

Design Science Research

An Introduction to DSR

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2nd FAST meeting



About me

Dominik Siemon

- Assistant Professor for Information Systems and Service Development
- PhD in 2019
- LUT University, Finland

- **Research**
 - Interaction and collaboration with intelligent systems
 - Design and development of intelligent systems and services
 - Meta-research on design science in IS and HCI
 - Promoting sustainability through IS: environment, social, health, and justice

- Exemplary DSR Publications
 - Ahmad, R., Siemon, D., Gnewuch, U., & Robra-Bissantz, S. (2022). Designing personality-adaptive conversational agents for mental health care. *Information Systems Frontiers*, 24(3), 923-943.
 - Becker, F., Siemon, D., & Robra-Bissantz, S. (2022, June). Smart participation design: Prescriptive knowledge for bottom-up participation. Association for Information Systems.
 - Strohmann, T., Siemon, D., Khosrawi-Rad, B., & Robra-Bissantz, S. (2023). Toward a design theory for virtual companionship. *Human-Computer Interaction*, 38(3-4), 194-234.

Design Science Research

- **Design Science Research (DSR)**
= Research paradigm in information systems research (also used in other disciplines, such as SWE)

- „extend the boundaries of human and organizational capabilities by creating new and innovative artifacts“
(Hevner et al., 2004, p. 75)

- → "exploring by building"
(Vaishnavi and Kuechler, 2015, p. 2)

- **Today:**
 - Definition about DSR
 - Artifact and solution
 - Design knowledge
 - Frameworks and processes
 - How to!

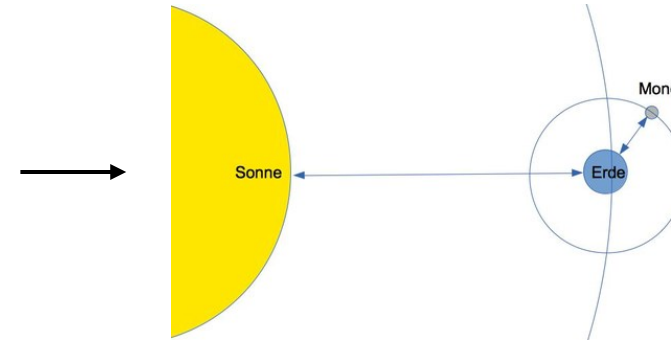
Design Science Research

Design Science
Research



Research = activity that contributes to the **understanding** of a **phenomenon** (Lakatos, 1978)

Design Science Research



Isaac Newton (1687)

Design Science Research

“to invent and bring into being”
(Webster’s Dictionary and Thesaurus, 1992)



Design Science
Research

Design Science Research

“to invent and bring into being”
(Webster’s Dictionary and Thesaurus, 1992)



Artefact
= a product or phenomenon
caused by human or technical
action



Design Science Research



Design Science Research



Design Science
Research

A science of the artificial (...) is a body of knowledge about **artificial** objects and phenomena designed to **meet certain desired goals**.
(Simon, 1996)

Design Science Research

A natural science is a body of knowledge about (...) objects or phenomena **in the world (nature or society)** that describes and explains how they **behave** and **interact** with each other.
(Simon, 1996)

Design Science
Research

Natural Science

A science of the artificial (...) is a body of knowledge about **artificial (man made)** objects and phenomena designed to **meet certain desired goals**.
(Simon, 1996)

Design Science Research

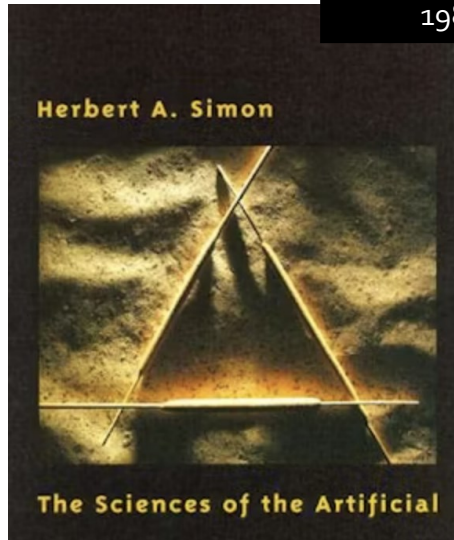


Design Science
Research

DSR is a research paradigm or approach involving a research activity focused on creating **knowledge about the artificial** through the creation and study of artifacts

