Knowledge Contribution Diagrams for Design Science Research: A Novel Graphical Technique

David G. Schwartz[1(✉)] and Inbal Yahav[2]

[1] Bar-Ilan University, Ramat-Gan, Israel
david.schwartz@biu.ac.il
[2] Tel-Aviv University, Tel-Aviv, Israel

Abstract. We extend Gregor and Hevner's knowledge contribution framework (KCF) to cover complex IS artifacts comprised of multiple sub-artifacts. Drawing from the work of Lee, Thomas, and Baskerville which advocates a return to the IS artifact in design science research, we initially extend knowledge contribution evaluation to include distinct information, social, and technology artifacts, by adding graphical elements to create a Knowledge Contribution Diagram (KCD). Additional artifact types are added to show extensibility and expressive power. We demonstrate the approach on four research articles, two from the original set classified by Gregor and Hevner, and two from more recent publications. KCD create an expressive visual evaluation tool. Better articulation of multiple knowledge contributions from complex information system artifacts can improve the appreciation of DSR knowledge contributions in the field. The proposed technique is intuitive, extensible, and can add expressiveness to all design science research reporting.

Keywords: Design science · Knowledge contribution · IS artifact · Graphic

1 Introduction

Knowledge contribution (KC) is a measure for assessing the value of individual research projects, as well as the overall direction taken by an academic discipline [1–3]. Knowledge contribution is often insufficiently articulated by authors resulting in lower potential acceptance of a research manuscript, and underappreciation of the value of a manuscript once published. Expressing the knowledge contribution of a new design is inherently challenging [4–6]. In fact, a meta-analysis of Design Science Research (DSR) research efforts reports that less than half of DSR articles effectively report knowledge contribution, showing only a modest increase over time [7]. Gregor and Hevner [8] explicitly address the challenges of presenting DSR for maximum impact, by analyzing 13 articles published in MISQ ([8] pg 348, Table 2), placing particular emphasis on expressing the contributions of artifact abstraction, and positioning such contributions within a formal and structured DSR Knowledge Contribution framework (KCF, Fig. 1). They focus their efforts on the "role of the IT artifact as a basis for appreciating levels of artifact abstractions that may be DSR contributions" ([8] pg 339). It is the focus on singular IT artifact knowledge

L. Chandra Kruse et al. (Eds.): DESRIST 2021, LNCS 12807, pp. 174–187, 2021.
https://doi.org/10.1007/978-3-030-82405-1_19

contribution that we address in this paper. Gregor and Hevner footnote that they use the term 'IT artifact' as synonymous with 'IS artifact', and there is nothing in their presentation that precludes the use of their framework to map multiple artifacts. DSR projects are recognized as complex and can offer multiple varied contributions to design knowledge [9]. Yet the original analysis of 13 articles addresses a singular one-dimensional artifact and contribution from each paper. While some have questioned the efficacy and completeness of the framework [10], we believe that taking an expanded view of 'IT artifact', and graphically presenting knowledge contribution, will lead to a more effective use of KCF uncovering more and varied contributions, to the benefit of the field.

Academic discourse in the IS field has long considered the 'information technology (IT) artifact' as the atomic-level item of interest in DSR. This approach has been challenged by Lee, Thomas, and Baskerville [11] who advocate unpacking the IT artifact into a separate 'information artifact', 'technology artifact', and 'social artifact' which, when taken together, comprise an 'information system (IS) artifact', a position hotly debated [12]. We contribute to this debate by taking the ideas espoused by Lee et al. and using them to expand the DSR Knowledge Contribution framework of Gregor and Hevner [8]. In doing so we achieve two significant outcomes: a compelling empirically-grounded argument in favor of the IS-artifact approach; and the introduction of Knowledge Contribution Diagrams (KCD) which adds significant expressiveness to the presentation of DSR. After a brief review of the two primary building blocks for our work – the KCF and the IS-artifact approach, we introduce KCD through an example from Cascavilla et al. [13] where the technique is first demonstrated. This is followed by analysis of four DSR articles - two revisited from the set analyzed by Gregor and Hevner in their original work, and two from recent DESRIST proceedings. A series of examples drawn from the article set illustrates the additional expressive power of the approach.

