Problematizing in IS Design Research

Nielsen, Peter Axel

Published in:
Designing for Digital Transformation. Co-Creating Services with Citizens and Industry

DOI (link to publication from Publisher):
10.1007/978-3-030-64823-7_24

Publication date:
2020

Document Version
Accepted author manuscript, peer reviewed version

Problematizing in IS Design Research

Peter Axel Nielsen [0000-0002-0282-7445]

Human-Centred Computing, Dept. of Computer Science, Aalborg University, Denmark
pan@cs.aau.dk

Abstract. This paper is based on the interest to see how problems are addressed in information systems design research. Problems addressed by design research are often implicit, sometimes open, and sometimes even underdeveloped. Problem-solving processes, action research and in a broader sense, engaged scholarship all encompass the explicit addressing of problems and investigation problem situations. Such a problem-orientation is to a lesser degree part of design research. In this paper, we will investigate how we can provide a better understanding of problematizing in design research; and in particular what we may learn from other approaches with a stronger problem-orientation.

Keywords: Problematization; problem formulation; problem analysis; action research; design research; engaged scholarship

1 Introduction

With this paper, we seek to understand problematization in information systems design science research and how and why problematization may be improved. There is a sequence in the argument:

1. Problematization is already known within inquiry and design. In research it is well-known in engaged scholarship and in action research.
2. Design science research methodologies mention problems, but they do not seem to play a vital role.
3. Compared to other problem-oriented approaches, what is missing in design science research is:
   a. an explication of problematization,
   b. viewing the process as problem-setting rather than problem-solving, and
   c. empirical grounding of problematization in addition to theoretical grounding.

We do this by first looking at the role of problematization in inquiry and design in general through the works by Checkland [1] and Schön [2]. Then we turn attention towards how problematization is a crucial activity of engaged scholarship as explained by Van der Ven [3] and key in information systems action research as explained by McKay & Marshall [4], in canonical action research by Davidson et al. [5] as well as collaborative practice research by Iversen et al. [6].

Based on a broad understanding of problematization we analyze its role and methods in information systems design science research (DSR) through Hevner et al.'s original exposition of the ideas [7], and DSR methodologies such as Peffers et al. [8] together with central examples of published DSR. There are exceptions [e.g., Venable 9, 10], but problematization does not play a key role in how design science research gets reported.

In summary, we intend to argue that problematization in design science research can be informed by what is already known about problem-solving and problem-setting. That is, we should concern ourselves with what we can learn from problem-solving and research approaches engaging in problem situations. From this, we can discuss how an empirical process for problem formulation can be understood and supported, and thereby contribute to the grounding of problematization in DSR studies.

2 Problematizing in inquiry and design

A problem is not just given as though it exists objectively. A problem situation may be open to different ideas or interpretations. This has been referred to as 'unstructured problem situation' by Checkland [1, 11], as 'problem setting' by Lanzara [12], and as 'reflection-in-action' by Schön [2]. It is key to a modern understanding of inquiry and design that it takes effort to arrive at an understanding and formulation of what the problem may be taken to be. We will refer to this effort as 'problematization.'

2.1 Soft Systems Methodology

Checkland's Soft Systems Methodology (SSM) is a process for organizational change and problem-solving [1, 11]. It is suggested in SSM that every problematic situation is unique. In SSM, the problematization process is based on several techniques including analysis of problem owners and intervention, analysis of the political system, and analysis of the system [13]. The problem situation is expressed in rich pictures. The problem analysis can be elaborate, but in all cases, the reason for performing the problem analysis is to lead to the solving of problems (or in Checkland's terms the alleviation of problems). It prepares the ground for achieving better results, it is an empirical process that links the more formal thinking to the problem situation at hand, and it is also suggesting which changes may be feasible in the present problem situation [13]. Following Checkland on problem analysis, we should take care in analyzing problem situations empirically to such a degree that it prepares the ground for evaluating and accepting solutions the better they match the understanding of the problem situation. The process of moving back and forth between understanding the problem situation and the solutions is genuinely iterative.