Design Science Research

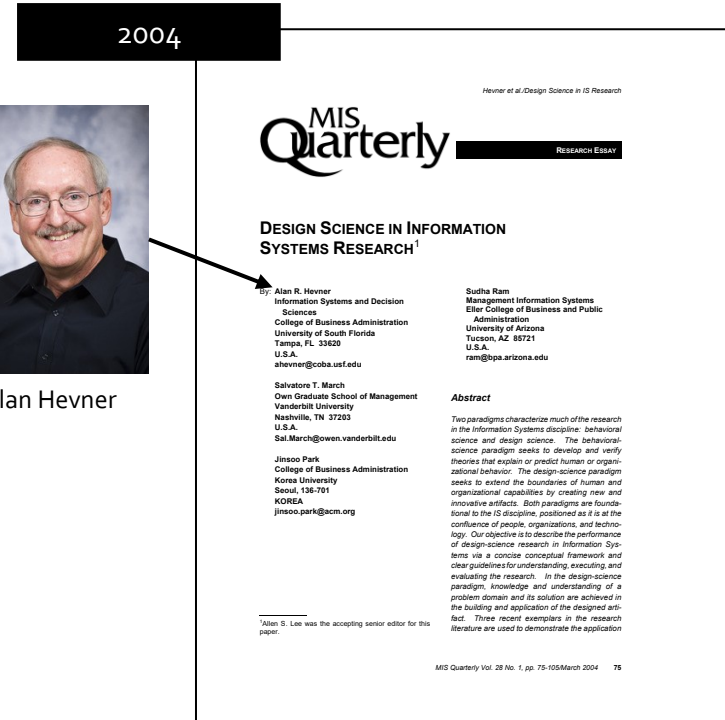
- **Design Science Research**
= Origin in information systems research
- General recognition is attributed to Hevner et al. (2004):
Design science in information systems research in MIS Quarterly



1988



Herbert A. Simon




Alan Hevner

Design Science Research

- „**extend the boundaries** of human and organizational capabilities by creating new and **innovative artifacts**“
(Hevner et al., 2004)
- „knowledge and understanding of a design problem and its solution are acquired in the **building and application of an artifact**“
(Hevner et al., 2004)
- **Components:**
 - Artifact or solution
 - Design knowledge
 - Approaches and processes

2004



Alan Hevner

Hevner et al./Design Science in IS Research

MIS Quarterly

RESEARCH ESSAY

DESIGN SCIENCE IN INFORMATION SYSTEMS RESEARCH¹

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Abstract
Two paradigms characterize much of the research in the Information Systems discipline: behavioral science and design science. The behavioral-science paradigm seeks to describe and verify theories that explain or predict human or organizational behavior. The design-science paradigm seeks to extend the boundaries of human and organizational capabilities by creating new and innovative artifacts. Both paradigms are foundational to the IS discipline, positioned as it is at the confluence of people, organizations, and technology. Our objective is to describe the performance of design-science research in Information Systems via a concise conceptual framework and clear guidelines for understanding, executing, and evaluating the research. In the design-science paradigm, knowledge and understanding of a problem domain and its solution are achieved in the building and application of the designed artifact. Three recent exemplars in the research literature are used to demonstrate the application

¹Alan S. Lee was the accepting senior editor for this paper.

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DSR Artifact

An artifact is the **product** of a design process (Hevner et al., 2004)


Artifacts can be software products, constructs, methods, models, technological rules (Hevener et al., 2004; Gregor and Hevner, 2023)

The artifact is the **solution** that addresses the identified problem and has the desired goals (Hevner et al., 2004)

DSR Artifacts and Frameworks

Design Knowledge

2020



Jan vom Brocke

Accumulation and Evolution of Design Knowledge in Design Science Research – A Journey Through Time and Space¹

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Abstract

Sir Isaac Newton famously said, “If I have seen further it is by standing on the shoulders of giants.”² Research is a collaborative, evolutionary endeavor—and it is no different with design science research (DSR) which builds upon existing design knowledge and creates new design knowledge to pass on to future projects. However, despite the vast, growing body of DSR contributions, scant evidence of the accumulation and evolution of design knowledge is found in an organized DSR body of knowledge. Most contributions rather stand on their own feet than on the shoulders of giants, and this is limiting how far we can see; or in other words, the extent of the broader impacts we can make through DSR. In this editorial, we aim at providing guidance on how to position design knowledge contributions in wider problem and solution spaces. We propose (1) a model conceptualizing design knowledge as a resilient relationship between problem and solution spaces, (2) a model that demonstrates how individual DSR projects consume and produce design knowledge, (3) a map to position a design knowledge contribution in problem and solution spaces, and (4) principles on how to use this map in a DSR project. We show how fellow researchers, readers, editors, and reviewers, as well as the IS community as a whole, can make use of these proposals, while also illustrating future research opportunities.