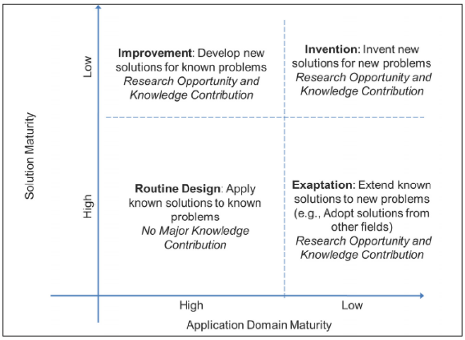

Fig. 1. The DSR knowledge contribution framework (from [8])

1.1 The Knowledge Contribution Framework

The KCF is meant to assess contribution relative to x:problem maturity (also referred to as *application domain maturity*) and y:solution maturity. Scaling regions of high and low for each axis gives the four quadrants of: *Routine design* (high, high) applying known solutions to known problems; *Exaptation* (low, high) extending known solutions to new problems; *Improvement* (high, low) developing new solutions to known problems; and *Invention* (low, low) inventing new solutions for new problems. Of the original thirteen articles analyzed, 10 (77%) were classified as *improvement*, 3 (23%) as *exaptation*, and none as either *routine design* or *invention.* At first this may seem surprising as one would expect DSR work to regularly report some form of invention and incorporate, to a lesser extent, routine design. However, when we look at the component breakdown, as will be shown later, we see a very different picture.

1.2 The IS-Artifact Approach

There has been considerable debate around the question of artifacts and their centrality to DSR. Much of DSR work describes information technology (IT) artifacts, which Orlikowski and Iacono [14, 15] define as “bundles of material and cultural properties packaged in some socially recognisable form such as hardware and/or software”. However, not all agree that the “bundled” IT artifact should be the focal point of information systems research in general and DSR in particular. Lyytinen and King [16] note that IT artifacts do not deliver value in their own right and must be viewed in the context of a system. Schwartz [17] advocates the decomposition of IT artifacts into several distinct yet interconnected artifacts. Lee Thomas, and Baskerville [11] suggest a multi-artifact view when approaching DSR, arguing that the IT artifact is just one element within a broader Information Systems artifact, which should be viewed as a construct incorporating information, social, and technology artifacts – and must be addressed as such in DSR. They define a framework comprised of three major elements (not to the exclusion of other potential elements, as they discuss) as follows: (1) A *Social artifact* is an artifact embodying relationships or interactions among multiple individuals; (2) An *Information artifact* is an instantiation of information produced by a human participant either directly (as their own creative output) or indirectly (through an individual’s invocation of a software program or other automated information production process); (3) A *Technology artifact* is a human-created tool used to solve a human-defined or perceived problem. All three interact within a broader systems framework achieving a result that is greater than the sum of its parts, comprising the IS artifact. But as Lee et al. ([11], pg 6) state “*An examination of the larger system of which any IT artifact is necessarily a part quickly expands the focus from IT artifacts to include artifacts that are not IT and artifacts that are created by people who are not IT designers. We may conceptualize these different artifacts as enabling, interacting with and even transforming one another.*” By following their analytical approach, the precise contribution of each element in DSR comes into sharper focus. For a discussion of the applicability and value of the IS-artifact framework the reader is referred to [11, 13]. We will refer to the approach defined by Lee, Thomas, and Baskerville as the IS-artifact framework. We give a motivating example illustrating the use of three artifact types in the IS-artifact framework, then extend this to diverse DSR knowledge contributions such as *design principles* [18], *design theory* [19], and a potpourri of others [7]. In this manner we add component level analysis to the existing systems level analysis.

1.3 Motivating Example

The first use of an enhanced graphical KCD to present an information system artifact appears in [13], which we repeat here by way of introduction. That work describes an IS-artifact that consists of five distinct modules as part of an *information system* artifact to Detect Unintentional Information Leakage (DUIL). In their DSR analysis of the DUIL artifact the authors examine knowledge contribution by applying the KCF which, accordingly, classifies their artifact in the *improvement* quadrant owing to low *problem maturity* and high *solution maturity* of the overall system. However, the authors go a step further by breaking down the overall IS-artifact into **five component artifacts** following the IS-artifact framework. The result is two *information artifacts* - articles of interest (AoI); comments of interest (CoI)*;* two *technology artifacts* - network analysis (Egonet); and visualization (Viz); and one *social artifact* - users of interest (UoI). Each of these artifacts were then assessed for knowledge contribution according to KCF and assigned their own symbology as shown in Fig. 2. This allowed the authors to present and discuss the specific contributions of each module, showing some elements could be considered *routine design* and others *exaptation*, leading to a higher level artifact exhibiting *improvement*, bordering on *invention*. This six-fold contribution analysis of what would have been a single DSR artifact stands in sharp contradistinction from the currently accepted single contribution approach.

