Clustering Design Science Research Based on the Nature of the Designed Artifact

Joakim Laine[1], Markus Philipp Zimmer[1,2], Matti Minkkinen[1(✉)], Hannu Salmela[1], and Matti Mäntymäki[1]

[1] University of Turku, 20014 Turku, Finland
matti.minkkinen@utu.fi

[2] Leuphana University Lüneburg, Universitätsallee 1, 21335 Lüneburg, Germany

Abstract. During the past two decades, Design Science Research (DSR) has become a central research paradigm in information systems (IS) science. It provides a possibility for researchers to contribute to their field's existing knowledge base by abstracting knowledge from constructing and using design artifacts. DSR scholars have classified their research paradigm by its potential knowledge contributions looking into dimensions such as researcher role, research activity, and knowledge type. Despite the central role of design artifacts in DSR, we know little about the role of these artifacts for DSR's knowledge contribution. We therefore extend the discussion on DSR knowledge contributions to the nature of design artifacts, asking how the nature of design artifacts clusters DSR research and its potential knowledge contributions. To answer this research question, we conducted a literature review of DSR research and selected a sample of 20 papers published during the years 2017–2021 in four major IS journals. We found that the nature of the design artifact forms clusters of knowledge contribution and research activity. Our study suggests a relationship between design artifacts, abstractions of knowledge from these artifacts and the conducted research activities. We acknowledge that this relationship stems from a relatively small sample of DSR studies and propose that further research is needed to confirm our findings.

Keywords: Design Science Research · Design artifact · Classification · Methodology · Literature review

1 Introduction

Design science research (DSR) is a central research paradigm within information systems (IS) science [6, 12, 20]. One core tenet of DSR is constructing contributions via design artifacts [12]. These artifacts can be instantiations, constructs, models, and methods within and for the software development process [12]. That is, design artifacts are at the core of DSR and tie the research paradigm strongly to IS and its endeavor to solve wicked problems by leveraging technology. However, the potential contributions of DSR extend beyond producing design artifacts that solve practical problems.

Published by Springer Nature Switzerland AG 2022
S. Papagiannidis et al. (Eds.): I3E 2022, LNCS 13454, pp. 254–266, 2022.
https://doi.org/10.1007/978-3-031-15342-6_20

IS scholars have outlined process models and guidelines for DSR to produce not only design artifacts but knowledge contributions [12, 15, 24]. These process models provide blueprints for bridging the rigor and relevance cycles of DSR [12]. They provide guidance on iterating between the existing knowledge base that can inform the design artifact and abstracting knowledge contributions from constructing and using the design artifacts [15, 24]. We can also find guidelines on design principles [8], design theories [10], and classifications of DSR knowledge contributions [6, 9, 19]. Thus, the DSR community has focused on crafting blueprints that underpin the DSR research paradigm illustrating that it contributes knowledge beyond the design artifact [6, 9, 14].

Multiple frameworks classifying the knowledge contribution of DSR emerged. Gregor and Hevner [9] classify DSR studies' knowledge contribution by maturity of the solution and its application domain maturity. Similarly, Baskerville et al. [6] suggest a continuum from novel artifacts to routine design. Maedche et al. [19], classifying DSR activities, differentiate between researcher role and knowledge contribution. These frameworks share a focus on the potential knowledge contributions of DSR but they are silent on how the nature of the design artifact underlies these contributions.

Science is about producing knowledge beyond the efficacy of design artifacts [12]. Thus, DSR, to differentiate itself from mere design, cannot solely rely on the contribution that stems from the design artifact [9, 12]. This view is reflected in the frameworks for classifying potential DSR knowledge contributions. However, since March and Smith's [20] classification of different design artifacts, the debate has lost view of one centerpiece of DSR – the design artifact – and how it relates to the knowledge contributions that emerged over the course of instilling rigor in DSR. Therefore, we aim to extend the discussion on DSR knowledge contributions to the nature of design artifacts, positing the research question of *how the nature of design artifacts clusters combinations of the potential knowledge contributions and research activities of DSR*.