Keywords design science research, design knowledge, knowledge bases, problem space, solution space, accumulation, evolution

¹ Cite as: vom Brocke, J., Winter, R., Hevner, A., Maedche, A. (2020), *Accumulation and Evolution of Design Knowledge in Design Science Research – A Journey Through Time and Space*, in: *Journals of the Association for Information Systems (JAIS)*, 2020.
² Newton, Isaac, “Letter from Sir Isaac Newton to Robert Hooke”, *Historical Society of Pennsylvania*.

In DSR you generate knowledge on **how to build innovative solutions to important problems effectively**.

Design knowledge will include information about

- the **important problem**,
- the **designed solution**,
- and the **evaluation evidence**, specifically *measures of timely progress* on how well the problem solution satisfies the key problem stakeholders.

Design knowledge are abstract and generalizable **prescriptive statements**

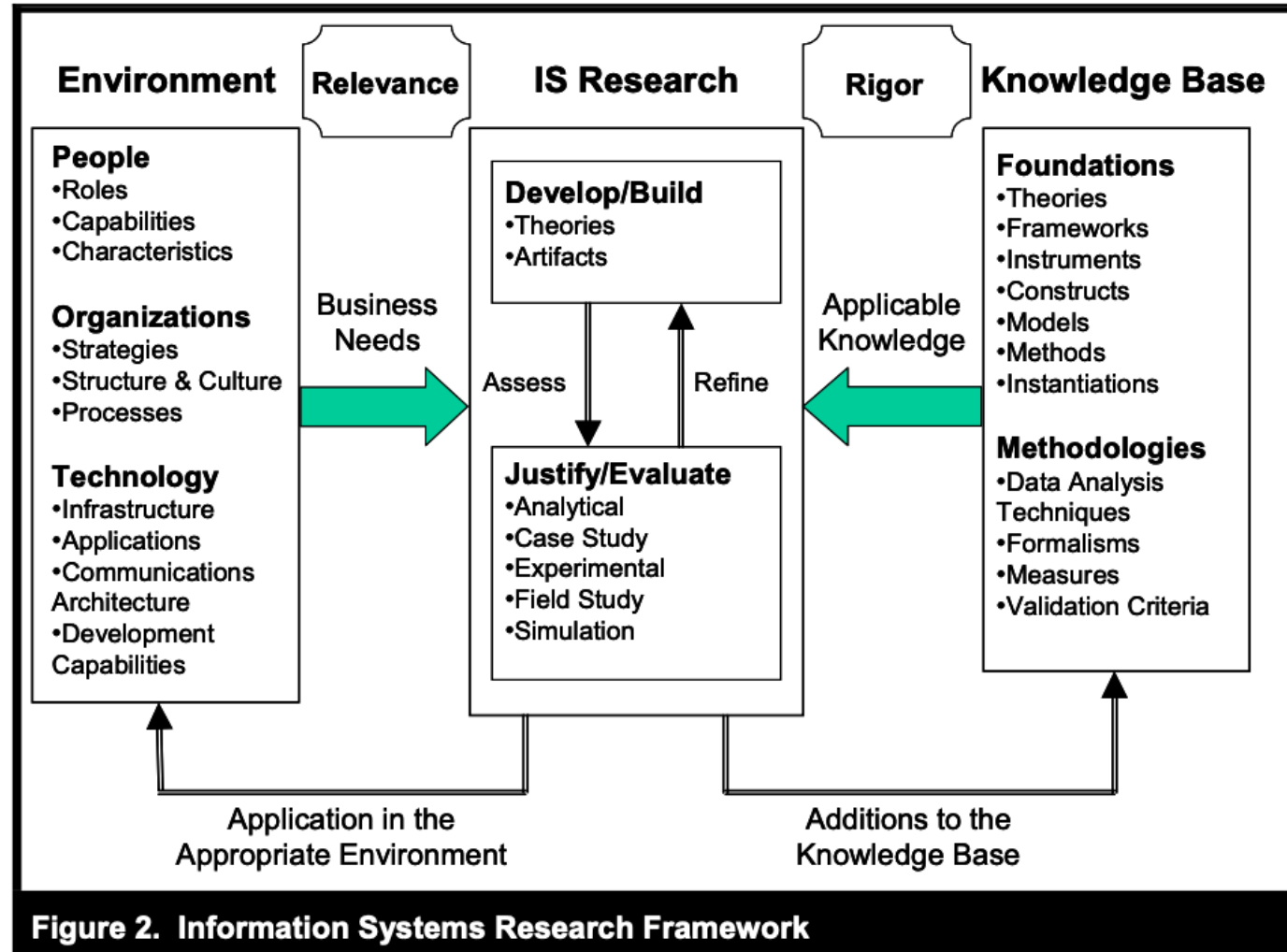
- Design principles
- Design theories

„[...] in [situation] S, to achieve [outcome] O, perform [Action] A.“

Purao et al. (2020). The Origins of Design Principles: Where do... they all come from?

vom Brocke et al. (2020) Accumulation and Evolution of Design Knowledge in Design Science Research: A Journey Through Time and Space