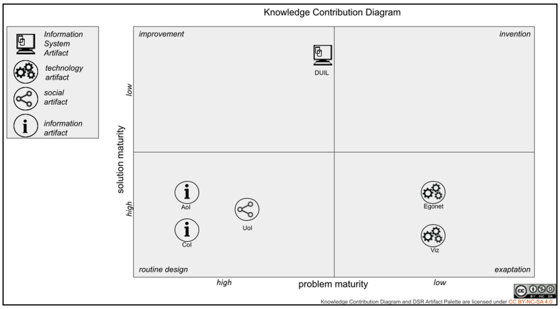

Fig. 2. KCD for "The insider on the outside: a novel system for the detection of information leakers in social networks" [13]

2 Knowledge Contribution Diagrams

We define a Knowledge Contribution Diagram as *a graphical representation of one or more design science artifacts on a knowledge contribution grid to present the contribution of each artifact in terms of problem maturity and solution maturity.* A KCD template consists of a 2 × 2 grid on the axes of *problem maturity* and *solution maturity* alongside a palette presenting a library of information technology-related artifacts that can be drawn upon to complete the diagram. The choice of artifacts to include in the palette is wholly subjective and extensible. Following Lee et al. [11] our initial KCD template included only

Table 1. Artifacts and icons

Artifact	Acronym	Icon
Information Systems Artifact	ISA	
Technology artifact	TA	
Social artifact	SA	
Information artifact	IA	
Policy artifact	PA	
Guideline artifact	GA	
Theory artifact	ThA	
Principle artifact	PrA	

information system, *technology*, *information*, and *social* artifacts; however given the diversity of knowledge contribution found in DSR articles, we have extended this to include icons for *policy*, *guideline*, *design theory*, and *design principle* [7]. To simplify our textual discussion of the graphic-analytical framework we refer to the artifacts by acronym as per Table 1.

3 Methodology and Data

Using a purposeful sampling approach [20, 21] we conducted qualitative text analysis of four DSR articles listed below, two from the original set discussed in Gregor and Hevner and two from DESRIST proceedings. According to Patton, "*The logic and power of purposeful sampling lie in selecting information-rich cases for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the inquiry, thus the term purposeful sampling. Studying information-rich cases yields insights and in-depth understanding rather than empirical generalizations* ([20, 21] p. 230)." We followed the content extraction process detailed by [7] to identify and extract information such as a research summary, artifact description, and any knowledge contribution declared by the authors. The use of key quotes from the target manuscripts to identify knowledge contributions follows the approach of [8].

The following four articles were selected:

1. Abbasi, A., Zhang, Z., Zimbra, D., Chen, H., and Nunamaker, J., Detecting Fake Websites: The Contribution of Statistical Learning Theory, MISQ, 2010 [22].
2. Adipat, B., Zhang, D., and Zhou, L., The Effects of Tree-View Based Presentation Adaptation on Mobile Web Browsing, MISQ, 2011 [23].
3. Hönigsberg, S., A Platform for Value Co-creation in SME Networks, DESRIST, 2020 [24].
4. Brahma, A., Chatterjee, S., & Li, Y., Designing a Machine Learning Model to Predict Cardiovascular Disease Without Any Blood Test, DESRIST 2019, [25].

4 Results

Content analysis of the four DSR articles yielded 15 identifiable sub-artifacts with independent knowledge contribution (MAX = 5; MIN = 3; AVG = 3.75). Seven technology artifacts, three information artifacts, two guidelines, one theory, one principle, and one social, were identified. Knowledge contribution was spread across all four quadrants: six exaptation, four improvement. three invention, two routine design. Detailed analysis of each article in a table documenting component decomposition and knowledge contributions, along with the resulting KCD, follows.