To answer this question, we conducted a literature review of DSR published in major IS journals. Taking a random sample, we classify DSR studies' knowledge contributions and activities leveraging Gregor and Hevner's [9] and Maedche et al.'s [19] frameworks. In addition, we classify the design artifacts using March and Smith's [20] classification. Then, we identify clusters of knowledge contributions and research activities per nature of the design artifact. We argue that these clusters contribute to DSR scholars' debate on the potential knowledge contribution and the role of the design artifact. Our study suggests that different design artifacts tend to underlie certain types of knowledge contributions and research activities. This implies that different guidelines are applicable depending on the artifacts' nature and that different design artifacts can produce different abstractions of knowledge contribution.

2 Design Science Research: Classifying the Design Artifacts, Knowledge Contributions, and Research Activities

DSR is a problem-solving paradigm with roots in engineering and the sciences of the artificial [12, 20]. DSR scholars create artifacts that help accomplish analysis, design, implementation, and use of IS effectively via ideas, practices, technical capabilities, and products [6]. The DSR relevance for IS research is related to its applicability in design as researchers apply technological artifacts to new areas. DSR provides intellectual and computational tools that were not previously believed to be possible [12].

Constructing artifacts to solve wicked problems, DSR appears similar to what practitioners do: solving problems by developing technological solutions. This comparison inspired debate in the DSR community on what differentiates DSR from practicing design [9]. Researchers contributed to this debate by suggesting process models [15, 24], guidelines for conducting and publishing DSR [9, 12], guidelines for developing design theories [10], and frameworks on the knowledge contribution of DSR [6, 9, 19]. These efforts share the ideas that DSR differs from practicing design in being rigorous, drawing on the existing knowledge base, following certain guidelines, and abstracting knowledge from constructing the design artifact. This means that the design artifact takes center stage in the knowledge production through DSR [12].

Design artifacts can be decision support systems, modeling tools, governance strategies, methods for IS evaluation, and IS change interventions [9]. Given the importance of the design artifact, scholars have proposed guidelines for good artifacts, how to present artifacts, and how artifacts differ. March and Smith [20] differentiate between research outputs and research activities (see Table 1). *Research outputs* comprise constructs, models, methods, and instantiations. These can be vocabulary and symbols (constructs), abstractions and representations (models), algorithms and practices (methods), and implemented or prototype systems (instantiations). *Research activities* include build, evaluate, theorize, and justify. Build refers to constructing the design artifact. Evaluation captures the development of design and performance criteria and assessing the design artifact's performance. Theorize describes how and why the artifact accomplishes the criteria. Justify refers to providing a theory that informed the design. According to March and Smith [20], these activities form the iterative DSR process.

Table 1. March and Smith's [20] framework of research outputs and research activities

		Research activities			
		Build	**Evaluate**	**Theorize**	**Justify**
Research outputs	**Constructs**				
	Model				
	Method				
	Instantiation				

Hevner et al. [12] build on the research outputs and research activities presented in March and Smith [20]. They draw on the research outputs to define design artifacts and refer to the research activities as the "build-and-evaluate loop." However, they put forth that theorizing and justifying present the distinct value of DSR, not the research outputs. This argument entailed a discussion of the knowledge contribution of DSR. While the design artifact presents a contribution, this falls short of what we expect in science: a contribution to knowledge [9]. This argument entailed that DSR scholars engaged in developing frameworks that classify DSR's potential knowledge contributions. We will present two of these frameworks: Gregor and Hevner [9] and Maedche et al. [19].

Gregor and Hevner [9] created a framework of two dimensions: solution maturity and application domain maturity. Solution maturity captures whether existing artifacts have the development status to tackle the problem. Application domain maturity refers to the degree of understanding of the problem for which, or within which, the artifact will be used. Conceptualizing the resulting four quadrants, the authors differentiate between routine design, improvement, exaptation, and invention (see Table 2).

Table 2. DSR knowledge contribution framework (Gregor and Hevner 2013)

Solution maturity	Low	**Improvement** New solutions for known problems	**Invention** New solutions for new problems
	High	**Routine design** Known solutions for known problems	**Exaptation** Known solutions to new problems
		High	Low
		Application domain maturity	

Maedche et al. [19] present a framework for classifying design research activities based on researcher role and knowledge contribution (Table 3). Accordingly, researchers can create or observe, and the knowledge contribution can be descriptive or prescriptive statements. Creating means that researchers develop artifacts or their variants while observing means that researchers examine the application of artifacts. Descriptive knowledge focuses on understanding IT's nature (what-is), while prescriptive knowledge focuses on improving IT's performance (how-to). These two dimensions form four quadrants: deployment, elucidation, construction, and manipulation.