2.2 Problem Setting in Design

There are many accounts of what problem-solving is or perhaps more rightly, what problem-setting should be taken to be. For information systems design, Lanzara argues

that there are three distinctly different ways of looking at it: functional analysis, problem-solving, and problem setting [12]. Few will take functional analysis to be a design process, but it nevertheless gets practiced. Problem-solving, on the other hand, is ascribed to Simon and his work on bounded rationality and satisficing behaviour. A problem is taken as given and design is the search for a solution. The emphasis is on the search and not on what the problem is taken to be. Lanzara argues that Simon's theory of design processes is limited and that it provides a poor understanding of design practice. He emphasizes that design is "a process of collective inquiry" "among several actors in cooperation or competition, or with mixed interests over the problem at hand" [12, p. 33]. He then argues that we need to embrace design processes as problem-setting as done by Schön. His argument is compelling as it emphasizes how a problem is a particular framing of a situation and that there are many possible framings that all make sense.

Schön is a key innovator in turning design as problem-solving into design as problem-setting [2]. Schön's empirical studies of design processes reveal a critique and a new theory of design as reflection-in-action. First, in his critique he argues strongly against what he calls 'technical rationality' in which problems, as addressed by professional practitioners, fall into scientific categories each pointing to solutions through instrumental problem-solving, and "with this emphasis on problem-solving, we ignore problem setting" [2, p. 40]. Problem setting, to Schön, is a "process in which, interactively, we name the things to which we will attend and frame the context in which we will attend to them" [2, p. 40]. Situations rarely fall into scientific categories as situation are unique, thus escaping an idealized image of professional knowledge.

Second, Schön's theory of design as reflection-in-action is an understanding of design where every situation is unique [2]. Following Schön, we shall need to see problems as embedded in a unique situation and requiring their own unique problem setting based on how we frame the situation. Key aspects are [2]:

- *Experimental problem setting* in which situations are complex, uncertain and problematic and means and ends are mutually dependent. Problem setting is seen as a series of experiments to reframe the situation (p. 132). The understanding of what constitutes an experiment is broad, and it may be as loose as asking 'what-if?', on the spot experiments, and exploratory experiments, and it may be as formal as hypothesis-testing experiments (p. 145-147).
- *Repertoire* is the utilization of past experience in terms of "examples, images, understandings, and actions" (p. 138). The designer makes sense of a unique situation by seeing it "as something already present in [her/]his repertoire" (p. 138) to see the unfamiliar and potentially transcend it. This is not to succumb to existing theories, concepts, or rules. Seeing-as is rather an experimentation and thinking with metaphors, i.e., seeing it as something it is not (p. 184).
- *Stance towards inquiry* is about how the designer is not an observer or a spectator. The designer is an agent in "reflective conversation with a situation that [s]he treats as unique and uncertain" (p. 163). The designer imposes a framing and listens to the situation's backtalk and must entertain new confusion in the process of inquiry.

Schön's theory is concerned with many forms of professional knowledge and work, but his position on design is a significant part of it. In addition to seeing all situations a unique and requiring framing to set the problem, his research has also led to understanding design as an activity that is much more complex than search for a solution to a given problem.

It is also important to understand the implication of Schön's theory that problem setting includes problem solving. Problem setting does not preclude problem solving as there is an intricate not to say intrinsic relationship between the framed problem and the design outcome.

3 Problematizing in Research

Problematizing is a common aspect of much research. This is particularly the case in Van de Ven's approach to engaged scholarship and in all explanations of action research of which we give a few examples by McKay & Marshall and by Davidson et al.'s model of canonical action research for IS.

3.1 Engaged scholarship

Engaged scholarship by Van der Ven is concerned with the relationship between research and practice, and it covers both action research and design research [3, 14]. One of the four key activities in engaged scholarship is problem formulation. It is understood as playing "a key role in grounding the subject or problem in reality" [3, p. 71]. Van de Ven discusses several challenges and suggests several perspectives that must be applied to problem formulation. These include [3, pp. 72-84]:

- Understanding the problem situation, its focus and timespan, organisational level, and scope.
- Gathering information to ground an understanding of the problem in its situational context is basically asking: who?, where?, what?, when?, why?, and how?
- Diagnosing its symptoms and characteristics, e.g., breakdown, clarifying observations, using heuristics to match problem and solution.