4.1 Case 1

In this case, the identification of two technology artifacts and one information artifact gives us the first indication that there are component-level aspects to this project that

Table 2. Analysis of "Detecting Fake Websites: The Contribution of Statistical Learning Theory" [22]

System artifact	Original KC	Basis
Fake website detection	Improvement	"Systems grounded in SLT can more accurately detect various categories of fake web sites" (p. 435)
Component decomposition		
Component artifact	Component-level KC	Basis
TA: custom kernel functions	Exaptation	"Custom kernels have been devised for many classification problems… studies have noted that fake website detection could greatly benefit from the use of custom kernel functions, although none have been proposed…" (p. 442)
IA: fake fraud cues	Routine Design	"The set of fraud cues required to represent these design elements for accurate fake website detection may encompass thousands of attributes." (p. 442)
TA: page level linkage display	Improvement	"although component 1 sufficiently conveys the system's classification results, additional components… illustrate why a particular website is considered legitimate or fake" (p. 449)

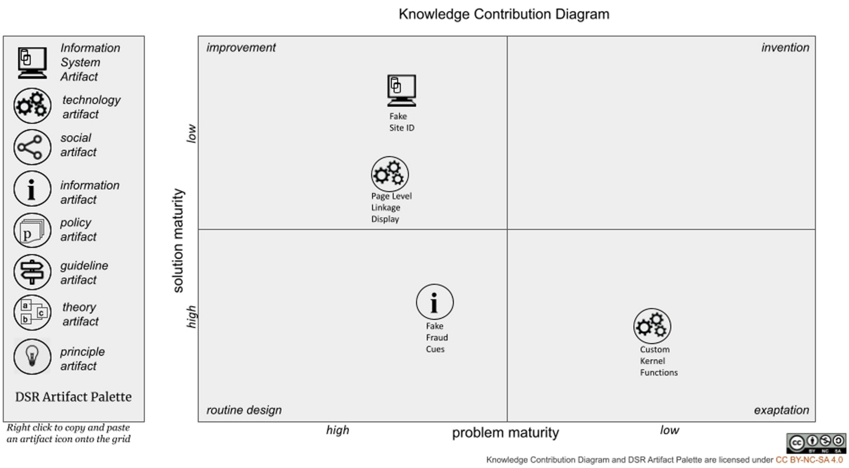

Fig. 3. KCD for "A fake website detection system" [22]

could be of interest to the reader and there is potential contribution beyond that found at the systems level (Table 2 and Fig. 3).

Table 3. Analysis of "The Effects of Tree-View Based Presentation Adaptation on Mobile Web Browsing" [23]

System artifact	Original KC	Basis
A mobile web browser	Exaptation	"Presentation adaptation has been studied in the desktop environment and been proven beneficial… However, research on adaptation of Web content presentation for mobile handheld devices is still rare." (p. 100)
Component decomposition		
Component Artifact	Component-level KC	Basis
Theory artifact: adaptation research model	Invention	"There are three types of artifacts created in this research…. research model that relates presentation adaptation to user performance" (p. 100)
Guideline artifact: approaches to presentation adaption	Exaptation	"identify and integrate several approaches to presentation adaptation based on cognitive fit theory and information foraging theory" (p 100)
TA: tree-view presentation	Exaptation	"tree-view presentation adaptation will improve user performance…and user perception…in the task of mobile Web browsing" (p 103)
TA: hierarchical text summarization	Improvement	"…providing hierarchical text summaries of Web content in tree view will have a positive impact on information search via Web browsing" (p. 104)
TA: coloured keyword highlighting	Exaptation	"colored keyword highlighting should be extended to the mobile Web environment" (p. 104)