Information Systems Research Framework



Three Cycle View

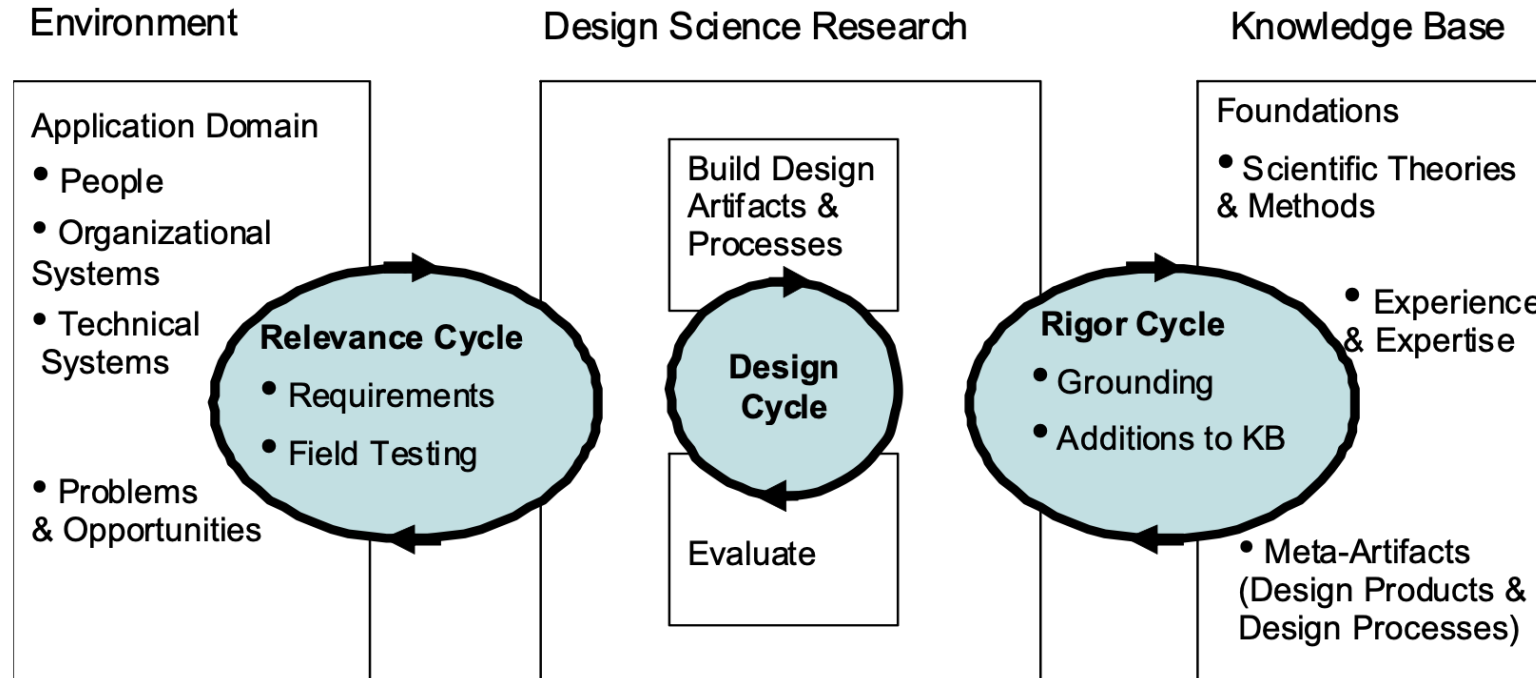


Figure 1. Design Science Research Cycles

DSR Frameworks

Frameworks



Ken Peffers

A Design Science Research Methodology for Information Systems Research

KEN PEFFERS, TUURE TUUNANEN, MARCUS A. ROTHENBERGER, AND SAMIR CHATTERJEE

Ken Peffers is an Associate Professor and Chair of the Management Information Systems Department at the University of Nevada, Las Vegas. He earned his Ph.D. in Management Information Systems from Purdue University. His current research focuses on making the right IS investments for the firm, on IS planning, and on requirements determination for new information systems. His research articles have been published in journals such as *Communications of the ACM*, *Journal of Management Information Systems*, *Information Systems Research*, *IEEE Transactions on Engineering Management*, *Organization Science*, *Journal of Information Technology Theory and Application*, and *Information & Management*.

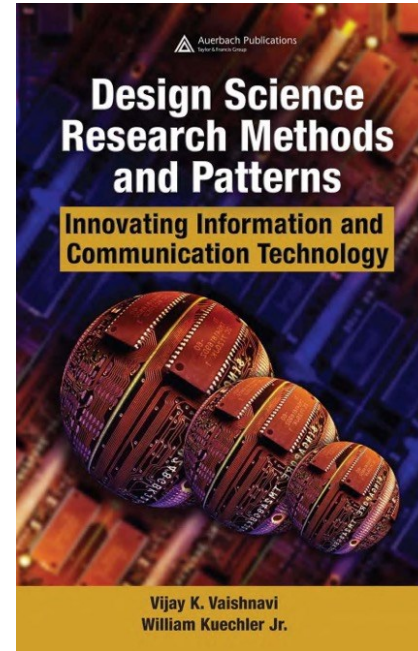
TUURE TUUNANEN is a Senior Lecturer in the Department of Information Systems and Operations Management at the University of Auckland. He holds a D.Sc. (Econ) from the Helsinki School of Economics. His research interests are in IS development and convergence consumer services. He has published in *Management Science*, *Information Systems Research*, *Journal of Management Information Systems*, *Journal of Information Technology Theory and Application*, and *Journal of Management Information Systems*.

MARCUS A. ROTHENBERGER is an Associate Professor of Management Information Systems at the University of Nevada, Las Vegas. He holds a Ph.D. in Information Systems from Arizona State University. Dr. Rothenberger's work includes theory testing, theory development, and design science research in the areas of software process improvement, software reusability, performance measurement, and the adoption of enterprise resource planning systems. His work has appeared in major academic journals, such as *Decision Sciences*, *IEEE Transactions on Software Engineering*, *Communications of the ACM*, and *Information & Management*. Dr. Rothenberger is regularly involved in major academic conferences, including the *International Conference on Information Systems* and the *American Conference on Information Systems*. He is a member of the Association for Information Systems and the Decision Sciences Institute.

Outdated and updated!

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0732-1222/2008 \$0.00 + 0.00
DOI: 10.17135/JMIS.2008.24.3.184

Design Science Research Methodology (DSRM)
(Peffers et al., 2007)



