Approach for preserving privacy at the data source while integrating multiple data sources for knowledge discovery for evidence based medicine (p. 2)
Ideal input:	DIVERSIFIED SOURCE ─ Supporting evidence based medicine (EBM) and clinical decision making (CDM) requires access to accurate predictive models and a multidimensional patient view that is aggregated from multiple sources in a multitude of configurations (p. 1)
Input used:	RESTRICTED SOURCE ─ While MAPP4MD has performed well in our evaluation with limited datasets (p. 14)
Limitation of input:	While MAPP4MD has performed well in our evaluation with limited datasets, it has to be evaluated using larger datasets from an actual healthcare organization to make definitive conclusions. (p. 14)
Article:	Nussbaumer et al. (2012)
Name of the artifact:	Collaborative tabletop artifacts (p. 347)
Function:	We present a design science research cycle on how cost transparency may be provided in client-advisor encounters as a feature of collaborative tabletop artifacts. (p. 347)
Ideal input:	INVESTOR AS SOURCE ─ [doubts and opinions] of the population of investors. (p. 359)
Input used:	STUDENT AS SOURCE ─ Our evaluation involved 12 clients and 2 advisors from a medium-size Swiss bank. [...]The recruited participants (9 of them being students) were between 21 and 48 years of age, 5 of them being female, (p. 355)
Limitation of input:	We acknowledge, however, that the majority of client participants were students rather than “real” investors. (p. 359)

Aspects associated with the use of the artifact

In an applied DSR study, it is expected that the artifact will be used effectively. If the artifact is not used, clearly the three conditions analyzed in the previous subsections will all be impossible to analyze (test user, use environment, and inputs for use). In that kind of situation, the evaluation process is even more severely limited and perceivable by the reader and should be equally highlighted by the researchers. An example is the article of Van Biljonet, Marais, and Platz (2017), which clearly indicates the non-use of the artifact: “the evaluations were focused on the content and functionality and not on user experience” (p. 10). Aware of this limitation, the authors formally recognize it in the text: “the findings are limited by the fact that the evaluation excluded user experience evaluation” (p. 18).

Conversely, there are DSR studies that, despite having effectively used the artifact, did so without observing the other three conditions (codes) analyzed. This is the typical case of testing an artifact through a laboratory experiment: test user who is not a typical user, generally the researchers themselves operating the artifact; use environment that is not a typical environment, for example, a laboratory at a university or research center; and with a historical data mass developed by the researchers or generated by specialized test software. The article of Wastell et al. (2009) is one of the sample articles that were tested through a laboratory experiment, with the authors pointing out this limitation: "Of course, the simulation is not the real thing, and external validity is inevitably problematic, as for any laboratory experiment. Such limitations are certainly recognized here." (Wastell et al., 2009, p. 345).

It is important to highlight that in the applied DSR literature, taking as an example the 92 articles analyzed, there are various other scenarios beyond non-use and use through a laboratory experiment. Although the DSR reference articles clearly state the use of the artifact as the central activity of the evaluation process, many articles in the sample adopt and practice other actions, labeling them as artifact evaluation processes. An example of this is the article of El-Mekawy, Rusu, and Perjons (2015), which pointed out the action of interviewing users after a demonstration of the artifact: "Finally, the framework was evaluated by interviewing five business consultants and seven IT managers" (p. 1). The article of Miah, Kerr, and von Hellens (2014) stated that a focus group had been formed with typical users: "The UCDE enables end-users to apply locally specific and contextual knowledge using [...] and other aspects were positively evaluated using focus groups method which is justified for artefact refinement and evaluation in design science research paradigm" (p. 274). The article of Shrestha, Cater-Steel, Toleman, and Rout (2018) combined both these techniques, focus group and interviews, as evaluation processes: "The SMPA method was evaluated with focus group discussions of SMPA survey participants and one-on-one interviews with the assessment facilitators at the two IT service providers" (p. 6). These situations demonstrate the importance of observing the four codes identified and used in this study to analyze the evaluation process, striving for a clearer and more objective definition of it.

CONCLUSION

The longitudinal analysis of research projects using the DSR approach helped to characterize some problematic aspects of the approach and opportunities for the continuity of DSR projects. First, it was observed that the central concept of the approach, the artifact, is not clearly defined in applied DSR studies. Adopting the definition of artifact from reference articles resulted in the identification of a precedence hierarchy among different kinds of artifacts and nine opportunities for entry points for the continuity of DSR studies. Regarding the activities of the DSR approach, the use of four codes for analyzing the artifact evaluation process was identified and demonstrated: use of the artifact, test user, use environment and inputs for use. An analysis of studies using these codes found that 86% of the evaluations of DSR artifacts are artificial and unrealistic, and are also characterized as opportunities for the continuity of DSR projects.

The four codes identified for the analysis of the evaluation process serve as guides for researchers to conduct a realistic evaluation of artifacts and provide support for editors and reviewers when it comes to analyzing articles that apply the DSR approach. From a pragmatic viewpoint, it would be highly opportune for journals that concentrate on the publication of scientific artifacts to ask authors to provide information on the type of artifact or artifacts that have been developed and presented in their research, along with details of the evaluation process conducted using the four codes. These five items (type of artifact, typical user, typical environment, typical input and use of the artifact) could be listed as meta-information, for instance, in the structured abstract provided by the authors upon submission of their articles. These recommendations, publicized in the "Instructions for Authors" section of the journal, would characterize a direct communication with the generators of content on the applied DSR approach, the researchers, configuring an effective action in the sense of making the approach "more approachable and less confusing."

A limitation of the present study is the lack of a discussion on the passage between two activities of the DSR method described in Figure 1: from "evaluate utility in the field" activity to the "discuss theories" activity. Although the DSR lifecycle is in its early years and continues to require a better conceptualization and structuring as an approach, we observed that some recent applied DSR projects, with follow-up articles, have begun to propose and discuss theories. Gregor and Hevner (2013) referred to this type of contribution to DSR as "Level 3". At this third and final level of the DSR project, researchers already have a better understanding of the problem and solution spaces. Thus, the results of using the new artifact in reality under study allow researchers to formulate mid-range design theory (Gregor & Hevner, 2013). Considering the exponential growth observed in articles using the DSR approach, the analysis of nascent theories through DSR projects configures an opportunity for the continuity of this research.

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