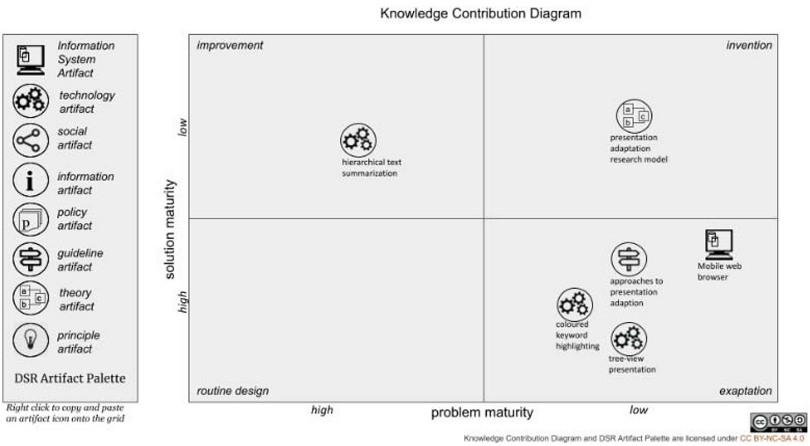

Fig. 4. KCD for “Tree-View Based Presentation Adaptation on Mobile Web Browsing” [23]

4.2 Case 2

This case presents the opportunity to identify both *theory* and *guideline* artifacts, the former contributing an invention and the latter an exaptation. In addition, there are three technology artifacts, two of which provide exaptation and one an improvement (Table 3 and Fig. 4).

Table 4. Analysis of “A Platform for Value Co-creation in SME Networks” [24]

System artifact	Original KC	Basis
Digital value cocreation platform	Exaptation	“Our research contribution can be seen as an exaptation since we transfer the known artifact type of VCC platforms into the still under-researched context of SME networks” (p. 294)
Component decomposition		
Component artifact	Component - level KC	Basis
Technology artifact: analytics component	Exaptation	“The implemented pattern is that new requests are compared with known solutions in the network… examined for optimization potentials and new (re-) configurations are learned” (p. 294)

(*continued*)

Table 4. (*continued*)

Component decomposition		
Component artifact	Component - level KC	Basis
Information artifact: Centralized knowledge base	Routine design	"The central knowledge base provides the modules in a liquified and dense way during the third configuration level… integration process of the VCC can be improved and thus the class of problems of resource integration in SME networks is addressed by the proposed platform" (p. 294)
Social artifact: service configuration	Exaptation	"Via the shared IT platform arbitrary actors/service systems… participate in the VCC process"; "This pattern, previously practiced between the actors, has now manifested itself in the platform via the various components" (p. 295)
Principle artifact: VCC design principles	Invention	"During the development and feedback loops with the company representatives, we were able to derive design principles (DP) that link the DR to the DF" (p 291)

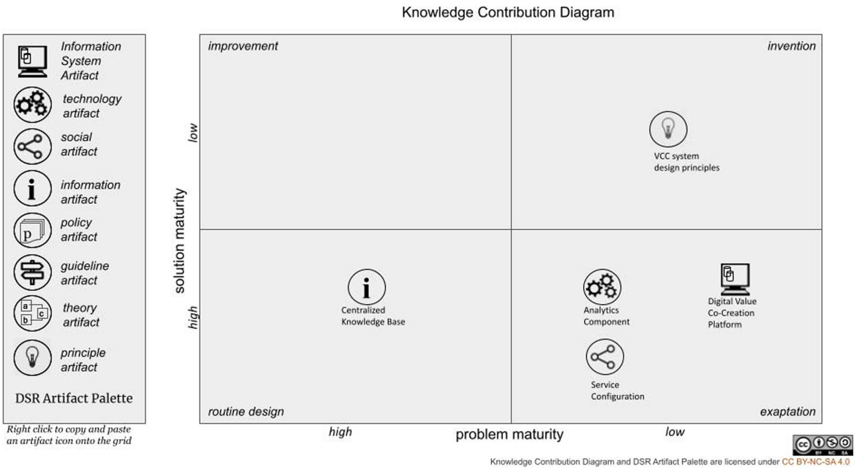

Fig. 5. KCD for "A Platform for Value Co-creation in SME Networks" [24]

4.3 Case 3

In this case, the overall system is described as an exaptation KC, yet the breakdown shows exaptation contributed by the Service Configuration and Analytics sub-artifacts. Here we see the first example of identifying and reporting knowledge contribution of a *principle artifact*, which can be mapped to the invention quadrant (Table 4 and Fig. 5).