Table 3. Design research activities classification framework [19]

Researcher role	Observation	**Deployment**	**Elucidation**
	Creation	**Construction**	**Manipulation**
		Prescriptive	Descriptive
		Knowledge contribution	

The frameworks indicate three complementary ways of classifying DSR: the nature of the design artifact [20], the knowledge contribution [9], and research activities [19]. However, these frameworks remain silent on the relation between these classifications. Therefore, we aim to identify clusters of DSR by the nature of the design artifact.

3 Methodology

We conducted a literature review to classify DSR studies employing the presented frameworks. Afterward, we analyzed the published papers for patterns, i.e., whether the nature of the design artifact suggests combinations of knowledge contribution and research activities. For the literature review, we undertook a systematic mapping of DSR published in four major IS journals, MIS Quarterly (MISQ), Information Systems Research (ISR), Journal of Management Information Systems (JMIS), and Journal of the Association for Information Systems (JAIS), between 2017 and 2021. This scope and period were selected as a starting point which future studies can broaden. To identify the DSR studies, we screened the titles, abstracts, and keywords of all articles published in these journals. We marked articles as DSR if they contained an explicit statement on using DSR or created an artifact based on the definition of March and Smith [20].

We found 303 DSR studies. Of these, 67 were published in the JAIS, 93 in the MISQ, 67 in the JMIS, and 77 in ISR. Considering this breadth and our deductive approach to cross-tabulating existing frameworks, we decided to take a random sample. We selected one article per year from each journal. This resulted in a subsample of 20 studies (Table 4). Analyzing the selected articles, we classified them using the three frameworks presented in Sect. 2: the nature of the artifact, the knowledge contribution, and DSR activities. This cross-tabulation revealed that knowledge contribution and DSR activity form combinations in relation to the nature of the artifact.

Table 4. Random sample of the identified DSR studies in the four IS journals

Author	Title	Source	Design artifact
Lin et al. 2017	Healthcare predictive analytics for risk profiling in chronic care: A Bayesian multitask learning approach	MISQ	Bayesian multitask learning (BMTL)
Abbasi et al. 2018	Text Analytics to Support Sense-Making in Social Media: A Language-Action Perspective	MISQ	The language-action perspective (LAP)
Li et al. 2019	Modeling Multi-Channel Advertising Attribution Across Competitors	MISQ	An integrated individual-level choice model
Haki et al. 2020	The Evolution of Information Systems Architecture: An Agent-Based Simulation Model	MISQ	Theory-informed simulation model

(*continued*)

Table 4. (*continued*)

Author	Title	Source	Design artifact
Baird and Maruping 2021	The Next Generation of Research on IS Use: A Theoretical Framework of Delegation to and from Agentic IS Artifacts	MISQ	IS delegation theoretical framework
Piel et al. 2017	Promoting the System Integration of Renewable Energies: Toward a Decision Support System for Incentivizing Spatially Diversified Deployment	JMIS	A model for the quantification of location-based investment
Lehrer et al. 2018	How Big Data Analytics Enables Service Innovation: Materiality, Affordance, and the Individualization of Service	JMIS	Theoretical model of BDA-enabled service innovation
Maruping et al. 2019	A Risk Mitigation Framework for Information Technology Projects: A Cultural Contingency Perspective	JMIS	A holistic nomological network that integrates consideration of people, process, and technology
Silic and Lowry 2020	Using Design-Science Based Gamification to Improve Organizational Security Training and Compliance	JMIS	A gamified security training system
Xie et al. 2021	Unveiling the Hidden Truth of Drug Addiction: A Social Media Approach Using Similarity Network-Based Deep Learning	JMIS	SImilarity Network-based DEep Learning (SINDEL)
Wu et al. 2017	Understanding User Adaptation toward a New IT System in Organizations: A Social Network Perspective	JAIS	A cognitive-affective-behavioral classification

(*continued*)

Table 4. (*continued*)