Van de Ven goes on to provide guidelines for conducting problem formulation and "situate, ground, diagnose and infer the problem up close and from afar" [3, p. 10]. At a detailed level the guidelines include problem diagnosis as an empirical process to classify phenomena into categories – existing or emergent. Part of the manifestation of problem formulation is also a research question that singles out the particular knowledge interest and as such it resembles Schön's framing through reflection-in-action. At an even more detailed level, Van de Ven employs two techniques to bring the diagnosis forward and surface the problems: cognitive mapping and group process technique.

3.2 Action research

The need to address problems is clear from the definitions of action research [15, 16]. Action research aims to "contribute both to the practical concerns of the people in an immediate problem situation" and to research [16]. McKay & Marshall [4] explain what they call the dual imperative of action research, i.e., that is the problem-solving process and the research process. They explain this with a clear emphasis on the differences in the processes, but also with a clear focus on how, when and why they relate. The problem-solving interest has in particular two activities 'problem identification' and 'reconnaissance about the problem', the latter including "where the action researcher endeavours to find out about the nature of the problem and the problem context, who the problem owners are, key stakeholders in the problem-solving process, historical, cultural, and political components of relevance, and so on" [4, p. 50].

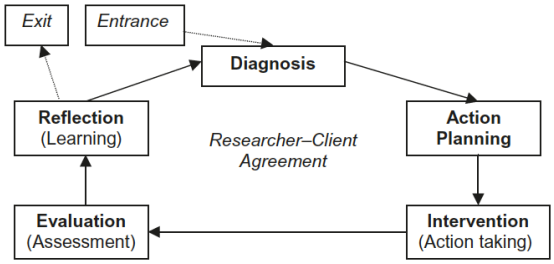

Fig. 1. Action research cycle [17]

Action research comes in different forms, e.g., canonical action research [17] and collective practice research [6, 18]. Problem analysis is key in both forms. In canonical action research there is an explicit activity in the circular, iterative research process through which problems are addressed, e.g., diagnosis in canonical action research [5, 17], followed iteratively by a planned intervention to handle these identified problems. This is supported by two criteria claiming that the action researchers should conduct an independent diagnosis of the organizational situation and not only take the clients' problems at face value to understand the nature of the problems and determine their causes (criteria 2b) and whether the planned intervention was explicitly based on the diagnosis (criteria 2c). An exemplary use of canonical action research is found in [19]. In their diagnosis "researchers and practitioners jointly formulate a working hypothesis of the research phenomenon" [19, p. 441] from which they identify several problems and ended with a problem-solving hypothesis. In their second iteration, the problem-solving hypothesis focused more on the prototyping results, in which ways the initial problems had been solved, and in which ways new problems had arisen.

There are several examples of elaborate problem analysis in collaborative practice research [18, 20]. Further illustration of an empirical problematization in collaborative practice research is found in [6]. Their appreciation of the problem situation was based on months of joint meetings between the practitioners and researchers, qualitative interviews with key actors, and process assessments. The collaboration went on for three years, and when different problems were teased out, they were addressed iteratively and with their intervention planning. The problem situation was eventually framed as one of poor understanding of the risks faced by change initiatives and equally poor

understanding of what to do about these risks. This appreciation of the problem situation did not come immediately and was not easily achieved.

4 Problematizing in Design Science Research

Design science research has with the account by Hevner et al. [7] gained increasing momentum in IS research. DSR methodologies are often used, and there is by now a body of knowledge on DSR [21] as well as very diverse applications of the research approach.

4.1 IS DSR

Design research as it is outlined by Hevner et al. is fundamentally problem-solving [7]. In their version of design science research, they emphasise a problem-orientation in stating "design science […] creates and evaluates IT artefacts intended to solve identified organizational problems" [7]. They also recommend seven guidelines of which one is 'problem relevance' as an objective to develop solutions to important and relevant business problems. The detailed guidelines are however more concerned with the relevance of research with little recommendation on how to address what the problem is or should be taken to be. There is much allegiance to a Simonian theory of problem-solving. This is emphasised in [22] where the relevance cycle translates the environment (of which the problem situation is part) to requirements, see figure 2.