Table 5. Analysis of "Designing a Machine Learning Model to Predict Cardiovascular Disease Without Any Blood Test" [25]

System Artifact	Original KC	Basis
Machine-learning model	Invention	"This research has led to the design and development of a high performing CVD predictor artifact that does not require any blood test or invasive patient data, based on machine learning approach." (p. 138)
Component decomposition		
Component artifact	Component-level KC	Basis
Guideline artifact: selection methodology	Improvement	"This research has developed a unique and custom feature selection methodology that allowed selection and reduction of features" (p. 137)
TA: front-end user interface	Improvement	"while meeting the goal of a small predictive feature set of only 16 which will make the user interface practical, operationally acceptable, and easily adoptable" (p 134)
IA: predictive features dataset	Invention	"A new set of 16 predictive features capable of CVD prediction" (p. 134)

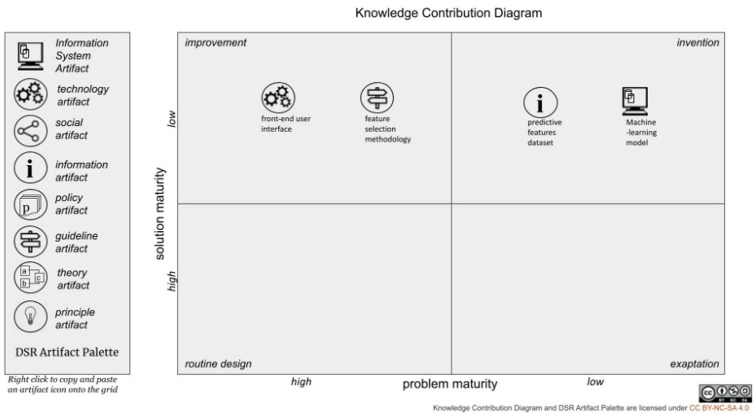

Fig. 6. KCD for "Designing a Machine Learning Model to Predict Cardiovascular Disease Without Any Blood Test [25]

4.4 Case 4

In this case we see a pattern emerge with no *exaptation* and no *routine design* - all KC is found concentrated in the *improvement* and *invention* quadrants. While our study is limited to identification of KC and does not attempt to use KCD to measure knowledge contribution *value,* we hypothesize that projects populating these upper quadrants may have higher overall value - an important focus of future research (Table 5 and Fig. 6).

Table 6. Knowledge contribution at original system level and subsequent component level post KCD analysis

Knowledge Contribution	Routine Design	Exaptation	Improve-ment	Invention	Total
Original in each DSR article (n=4)	0	2	1	1	4
Subsequent KCD analysis (n=4)	2	6	4	3	15

5 Discussion

Knowledge contribution
of DSR is not one-dimensional and need not be distilled to a single artifact when undertaking a complex project. By drawing attention to the KC of each component of their designs, authors can provide valuable insights relevant to a wider range of readers. In espousing this view we knowingly diverge from the view that IS artifacts are systems requiring a holistic view of their evaluation [26]. Further, they can compare the novelty of each component in comparison to other components, and the overall ‘pareto’-like novelty of the entire system. Summary comparison of the knowledge contributions following our approach (Table 6) shows a threefold increase in identified exaptation and invention, a fourfold increase in identified improvement, and 2 incidents of routine design where previously there was none. Knowledge contribution can also be used as a basis for comparison between different systems. By comparison, we do not refer to a quantitative ‘score’ but rather to the qualitative, multi-dimensional comparison that considers both novelties, the integration of routine-design components as part of a complex design, the level and deviation of exaptation and improvement, etc. For KCD to be used as a comparison method, an objective quantification of problem and solution maturity should be developed. We plan to develop a set of objective questions that together ‘place’ a component within each quadrant of the KCD. To do so, we will recruit multiple domain experts that will be asked a set of objective questions about a component in an artifact (e.g., ‘are you familiar with the method used?’), and then to rate the two-dimensional maturity level of the component. We will then learn the relationship between the objective questions and the experts’ mean perceived maturity. We believe this will enable a more precise placement of each artifact within its quadrant which will be an improvement over the current subjective positioning. Our work has shown representation of knowledge contribution from 8 different artifact types. Dwivedi et al. [7] identify 9 different forms of knowledge contribution in DSR research, ranging from *guideline* to *generative*

mechanism. Each of these can potentially be incorporated in a KCD. Researchers use a plethora of artifact types, each with its expressive ability and contribution to the art. We see no reason that the valuable contributions of each artifact within a complex system should be lost in the interest of singular system-centric contributions. Graphical representations have been employed for other DSR uses such as project planning and characterization [9], and creating Design Knowledge Maps [27]. Our work builds on the spirit of Design Knowledge Maps to position DSR contributions in problem and solution spaces, by providing guidance on how to use KCD in presenting DSR results.