Vijay Vaishnavi

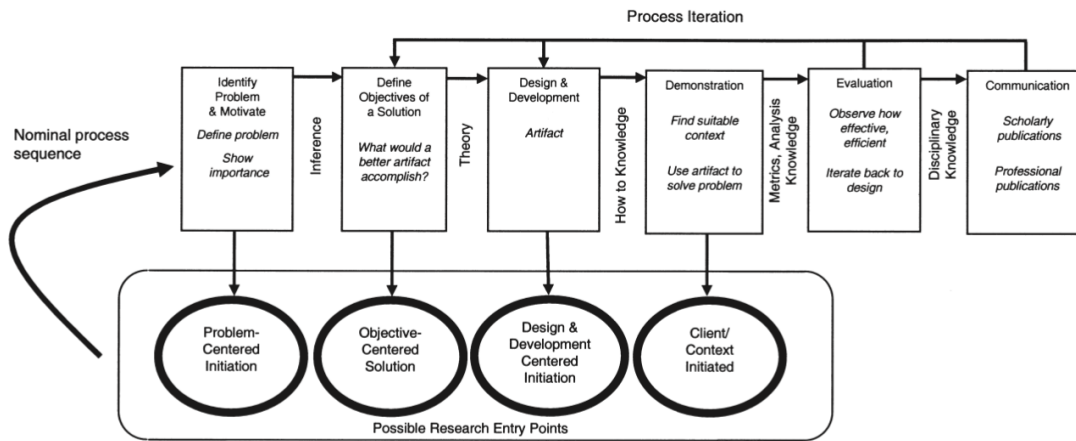


William Kuechler

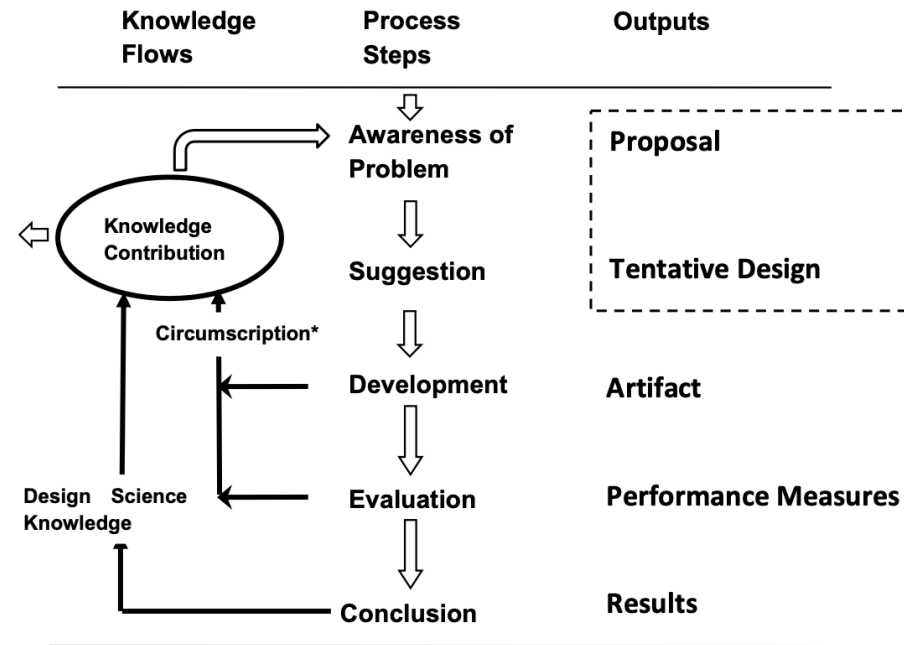
General Methodology of Design Science Research (GMDSR)
(Vaishnavi and Kuechler, 2007)

DSR Frameworks

Design Cycle



Design Science Research Methodology (DSRM)
(Peppers et al., 2007)



General Methodology of Design Science Research (GMDSR)
(Vaishnavi and Kuechler, 2007)

Recent Frameworks



Tuure Tuunanen

Dealing with Complexity in Design Science Research - A Methodology Using Design Echelons

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Robert Winter
Institute of Information Management, University of St. Gallen, Switzerland

Jan vom Brocke
European Research Center for Information Systems, University of Münster, Germany

Abstract. Design science research (DSR) aims to generate knowledge about innovative solutions to real-world problems. Consequently, DSR needs to deal with the complexity related to problem and solution spaces involving socio-technical phenomena that people perceive differently and are subject to constant change. This complexity poses challenges to sequential, process-based approaches—specifically, the existing DSR methodology. We designed a DSR methodology that extends existing approaches by adding a complementary organizing logic to address complexity. Based on the theory of hierarchical, multilevel systems, we suggest organizing DSR based on the concept of “echelon”—meaning to decompose DSR projects into smaller logically coherent self-contained parts—and suggest a set of five design echelons that imply a hierarchical organizing logic for DSR projects. The echeloned DSR (eDSR) methodology was developed in five iterations, involving seven design and evaluation episodes.