Author	Title	Source	Design artifact
Akhlaghpour and Lapointe 2018	From Placebo to Panacea: Studying the Diffusion of IT Management Techniques with Ambiguous Efficiencies: The Case of Capability Maturity Model	JAIS	A multi-perspective framework
Miah et al. 2019	A Metadesign Theory for Tailorable Decision Support	JAIS	A metadesign theory for tailorable DSS
Mingers and Standing 2020	A Framework for Validating IS Research Based on a Pluralist Account of Truth and Correctness	JAIS	An overall framework of truth and correctness
Velichety and Ram 2021	Finding a Needle in the Haystack: Recommending Online Communities on Social Media Platforms Using Network and Design Science	JAIS	The nominal process model
Ho et al. 2017	Disconfirmation Effect on Online Rating Behavior: A Structural Model	ISR	Conceptual Framework of the Online Rating Behavior
Barua and Mani 2018	Reexamining the Market Value of Information Technology Events	ISR	An exploratory framework involving the maturity and scope of an IT event
Bouayad et al. 2019	Audit Policies Under the Sentinel Effect: DeterrenceDriven Algorithms	ISR	The Diffusion-Deterrence Model / deterrence-based audit algorithm under network effects
Ye et al. 2020	Developing and Testing a Theoretical Path Model of Web Page Impression Formation and Its Consequence	ISR	A theoretical model of web page impression formation
Abbasi et al. 2021	The Phishing Funnel Model: A Design Artifact to Predict User Susceptibility to Phishing Websites	ISR	The phishing funnel model (PFM)

4 Findings

In this section, we present the results of our cross-tabulation of the randomly selected DSR studies using the existing DSR frameworks. Table 5 presents the findings of our analysis sorted by the nature of the design artifact. Across the random sample, models were the most prominent artifact (10 papers), followed by methods (4 papers), instantiations, and constructs (3 papers each). We found no deployment, invention, or routine design studies. After the table, we present the combinations of potential knowledge contribution and DSR activities clustered by the nature of the design artifact.

Table 5. Classifying the random sample by the nature of the design artifact

Paper	Knowledge contribution [9]	Design research activities [19]
Constructs		
Baird and Maruping 2021	Exaptation	Elucidation
Wu et al. 2017	Exaptation	Manipulation
Mingers and Standing 2020	Improvement	Elucidation
Models		
Li et al. 2019	Improvement	Construction
Haki et al. 2020	Improvement	Elucidation
Piel et al. 2017	Improvement	Construction
Maruping et al. 2019	Exaptation	Manipulation
Xie et al. 2021	Improvement	Construction
Lehrer et al. 2018	Exaptation	Construction
Ye et al. 2020	Exaptation	Construction
Ho et al. 2017	Improvement	Manipulation
Barua and Mani 2018	Improvement	Manipulation
Abbasi et al. 2021	Improvement	Construction
Methods		
Lin et al. 2017	Improvement	Construction
Abbasi et al. 2018	Improvement	Construction
Miah et al. 2019	Improvement	Elucidation
Velichety and Ram 2021	Improvement	Construction
Instantiations		
Silic and Lowry 2020	Improvement	Manipulation
Akhlaghpour and Lapointe 2018	Improvement	Elucidation
Bouayad et al. 2019	Improvement	Construction

4.1 Design Science Studies Presenting Constructs

Three studies in our sample provided a construct as design artifact. Two constructs had exaptation as the knowledge contribution. The theoretical framework developed by Wu et al. [28] focuses on post-adoption IT use. It integrates coping theory with the social network literature, classifies different types of post-adoption coping strategies, and focuses on the effects of post-adoption responses in new IT systems. The researcher role was to create a framework to address new problems, therefore, it goes into the manipulation category. Baird and Maruping [4], the only study in the exaptation and elucidation category, aimed to understand IS artifacts by developing a delegation theoretical framework and exploring the relationship between humans and IS. Mingers and Standing [23] developed a framework that encompasses multiple methods. It was considered an observation study as they examined existing artifacts and considered how problems and solutions are defined. It was marked as an improvement as their focus was on developing solutions for known problems.

4.2 Design Science Studies Presenting Models

For models, there was significant variation in the researcher role and knowledge contribution. Of the eight improvement studies, four of the DSR activities were marked as construction, three as manipulation, and one as elucidation. Construction methods, such as Li et al. [17], aimed to develop a solution by developing a new cross-channel attribution model that expands the literature's single-seller scope across multiple sellers, while Abbasi et al. [1] created a phishing funnel model (PFM) which represented solutions that predicts user susceptibility to phishing websites. Piel et al. [25] aimed to improve the distribution of wind energy deployment by proposing an IT artifact that integrates resource models, an economic viability model, and a spatial distribution model. Xie et al. [29] presented a novel IT system, Similarity Network-based Deep Learning (SINDEL), that aims to design analytics solutions to problems with societal impact.