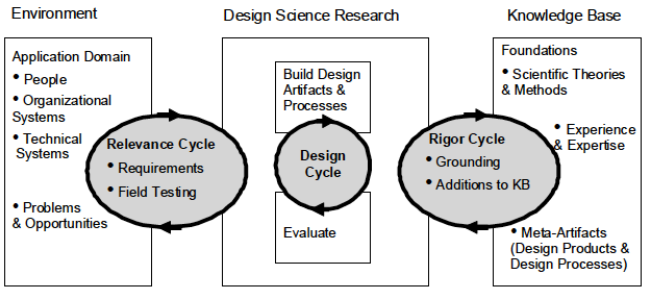

Fig. 2. Three cycles of design science research [23]

The design theory of emergent knowledge processes was developed through action research [23], and that has later been taken as design science research [7]. There seems to be much consensus that this solid piece of research is exemplary of design science research. While there is a problem stated [23] there is no problem analysis on which the research focus has been grounded. From the standpoint of problematizing, there are two issues missing. First, it would have been very interesting to see what the specific problems were, how they were experienced by the practitioners, and how 'wicked' they were. Second, the research involved four companies, and we are not informed about how they saw the problem situation, how the researchers got to know about their problem situations and their differences.

4.2 IS DSR Methodology

DSR methodologies emphasise 'awareness of problem' [24] and 'problem identification and motivation' [8]. The problem identification in DSRM suggests to define a research problem, justify the value of a solution to this problem and underpin the researchers' reasoning about the problem [8]. The recommended activity is not further elaborated, cf. [10], and the illustrative cases are sparse on how the problem identification can be conducted.

Design science research published in a recent special issue of the European Journal of Information Systems reveals that problem analysis and problem presentation is often very brief and sometimes even missing completely. For example, one exemplary article provides a design theory as a response to a theoretically defined research problem [25]. Another exemplar provides a design theory where the research was driven by research objectives identified from the literature [26]. A third exemplar develops a fuller utilization of DSRM in which they identify and formulate the problem and objectives to which the response is a set of design principles [27]; yet the problematization is theoretical and not grounded in an empirical understanding of problem situations.

Not all design science research downplays the importance of problematizing. In [24] there is a strong emphasis on theory development through DSR, but there is also an exposition of 'awareness of the problem' in which they first elaborate on the research problem to be addressed and then define it through a research question. The elaboration though is more theoretical than grounded in an empirical understanding of a wicket problem situation.

There had been recent interest in the problem-orientation of DSR. In a literature review of 72 DSR articles of which 41 were empirical they classified the different types of problems addressed into [28]: business problems, technology problems, and systems development problems. They do, however, not review how the problematization led to the types of problems. Current research suggests that despite the importance of problem-orientation in DSR research that it lacks a conceptualization of what a problem space is [29]. Their conceptualization of problem space consists of three distinctly different parts: needs, goals, and requirements; and that these three parts relate to stakeholders. This conceptualization was derived theoretically and then shown on two examples that needs and stakeholders are (sometimes or often) missing in the explanation of the problem space. The conceptualization does not per se suggest how to problematize, but do suggest that the four concepts should be covered in the results of a problematization process.

A different direction was taken in a current literature review of how research questions get asked in DSR studies [30]. How research questions are formed is as important as a broader conceptualization of the problem space. They distinguish between a problem statement and a research question where the problem statement leads to the research question. The review leads to an elaborated set of options for formulating a research question in DSR. It does not per se suggest how to problematize.

The limited role of problematization and the differences between exemplars of DSR may occur because of different article genres [31]. They may also occur because most are following what Iivari has labelled Strategy 1 where there is no client, no situation,

and no specific problem to be solved [32]. This seems not to the case, and it seems more likely that problematization in design science research has been downplayed over time. It is not that design science research is less supportive of problem-orientation [33] it is more that reporting on the problematization does not play a role.

There are exceptions to the mainstream DSR literature that emphasizes the importance of problematization [10]. Venable analyses the mainstream literature and reach the conclusion that there is "little to no guidance on how to understand, represent, and define the problem to be solved" [10, p. 347]. From this he suggests techniques to be used in the problematization process including fishbone diagrams, problematiques, and in particular coloured cognitive mapping. Coloured cognitive mapping is explained and evaluated in detail, and the emphasis is on the elaborate understanding and grounding of the problem situation.