Keywords: design science research, methodology, research project complexity, design knowledge development, organizing logic, design echelon, echelon-specific validation

1

Echeloned DSR (eDSR) methodology
(Tuunanen et al., 2024)

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FOCUS ON RESEARCH METHODS | WILEY

BAUSTEIN—A design tool for configuring and representing design research

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Abstract
Today's Information Systems (IS) design research projects pursue digital innovation to conquer complex societal challenges. Many of these projects reach out beyond disciplinary and organisational boundaries, as evident in interdisciplinary consortia and academia-industry collaboration. The design activities in each project differ based on contextual requirements and the team's underlying design logic. As diversity increases, shared understanding is essential for project success. Established design research methodologies need complementary tools to support design researchers in configuring their design activities and representing them faithfully, dimensions that contribute to a shared understanding. This article presents Baustein as an instance of such design tools. Baustein is tailorable to the contextual requirements of each design research project, comprising an ensemble of card-deck, ready-made configurations, and a manual. To ensure theoretical and practical relevance, the design of Baustein is based on primary empirical data (workshop and interviews with 16 IS design researchers) and a literature analysis of 99 published IS

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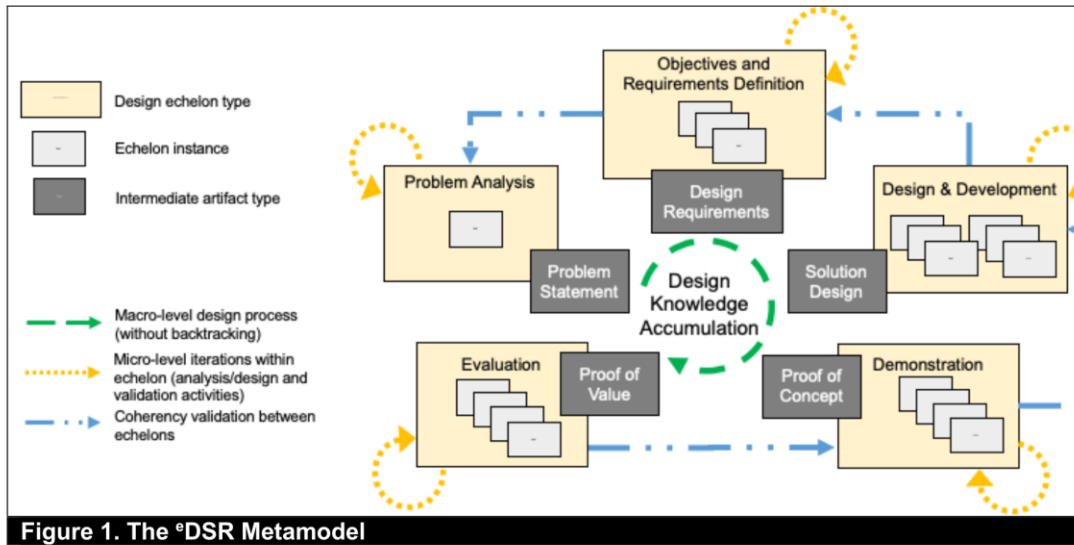


Thorsten Schoormann

BAUSTEIN
(Schoormann et al., 2024)

→ DSR is *still* evolving and being further developed and researched

DSR Frameworks



Echeloned DSR (eDSR) methodology
(Tuunanen et al., 2024)



FIGURE 5 Overview of card configurations.

BAUSTEIN
(Schoormann et al., 2024)

How to do Design Science Research?

- Does your research involve the creation of an artifact / a solution?

- DSR is highly individual
- There are processes and approaches, but there is **no** exact right or wrong
 - Follow Peffers et al. (2007), or Vaishnavi and Kuechler (2007), or Tuunanen et al. (2024), or Schoormann et al. (2024) or simply the three cycle view by Hevner (2007)?

- My advice:
 1. Structure your project first based on the DSR framework / three cycle view
 2. Engage with the problem space as much as you engage with the knowledge base
 3. Chose an appropriate process / method (the one you like)

→ "exploring by building"
(Vaishnavi and Kuechler, 2015, p. 2)

References



- Bibtex with 67 DSR papers:
- <https://tinyurl.com/2bkdas65>