The improvement–manipulation subset included two models. A framework developed by Barua and Mani [5] involved the maturity and scope of an IT event as they surveyed the suitability of short- versus long-term abnormal returns. Ho et al. [13] modeled individual perceptions of a review system to study how disconfirmation affects online consumer rating behavior. Haki et al. [11] (improvement–elucidation), in turn, developed a theory-informed simulation model that explores how IS architecture emerges under various levels of pressures and how their dynamic changes over time.

The models that contributed to exaptation were the construction models by Lehrer et al. [16] and Ye et al. [30] and the manipulation model by Maruping et al. [21]. Ye et al. [30] formulated a theoretical model that demonstrates the visual aesthetics of web page impressions, while Lehrer et al. [16] developed a model that explains how big data analytics technologies provide features of sourcing, storage, event recognition and prediction, behavior recognition and prediction, rule-based actions, and visualization. The holistic nomological network of technical risk mitigation processes developed by Maruping et al. [21] aimed to extend current IT project risk frameworks.

4.3 Design Science Studies Presenting Methods

The method cluster included four studies. All method studies were marked as improvement. In three of them, the researcher role was to create artifacts (construction). Lin et al. [18] presented a Bayesian multitask learning (BMTL) artifact, Abbasi et al. [2] proposed the language-action perspective (LAP)-based text analytics framework, and Velichety and Ram [27] proposed a combination of a method and a process. The BMTL approach [18] allows healthcare actors to simultaneously model a random number of events and outcomes, improving clinical decision-making and facilitating preventive and personalized care. The LAP approach [2], in turn, improves the design of IS that consider communicative context and actions and emphasizes the interplay between conversations, communication interactions between users and messages, and the speech act composition of messages. Velichety and Ram [27] surveyed the relationships among online communities and types of social media users and what features guide them.

The only method study which did not appear in the construction cluster was marked as an elucidation. Miah et al. [22] developed a decision support system design environment for both client context and tailored technologies. They focused specifically on DSR methods as a solution for practical decision-making issues. They observed meta-design theory for the general solution concept and design principles and illustrated innovation in tailorable technology, focusing specifically on DSR studies that use design science methods as a solution to articulated practical decision-making issues.

4.4 Design Science Studies Presenting Instantiations

Instantiations show that constructs, models, or methods can be implemented in a system. We found three improvement studies, one being construction, one manipulation, and one elucidation. Silic and Lowry [26] presented a DSR approach for a gamified security training system. Bouayad et al. [7] presented an algorithm that provided a new approach for auditing in healthcare, showing the value of deterrence-based auditing algorithms. Akhlaghpour and Lapointe [3] developed a multi-perspective framework for IT management techniques.

5 Discussion and Conclusion

We examined how artifacts, knowledge contributions, and activities can cluster DSR. While IS scholars have classified DSR's knowledge contributions and research activities, they remained silent on how the nature of artifacts underlies them. This observation warrants examination since contributing the artifact is a core tenet of DSR [6, 12]. Therefore, we analyzed DSR in major IS journals to identify clusters of knowledge contributions and activities based on the nature of the designed artifact.

The clusters suggest that certain design artifacts underlie specific knowledge contributions [9] and DSR activities [19] (Table 6). For example, models have not been deployed (observation and prescriptive statements) but present DSR knowledge contributions of improvement (high solution maturity and low application domain maturity) and exaptation (low solution maturity and high application domain maturity). This suggests that models fit certain DSR activities and knowledge contributions. Models are cognitive representations of reality. While they can take tangible form, agency in solving the problem rests with human actors taking action based on the model. The nature of the artifact thus has implications for the knowledge contribution and design of DSR.

Table 6. Clustering combinations of DSR knowledge contributions and research activities by the nature of the design artifact

Nature of the designed artifact	Knowledge contribution and research activity types
Construct	Exaptation–Elucidation Exaptation–Manipulation Improvement–Elucidation
Model	Improvement–Construction Improvement–Elucidation Exaptation–Manipulation Improvement–Manipulation
Method	Improvement–Construction Improvement–Elucidation
Instantiation	Improvement–Manipulation Improvement–Elucidation Improvement–Construction

These findings suggest two implications for DSR. First, the nature of the design artifacts supports certain knowledge contributions and DSR activities. The random sample suggests that if scholars construct a model, they are unlikely to contribute an invention. Similar relations can be drawn for other design artifacts. Hence, if we confine DSR to specific types of knowledge contribution and DSR activities, we exclude artifacts that cannot make these contributions or cannot be investigated through these activities. This implies that in future DSR, we should consider knowledge claims not only against the research process but also against the nature of the artifact and whether the combination of artifact and activity can support these knowledge claims.