4.3 Action Design Research

Action design research has come about as an attempt to cross-fertilise between action research and design research [34]. When "defining a problem as an instance of a class of problems" it places itself with design research in the sense that it purports to deal with several cases at the same time. The debate on whether action research and design science research are similar or distinctly different [35] has not been reconciled as they remain attached to what Iivari has termed Strategy 1 and 2 [32], but action design research is a serious attempt that creates much interest.

In action design research, there is through three problem-oriented tasks [34, p. 41] a stronger concern for the problem situation than in design research as suggested above. It is not clear, however, what is meant by a 'class of problems' in action design research or how these can be investigated, and it does not help much when a task of the learning stage is to abstract the learning into concepts for a class of field problems. It is then much easier to follow the exemplary action research because that has already been cast as action research in [19] in which the problematizing was empirically grounded as we have discussed above.

It is not only in action design research that we find the notion of 'class of problems'. It is also found in much DSR research, e.g., [9, 36–38]. The 'class of problems' seems to be a construct that is more needed for purposes of theorizing, for example, as can be seen in "the design is incomplete because it describes a class of design problems, not a single specific design problem" in the exposition of explanatory design theory [38]. It is more connected to a range of designs, i.e., a class of designs rather than a class of problems.

Designs that cater for a class of problem could perhaps be better understood as what Alexander refers to as 'patterns' [38], where a pattern acts as 'a partial solution looking for a problem' [39]. The patterns known from object-oriented modelling and programming are fine-tuned to suggest design opportunities to practitioners, and they encapsulate much knowledge of relationships between problems and solutions.

5 What's Missing?

In engaged scholarship, there is a clear distinction between action research and design research, namely that action research is conducted inside an organisation, attached, and where the researcher examines the problem domain as an internal participant [3]. Design research, on the other hand, is conducted as an external observer, detached from the organisation. The argument is that design research often requires evaluation across several cases [3]. This distinction has been utilised in an analysis of Scandinavian information systems research [14], but for information systems, in general, this distinction is not clear from the main bulk of design science research methodologies. Design science research does not take a clear stance on the inside-outside issue. For action design research, it is not clear whether it is based on an insider view of the problem situation, or it is an outsider view of a class of problems. The case in action design research [19, 34] stem clearly from action research and is viewed from the inside.

The outside view may be inherent in design research. It may be inherited from the origins of design research, from Simon, from walls et al. [36], or from Markus et al. [23]. In the case of [23], there is no grounding in problems inside an organization but across four organisations. With a design theory as the contribution, it is easy to see the design science research in it – also with the distinction from engaged scholarship. In early design research, there is the idea of 'meta-requirements' "rather than simply requirements because a design theory does not address a single problem but a class of problems" [36]. This initial understanding of what a problem is (or may be taken to be) is then transformed into requirements for the solution. It seems that while the problems are present in the research, they are not necessarily based on an empirical understanding. There is little reporting of empirical data being gathered and analysed.

While design science research at one level seems to be based on problem-solving, we can now see that much problematizing in design research is searching for research gaps in the literature and with less concern for an empirical grounding. We suggest that problematizing should not merely be gap-closing theory, and it should not take problems as given.

If we want to maintain that design research is genuinely problem-solving, we must pay attention to what the problem is taken to be. We may as much design research stay with a Simonian view of problem-solving and take problems as given, or we can take the view of pragmatism on problem-setting as Schön. The latter view on problematizing is so far underrepresented in information systems design research, and it is underdeveloped conceptually and methodologically. This raises the question: How can we improve on problematizing?

We need three things. First, we will need to take the consequences for problematizing of a modern stance towards problem-solving and problem-setting. This should include what we can learn from Schön, Checkland, and others on problem analysis as presented above. It should also include what we can learn from action research regarding problem diagnosis and from engaged scholarship regarding problem formulation. Borrowing from action research will not take care of the issue of whether we are inside an organisation solving problems for a client or we are outside working across cases.

The problem formulation in engaged scholarship does not choose a side on this issue and can be applied irrespective of the inside-outside issue.