5.1 Practical Implications

There are three main practical implications of this work. First, manuscripts presenting DSR can and should use the KCD template to help elucidate and amplify the knowledge contribution of their work. Second, our approach of identifying and presenting multiple forms of knowledge contribution of complex DSR projects can raise the perceived and actual impact of DSR. Finally, researchers who identify additional forms of artifact can extend the KCD approach to incorporate new research insights based on these artifacts.

5.2 Limitations and Future Research

Our analysis is based on post-publication interpretation of articles describing DSR which may not coincide with the original intent and/or interpretation of the authors of those articles. The articles analyzed were purposefully sampled to demonstrate the proposed technique and do not provide a random or representative sample. We note that while in most cases, a single Information System artifact will appear on the KCD, some DSR investigates systems of systems (e.g. [28]) in which case multiple instantiation of IS artifacts would be placed on the KCD. In such cases the component artifacts of each IS would need to be identified as connected to the correct IS, possible by the use of color or framing. Extending KCD for systems of systems should be the subject of future research. While this study has focused on *evaluation* and *presentation* of DSR research to enhance knowledge contribution, the component-level analysis of DSR knowledge contributions can be useful in the process of envisioning, designing, or executing a DSR project. Applying KCD at earlier stages of the DSR process may yield great benefits to the challenges faced by DSR and this potential should be explored.

6 Conclusions

Viewing Gregor and Hevner's knowledge contribution framework in juxtaposition with Lee et al. information system artifact decomposition adds depth to knowledge contribution analysis. Visually intuitive Knowledge Contribution Diagrams can improve presentation of DSR knowledge contribution, elucidating multiple knowledge contributions of a single DSR initiative, leading to greater impact. KCD are extensible for new design artifact types, adding further expressiveness. We believe that our technique to express multi-layered DSR knowledge contribution in graphical form can give a much needed boost to DSR research reporting of all kinds, and should also be investigated for possible uses in earlier stages of DSR project planning and execution. We hope that the explanations presented and examples given can help guide researchers in effectively presenting their DSR knowledge contribution leading to fuller appreciation of potential impact. The KCD template used to produce the graphs in this manuscript is available at http://bit.ly/3cdt3fI.

References

1. Katerattanakul, P., Han, B., Rea, A.: Is information systems a reference discipline? Commun. ACM **49**, 114–118 (2006)
2. Katerattanakul, P., Hong, S.: Quality and knowledge contributions of MISQ: a citation analysis. Commun. Assoc. Inf. Syst. **11**, 15 (2003)
3. Xiao, B., Cheung, C., Thadani, D., Assessing the quality and knowledge contribution of top is journals: a comparative citation analysis. In: ECIS Proceedings 227 (2011)
4. Baskerville, R.L., Kaul, M., Storey, V.C.: Genres of inquiry in design-science research: justification and evaluation of knowledge production. MIS Q. **39**, 541–564 (2015)
5. Beck, J., Sosa-Tzec, O., Carroll, J.M.: Communicating design-related intellectual influence: towards visual references. In: 37th ACM International Conference on the Design of Communication, p. 13. ACM (2019)
6. Wiberg, M., Stolterman, E.: What makes a prototype novel? A knowledge contribution concern for interaction design research. In: Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational (NordiCHI 2014), pp. 531–540. Association for Computing Machinery, New York (2014)
7. Dwivedi, N., Purao, S., Straub, D.W.: Knowledge contributions in design science research: a meta-analysis. In: Tremblay, M.C., VanderMeer, D., Rothenberger, M., Gupta, A., Yoon, V. (eds.) DESRIST 2014. LNCS, vol. 8463, pp. 115–131. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-06701-8_8
8. Gregor, S., Hevner, A.R.: Positioning and presenting design science research for maximum impact. MIS Q. **37**, 337–355 (2013)
9. vom Brocke, J., Maedche, A.: The DSR grid: six core dimensions for effectively planning and communicating design science research projects. Electron. Mark. **29**(3), 379–385 (2019). https://doi.org/10.1007/s12525-019-00358-7
10. Woo, C., Saghafi, A., Rosales, A.: What is a contribution to IS design science knowledge? In: International Conference on Information Systems, 15 December 2014
11. Lee, A.S., Thomas, M., Baskerville, R.L.: Going back to basics in design science: from the information technology artifact to the information systems artifact. Info Syst. J. **25**, 5–21 (2015)
12. Iivari, J.: Information system artefact or information system application: that is the question. Info Syst. J. **27**, 753–774 (2017)
13. Cascavilla, G., Conti, M., Schwartz, D.G., Yahav, I.: The insider on the outside: a novel system for the detection of information leakers in social networks. Eur. J. Inf. Syst. **27**(4), 470–485 (2017)
14. Orlikowski, W.J., Iacono, C.S.: Research commentary: desperately seeking the "IT" in IT research–a call to theorizing the IT Artifact. Inf. Syst. Res. **12**, 121–134 (2001)