Second, the nature of the design artifact requires aligned DSR guidelines. While we can construct models to offer prescriptive statements, we cannot observe and prescribe models. This means that the nature of the design artifact affects the DSR process and thus the applicable guidelines. If we applied the same guidelines regardless of the nature of the design artifact, we would limit DSR to design artifacts that emerge from design activities conducive to these guidelines. However, these activities may not support the construction of a model, method, or other artifacts. Thus, the guidelines can have a constraining effect on the breadth of the artifacts that DSR produces. If we consider that different problems require different solutions, limiting the artifacts entails limiting the problem space that DSR can address. Hence, our findings imply that the nature of the artifact produced in a DSR has implications for the applicable DSR guidelines.

Deciding to analyze a random sample, we acknowledge the risk that extending the analysis to the entire sample might falsify some conclusions. However, if we evaluate our findings against their plausibility, we can deduce that this random sample provides credible contributions by drawing on existing classifications of DSR. Nonetheless, we suggest that future research should extend our analysis to the entire sample.

References

1. Abbasi, A., Dobolyi, D., Vance, A., Zahedi, F.M.: The phishing funnel model: a design artifact to predict user susceptibility to phishing websites. Inf. Syst. Res. **32**(2), 410–436 (2021). https://doi.org/10.1287/isre.2020.0973
2. Abbasi, A., Zhou, Y., Deng, S., Zhang, P.: Text analytics to support sense-making in social media: a language-action perspective. MIS Q. **42**(2), 427–464 (2018). https://doi.org/10.25300/MISQ/2018/13239
3. Akhlaghpour, S., Lapointe, L.: From placebo to panacea: studying the diffusion of IT management techniques with ambiguous efficiencies: the case of capability maturity model. J. Assoc. Inf. Syst. **19**(06), 441–502 (2018). https://doi.org/10.17705/1jais.00498
4. Baird, A., Maruping, L.M.: The next generation of research on IS use: a theoretical framework of delegation to and from agentic IS artifacts. MIS Q. **45**(1), 315–341 (2021). https://doi.org/10.25300/MISQ/2021/15882
5. Barua, A., Mani, D.: Reexamining the market value of information technology events. Inf. Syst. Res. **29**(1), 225–240 (2018). https://doi.org/10.1287/isre.2017.0718
6. Baskerville, R., Baiyere, A., Gergor, S., Hevner, A., Rossi, M.: Design science research contributions: finding a balance between artifact and theory. J. Assoc. Inf. Syst. **19**(5), 358–376 (2018). https://doi.org/10.17705/1jais.00495
7. Bouayad, L., Padmanabhan, B., Chari, K.: Audit policies under the sentinel effect: deterrence-driven algorithms. Inf. Syst. Res. **30**(2), 466–485 (2019). https://doi.org/10.1287/isre.2019.0841
8. Gregor, S., Kruse, L.C., Seidel, S.: The anatomy of a design principle. J. Assoc. Inf. Syst. (2020). https://doi.org/10.17705/1jais.00129
9. Gregor, S., Hevner, A.R.: Positioning and presenting design science research for maximum impact. MIS Q. **37**(2), 337–355 (2013). https://doi.org/10.25300/MISQ/2013/37.2.01
10. Gregor, S., Jones, D.: The anatomy of a design theory. J. Assoc. Inf. Syst. **8**(5), 312–335 (2007). https://doi.org/10.17705/1jais.00129
11. Haki, K., Beese, J., Aier, S., Winter, R.: The evolution of information systems architecture: an agent-based simulation model. MIS Q. **44**(1), 155–184 (2020). https://doi.org/10.25300/MISQ/2020/14494
12. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design science in information systems research. MIS Q. **28**(1), 75–106 (2004)
13. Ho, Y.-C., Wu, J., Tan, Y.: Disconfirmation effect on online rating behavior: a structural model. Inf. Syst. Res. **28**(3), 626–642 (2017). https://doi.org/10.1287/isre.2017.0694
14. Iivari, J.: Editorial: a critical look at theories in design science research. J. Assoc. Inf. Syst. **21**(3), 502–519 (2020). https://doi.org/10.17705/1jais.00610
15. Kuechler, B., Vaishnavi, V.: On theory development in design science research: anatomy of a research project. Eur. J. Inf. Syst. **17**(5), 489–504 (2008). https://doi.org/10.1057/ejis.2008.40
16. Lehrer, C., Wieneke, A., vom Brocke, J., Jung, R., Seidel, S.: How big data analytics enables service innovation: materiality, affordance, and the individualization of service. J. Manag. Inf. Syst. **35**(2), 424–460 (2018). https://doi.org/10.1080/07421222.2018.1451953
17. Li, Y., Xie, Y., Zeng, Z.: Modeling multichannel advertising attribution across competitors. MIS Q. **43**(1), 287–312 (2019). https://doi.org/10.25300/MISQ/2019/14257