Second, we will need to figure out how the problematizing can become an empirical activity. The reported experiences are scattered, Nielsen & Persson [40] reports from a problem formulation activity inspired by engaged scholarship. From this experience they suggest three principles: (1) problem dialogue between practitioners and researchers including assessing assumptions underlying the problem situation; (2) problem deliberation involving practitioners in assessing relevance and priorities; and (3) problem flexibility to allow for an open problem space and re-visit the problem formulation. In their problem formulation, they employed qualitative interviewing in several organisations, a survey of all relevant organisations, and joint workshops with selected organisations. They also show one way to transition from a solution that worked for one organisation (as in Van de Ven's inside view) to evaluating how well it worked for several organisations (as in the outside view). They pursue empirical problematization further in [41].

Table 1 summarises a few techniques which can likely be transferred from problem-solving and design and from action research. Two concerns exist:

- What is the stance towards collecting data as an observer or as an involved actor? The observer and the participant-observer are the more common, but the engaged scholar and the action researcher are usually much more involved and sometimes even proactive. The former calls for data collection techniques such as observation and interviewing, e.g., [42], while the latter utilises more reflective techniques, e.g., [43, 44], and requires researchers with problem-solving competences.
- What is the stance towards the analysis of the data? The information systems literature is already filled with much background and discussion of this issue from a positivist stance, over an interpretive stance, to a critical, or a pragmatist stance, e.g., [45–48].

Table 1. A repertoire of problem analysis techniques

Problem analysis technique	**References, e.g.,**
Drawing rich pictures	[13, 49]
Grounded action research	[50]
Problem diagnosis based on qualitative interviewing	[20]
Coloured cognitive mapping	[10]
Analysis of the intervention, the social systems, and the political system	[13]
Problem formulation including cognitive mapping and group process technique	[3]
Engaged problematizing: survey, qualitative interviewing, and workshops	[40]
Qualitative interviewing	[42]
Participant observation	[42]
Prototyping	[51]
Research diaries and reflection	[43, 44]
Diagnostic mapping	[52]

Third, we need criteria by which we can evaluate the problematizing. It is interesting to observe a historical difference between action research and design research. Action research struggled early on with clarifying how theory comes into action, and all criteria now emphasise the need for a theory or framework in the research design. This came into action research through [53] and into information systems action research with the MIS Quarterly special issue and some key exemplars in which the criteria were elaborated [6, 19, 54, 55]. IS design science research has, from the very beginning been driven towards theory and design theory [7, 23, 36]. There has from the beginning been a focus on evaluating the design theories through empirical evaluation of the designed artefacts. What is now missing is a stronger empirical grounding of problems against which the artefacts (hence design theories) can be evaluated. It may be too early to suggest what the criteria should be, but with a starting point in criteria from action research, we can transfer and extend these. As an ending note:

- The problematizing should be empirically grounded and include transparent data collection and analysis
- The problematizing should be summarised and presented as an analysis of the empirical data and justify when the analysis is based on a theoretical framework

6 Conclusion

In this paper, we started with the simple observation that information systems design research was lacking a clear and strong component covering problem analysis. This is somewhat surprising as the design research literature claims a strong allegiance to a problem-solving paradigm. We have therefore investigated this by first outlining how it has been done in problem-solving processes based on Schön and Checkland then we have outlined it as it occurs in action research and the broader social research thinking behind engaged scholarship. From this, we have suggested that design research is missing this very important component of problematizing.

We can do better. The three things that can contribute to this are: (1) the stance towards problematizing should be based on problem-setting; (2) problematizing needs to become an empirical activity; and (3) problematizing requires new and elaborated criteria to be evaluated properly.

References

1. Checkland, P.: Systems Thinking, Systems Practice. Wiley, Chichester (1981).
2. Schön, D.: The Reflective Practitioner: How Professionals Think in Action. Basic Books (1983).
3. Van de Ven, A.H.: Engaged scholarship: A guide for organizational and social research. Oxford University Press, Oxford (2007).
4. Mckay, J., Marshall, P.: The Dual Imperatives of Action Research. IT People. 14, 46–59 (2001).
5. Davison, R.M., Martinsons, M.G., Ou, C.X.J.: The Roles of Theory in Canonical Action Research. MIS Q. Vol. 36, 763–786 (2012).
6. Iversen, J., Mathiassen, L., Nielsen, P.A.: Managing Risk in Software Process Improvement:

An Action Research Approach. MIS Q. 28, 395–411 (2004).
7. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design Science in Information Systems Research. MIS Q. 28, 75–105 (2004).
8. Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A Design Science Research Methodology for Information Systems Research. J. Manag. Inf. Syst. 24, 45–77 (2007).
9. Venable, J.R.: The Role of Theory and Theorising in Design Science Research. DESRIST 2006. pp. 1–18 (2006).
10. Venable, J.R.: Using Coloured Cognitive Mapping (CCM) for design science research. Proceedings of DESRIST 2014. pp. 345–359 (2014).
11. Checkland, P.: Soft Systems Methodology : A Thirty Year Retrospective. Syst. Res. Behav. Adcience. 17, 11–58 (2000).
12. Lanzara, G.F.: The Design Process: Frames, Metaphors, and Games. Systems Design For, With and By the Users. pp. 29–40 (1983).
13. Checkland, P., Scholes, J.: Soft Systems Methodology in Action. Wiley, Chichester (1990).
14. Mathiassen, L., Nielsen, P.A.: Engaged scholarship in IS research. Scand. J. Inf. Syst. 20, 3–20 (2008).
15. Avison, D.E., Lau, F., Myers, M.D., Nielsen, P.A.: Action research. Commun. ACM. 42, 94–97 (1999).
16. Rapoport, R.N.: Three Dilemmas in Action Research: With Special Reference to the Tavistock Experience. Hum. Relations. 23, 499–513 (1970).
17. Davison, R.M., Martinsons, M.G., Kock, N.: Principles of canonical action research. Inf. Syst. J. 14, 65–86 (2004).
18. Mathiassen, L.: Collaborative practice research. Inf. Technol. People. 15, 321–345 (2002).
19. Lindgren, R., Henfridsson, O., Schultze, U.: Design Principles for Competence Management Systems : A Synthesis. MIS Q. 28, 435–472 (2004).
20. Iversen, J., Nielsen, P.A., Nørbjerg, J.: Situated Assessment of Problems in Software Development. Data Base Adv. Inf. Syst. 30, (1999).
21. Hevner, A., Chatterjee, S.: Design science research in information systems. Design Research in Information Systems. pp. 9–22. Springer, Boston (2010).
22. Hevner, A.R.: A Three Cycle View of Design Science Research. Scand. J. Inf. Syst. 19, 87–92 (2007).
23. Markus, M.L., Majchrzak, A., Gasser, L.: A design theory for systems that support emergent knowledge processes. MIS Q. 26, 179–212 (2002).
24. Kuechler, B., Vaishnavi, V.: On theory development in design science research: Anatomy of a research project. Eur. J. Inf. Syst. 17, 489–504 (2008).
25. Brandt, T., Feuerriegel, S., Neumann, D.: Modeling interferences in information systems design for cyberphysical systems: Insights from a smart grid application. Eur. J. Inf. Syst. 27, 207–220 (2018).
26. Coenen, T., Coertjens, L., Vlerick, P., Lesterhuis, M., Mortier, A.V., Donche, V., Ballon, P., De Maeyer, S.: An information system design theory for the comparative judgement of competences. Eur. J. Inf. Syst. 27, 248–261 (2018).
27. Seidel, S., Chandra Kruse, L., Székely, N., Gau, M., Stieger, D.: Design principles for sensemaking support systems in environmental sustainability transformations. Eur. J. Inf. Syst. 27, 221–247 (2018).
28. Amrollahi, A., Ghapanchi, A.H., Talaei-Khoei, A.: From Artefact to Theory : Ten Years of Using Design Science in Information Systems Research. Proceedings of the 13th European Conference on Research Methodology for Business and Management Studies (ECRM). pp. 383–393. Academic Conferences International Ltd (2014).
29. Maedche, A., Gregor, S., Morana, S., Feine, J.: Conceptualization of the Problem Space in Design Science Research. Proceedings of DESRIST 2019. pp. 18–31. Springer (2019).
30. Thuan, N.H., Drechsler, A., Antunes, P.: Construction of design science research questions. Commun. Assoc. Inf. Syst. 44, 332–363 (2019).