15. Orlikowski, W.J., Iacono, C.S.: The artifact redux: further reflections on the "IT" in IT research. In: Lyytinen, K., King, J.L. (eds.) Information Systems: The State of the Field, pp. 287–292 (2006)
16. Lyytinen, K., King, J.L.: Nothing at the center?: academic legitimacy in the information systems field. J. Assoc. Inf. Syst. **5**, 220–246 (2004)
17. Schwartz, D.G.: Research commentary: the disciplines of information: lessons from the history of the discipline of medicine. Inf. Syst. Res. **25**, 205–221 (2014)
18. Hansen, M.R.P., Haj-Bolouri, A.: Design principles exposition: a framework for problematizing knowledge and practice in DSR. In: Hofmann, S., Müller, O., Rossi, M. (eds.) DESRIST 2020. LNCS, vol. 12388, pp. 171–182. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-64823-7_16
19. Vidmar, R., Kotzé, E., van der Merwe, T.M.: The suggestion of design theory artefacts for e-government in South Africa. In: Hofmann, S., Müller, O., Rossi, M. (eds.) DESRIST 2020. LNCS, vol. 12388, pp. 81–92. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-64823-7_9
20. Patton, M.Q.: Qualitative research. In: Encyclopedia of Statistics in Behavioral Science. Wiley (2005)
21. Suri, H.: Purposeful sampling in qualitative research synthesis. Qual. Res. J. **11**, 63–75 (2011)
22. Abbasi, A., Zhang, Z., Zimbra, D., Chen, H., Nunamaker, J.F.: Detecting fake websites: the contribution of statistical learning theory. MIS Q. **34**, 435–461 (2010)
23. Adipat, B., Zhang, D., Zhou, L.: The effects of tree-view based presentation adaptation on model web browsing. MIS Q. **35**, 99–121 (2011)
24. Hönigsberg, S.: A platform for value co-creation in SME networks. In: Hofmann, S., Müller, O., Rossi, M. (eds.) DESRIST 2020. LNCS, vol. 12388, pp. 285–296. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-64823-7_26
25. Brahma, A., Chatterjee, S., Li, Y.: Designing a machine learning model to predict cardiovascular disease without any blood test. In: Tulu, B., Djamasbi, S., Leroy, G. (eds.) DESRIST 2019. LNCS, vol. 11491, pp. 125–139. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-19504-5_9
26. Prat, N., Comyn-Wattiau, I., Akoka, J.: Artifact evaluation in information systems design-science research-a holistic view. PACIS **23**, 1–16 (2014)
27. vom Brocke, J., Winter, R., Hevner, A., Maedche, A.: Special issue editorial –accumulation and evolution of design knowledge in design science research: a journey through time and space. J. Assoc. Inf. Syst. **21**, 520–544 (2020)
28. Tarpey, R.J., Mullarkey, M.T.: Extending design science research through systems theory: a hospital system of systems. In: Tulu, B., Djamasbi, S., Leroy, G. (eds.) DESRIST 2019. LNCS, vol. 11491, pp. 108–122. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-19504-5_8