18. Lin, Y.-K., Chen, H., Brown, R. A., Li, S.-H., Yang, H.-J.: Healthcare predictive analytics for risk profiling in chronic care: a Bayesian multitask learning approach. MIS Q. **41**(2), 473–495 (2017). https://doi.org/10.25300/MISQ/2017/41.2.07
19. Maedche, A., Gregor, S., Parsons, J.: Mapping design contributions in information systems research: the design research activity framework. Commun. Assoc. Inf. Syst. **49**(1), 355–378 (2021). https://doi.org/10.17705/1CAIS.04914
20. March, S.T., Smith, G.F.: Design and natural science research on information technology. Decis. Support Syst. **15**(4), 251–266 (1995). https://doi.org/10.1016/0167-9236(94)00041-2
21. Maruping, L.M., Venkatesh, V., Thong, J.Y.L., Zhang, X.: A risk mitigation framework for information technology projects: a cultural contingency perspective. J. Manag. Inf. Syst. **36**(1), 120–157 (2019). https://doi.org/10.1080/07421222.2018.1550555
22. Miah, S.J., Gammack, J.G., McKay, J.: A Metadesign theory for tailorable decision support. J. Assoc. Inf. Syst. 570–603 (2019). https://doi.org/10.17705/1jais.00544
23. Mingers, J., Standing, C.: A framework for validating information systems research based on a pluralist account of truth and correctness. J. Assoc. Inf. Syst. 117–151 (2020). https://doi.org/10.17705/1jais.00594
24. Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A design science research methodology for information systems research. J. Manag. Inf. Syst. **24**(3), 45–77 (2007). https://doi.org/10.2753/MIS0742-1222240302
25. Piel, J.-H., Hamann, J.F.H., Koukal, A., Breitner, M.H.: Promoting the system integration of renewable energies: toward a decision support system for incentivizing spatially diversified deployment. J. Manag. Inf. Syst. **34**(4), 994–1022 (2017). https://doi.org/10.1080/07421222.2017.1394044
26. Silic, M., Lowry, P.B.: Using design-science based gamification to improve organizational security training and compliance. J. Manag. Inf. Syst. **37**(1), 129–161 (2020). https://doi.org/10.1080/07421222.2019.1705512
27. Velichety, S, Ram, S.: Finding a needle in the haystack: recommending online communities on social media platforms using network and design science. J. Assoc. Inf. Syst. **22**(5), 1285–1310 (2020). https://doi.org/10.17705/1jais.00694
28. Wu, Y., Choi, B., Guo, X., Chang, K.: Understanding user adaptation toward a new IT system in organizations: a social network perspective. J. Assoc. Inf. Syst. **18**(11), 787–813 (2017). https://doi.org/10.17705/1jais.00473
29. Xie, J., Zhang, Z., Liu, X., Zeng, D.: Unveiling the hidden truth of drug addiction: a social media approach using similarity network-based deep learning. J. Manag. Inf. Syst. **38**(1), 166–195 (2021). https://doi.org/10.1080/07421222.2021.1870388
30. Ye, X., Peng, X., Wang, X., Teo, H.-H.: Developing and testing a theoretical path model of web page impression formation and its consequence. Inf. Syst. Res. **31**(3), 929–949 (2020). https://doi.org/10.1287/isre.2020.0924