31. Peffers, K., Tuunanen, T., Niehaves, B.: Design science research genres: introduction to the special issue on exemplars and criteria for applicable design science research. Eur. J. Inf. Syst. 27, 129–139 (2018).
32. Iivari, J.: Distinguishing and contrasting two strategies for design science research. Eur. J. Inf. Syst. 24, 107–115 (2014).
33. Baskerville, R., Baiyere, A., Gregor, S., Hevner, A., Rossi, M.: Design science research contributions: Finding a balance between artifact and theory. J. Assoc. Inf. Syst. 19, 358–376 (2018).
34. Sein, M.K., Henfridsson, O., Purao, S., Rossi, M., Lindgren, R.: Action Design Research. MIS Q. 35, 37–56 (2011).
35. Iivari, J., Venable, J.: Action research and design science research - Seemingly similar but decisively dissimilar. 17th European Conference on Information Systems (2009).
36. Walls, J., Widmeyer, G., El-Sawy, O.: Building an Information System Design Theory for Vigilant EIS. Inf. Syst. Res. 3, 36–59 (1992).
37. Gregor, S., Jones, D.: The anatomy of a design theory. J. Assoc. Inf. Syst. 8, 312–335 (2007).
38. Baskerville, R., Pries-Heje, J.: Explanatory Design Theory. Bus. Inf. Syst. Eng. 2, 271–282 (2010).
39. Mathiassen, L., Munk-Madsen, A., Nielsen, P.A., Stage, J.: Object-oriented analysis & design. Marko, Aalborg (2000).
40. Nielsen, P.A., Persson, J.S.: Engaged problem formulation in IS research. Commun. Assoc. Inf. Syst. 38, (2016).
41. Nielsen, P.A., Persson, J.S.: Useful business cases: Value creation in IS projects. Eur. J. Inf. Syst. 26, 66–83 (2017).
42. Patton, M.Q.: Qualitative research and evaluation methods. Sage Publications (2001).
43. Engin, M., Ed, D.: Research Diary: A Tool for Scaffolding. Int. J. Qual. Methods. 10, 296–306 (2011).
44. Jepsen, L.O., Mathiassen, L., Nielsen, P.A.: Back to thinking mode: Diaries for the management of information systems development projects. Behav. Inf. Technol. 8, (1989).
45. Miles, M.B., Huberman, A.M.: Qualitative Data Analysis: An expanded sourcebook. Sage Publications, Thousand Oaks (1994).
46. Klein, H.K., Myers, M.D.: A Set of principles for Conducting and Evaluating Interpretative Field Studies in Information Systems. MIS Q. 23, 67–93 (1999).
47. Pozzebon, M.: Conducting and evaluating critical interpretive research: examining criteria as a key component in building a research tradition. In: Kaplan, B., Truex, D., Wastell, D., Wood-Harper, A.T., and DeGross, J.I. (eds.) Information Systems Research. pp. 275–292. Springer, Boston, MA (2004).
48. Goldkuhl, G.: Pragmatism vs interpretivism in qualitative information systems research. Eur. J. Inf. Syst. 21, 135–146 (2012).
49. Monk, A., Howard, S.: Methods & tools: the rich picture: a tool for reasoning about work context. interactions. 5, 21–30 (1998).
50. Baskerville, R., Pries-Heje, J.: Grounded action research: A method for understanding IT in practice. Accounting, Manag. Inf. Technol. 9, 1–23 (1999).
51. Lim, Y.-K., Stolterman, E., Tenenberg, J.: The anatomy of prototypes. ACM Trans. Comput. Interact. 15, 1–27 (2008).
52. Lanzara, G.F., Mathiassen, L.: Mapping situations within a system development project. Inf. Manag. 8, 3–20 (1985).
53. Checkland, P., Holwell, S.: Action Research: Its Nature and Validity. Syst. Pract. Action Res. 11, 9–21 (1998).
54. Baskerville, R., Myers, M.D.: Special issue on action research in information systems - making IS research relevant to practice - foreword. MIS Q. 28, 329–335 (2004).
55. Nielsen, P.A.: IS Action Rsearch and Its Criteria. In: Kock, N. (ed.) Information Systems Action Research. pp. 355–375. Springer, Boston (2007).