Improvement suggestions for the DSRM model

Full Paper

Elina Eteläaho
Laurea University of Applied Sciences
elina.etelaaho@student.laurea.fi

Pilvi Tuomi
Laurea University of Applied Sciences
pilvi.tuomi@student.laurea.fi

Rauno Pirinen
Laurea University of Applied Sciences
rauno.pirinen@laurea.fi

Abstract

This study addresses the process of Design Science Research Methodology (DSRM). The study's proposal is that the DSRM process can be revised by relevant elements, such as user experience, co-creativity, and trust building. The research revealed that user-centered aspects and user-computer interactions are important for the success of the design and realization of information systems, and thus are necessary to take into account in the DSRM process model. The main findings of the study are that it is imperative to integrate the users' experience and design research, trust building, and co-creativity aspects into the DSRM process as early as possible. It is also vital to train users to use the system so that the system's design-development-dissemination continuums can be as effective as possible. The outcome of this study addresses the DSRM process and its modularity, usefulness, and feasibility in the field of information systems design theory.

Keywords

Design research, design science, design science research, design theory, methodology, process model.

Introduction

This study targets the realization of the Design Science Research Methodology (DSRM) process for information systems. The focus of the study is on authentic and real-world research processes for information system-service design and its processing guidelines. The analysis of real-world research data is performed from the standpoints of DSRM process feasibility and the progress of system design, development, and service-systems realizations. The starting point for this research was a study unit held at the Laurea University of Applied Sciences, Espoo, Finland, where the business information technology master's degree students were asked as a research question: "What is included in the DSRM process in practice and in resonance with the [Peffers et al. 2008] DSRM process?" This research question was based on the setting of study unit and the researchers' own work motivation and experience (n=25 years). The data collection was addressed (see appendix) in two large Finnish public organizations, where ITIL (Information Technology Infrastructure Library) and practitioners achieve best practices that are widely used every day in real-world situations. The study found that the DSRM process can be further honed and revised by the focused aspects of the user experience, and research for the continuums of the design-development-dissemination process of the system's integration.

The target organizations in the research domain differ in the way that first mainly acquires the required solutions and the second develops them, offering researchers different insights and triangulation of the data and methods. Organizations have expert groups that make decisions concerning the systems; they also contain complicated integration with existing systems, which significantly affects the work processes. Nevertheless, the study revealed that the same problems and difficulties occurred in both organizations in the research domain.

To find out more about these revised views of the DSRM process, the scientific publications (n=40) were deeply reviewed; we noticed that these issues were rarely discussed in relation to DSRM processes. The user-centered approach, co-creativity support, and trust-building aspects thus provided a research gap and interest for the research of DSRM processes. The assumption of outcomes thus was that this research study can propose amended revisions to the DSRM process model (Peffers et al. 2008), which can be valuable for the research as well as for the practical utilization of DSRM and for future research continuums.

Related to (Peffers et al. 2008; Hevner et al. 2004; and Nunamaker et al. 1991) have contributed to the concept of taking users and usability into account, even though it was understood in this study that an information system has no value if it is not usable and users do not use it. Usability needs to be designed together with the users and their needs in order to be understood and realized. The other expected key advance of study was the contribution to change management and implications for the systematic deployment of dissemination processes of information systems or information-intensive service. The research premise was that no system can work effectively and give the best possible benefits without a good design-building-deployment process and users-actors who learn to use the features, the purpose of the system, and the achievements of trust and confidence (Rajamäki 2014; Pirinen 2015).

First, in this study, viewpoints on the DSRM process model (Peffers et al. 2008) on information systems in the literature were reviewed for building and improving artifacts, information-intensive services, and methodology. We reviewed the following works: “Systems Development in Information Systems Research” (Nunamaker et al. 1991); “Design and Natural Science Research on Information Technology” (March and Smith 1995); “Design Science, as Concept” (Simon 1996); “Building an Information System Design Theory” (Gregor 2002); “A Design Theory for Systems that Support Emergent Knowledge Processes” (Markus et al. 2002); “Design Science in Information Systems Research” (Hevner et al. 2004); “Anatomy of Design Theory” (Gregor and Jones 2007); “Information Systems as Work Systems” (Alter 2008); “Research Framework of Integrative Action” (Pirinen 2009); “Theory and Practice of Design Research in Information Systems” (Hevner and Chatterjee 2010); and “Design Theory for Complex Systems and Modularity” (Hanseth and Lyytinen 2010).

Different terms were used in the early literature to describe this mode of information systems research, including Design Science (DS) in Information Systems and Design Science Research (DSR), which is described in Hevner et al. (2004). The term “Design Research” (DR) consists of activities concerned with the construction and evaluation of technological artifacts to meet organizational needs, as well as the development of their associated theories. Consequently, the abbreviation “DR” is concerned with artificial rather than natural phenomena and is rooted as a discipline in the sciences of the artificial (March and Smith 1995). DR consists of activities concerned with the construction and evaluation of technological artifacts to meet organizational needs as well as the development of their associated theories. In brief, behavioral science is concerned with theories that explain human or organizational behavior, while the term “DSR” is concerned with creating new and innovative artifacts (Hevner et al. 2004; Hevner and Chatterjee 2010).

One set of guidelines for the conducting and evaluating of a DSR is the seven elements of “DSR criteria” in Hevner et al. (2004) and detailed in Hevner and Chatterjee (2010). In this sense, DSR necessarily makes a dual contribution to epistemic and practical utility. Any piece of research adds to existing theory in order to make a worthwhile scientific contribution, and the research should assist in solving the practical problems of practitioners: specifically, problems that are either current or anticipated. Two focused research methods in the information systems field with this dual orientation are DSR (Hevner et al. 2004) and action research (Baskerville and Wood-Harper 1998; Davison et al. 2004).

In the context of study, the similarities of the fundamental characteristics of action research and design science are reviewed in the Association of Information Systems (AIS) paper of the Americas Conference on Information Systems (Pirinen 2009). Then, different types of designs are integrated into an environment of study, practice, and action as well as living labs. Furthermore, sustainable action research phases include design; for example, economic design, service design, product design, system design, and action design. Thus, action research is similar to (but differs slightly from) design science. In this environment, action and learning builds bridges from knowledge to competence, and bridges design to the development and making of a commercial product and economic value returns, although this involves different processes, goals, and theoretical assumptions. The research setting then connects an innovative system to these perspectives through the behavioral sciences (i.e. psychological, sociological, and educational); these bases are then further articulated in viewpoints of the design-development approach in the integrative model (Pirinen 2009; Pirinen 2013).

Methodology

Several reviewed articles stated that information science demands rigor (Abdel-Hamid and Madnick 1989; Benbasat and Zmud 2003; Gregor and Jones 2007; Nunamaker and Briggs 2011). The focus is that using information science theories and methodologies research can be rigorous and can produce high-value, real-world impacts. The information science discipline is a relatively new branch of science, and it can comprise multiple methods and triangulation, especially in the evaluation phase. In the context of this study, the term "triangulation" is addressed to the use of multiple sources of evidence. Related to this study, there were four types of triangulation in the reviewed literature: the triangulation of data sources, as data triangulation; among different evaluators, as investigator triangulation; of perspectives on the same data set, as theoretical triangulation; and methods as methodological triangulation (Campbell and Fiske 1959; Lincoln and Guba 1985; Patton 1990; Miles and Huberman 1994; Robson 2002).

Weber (1987) noticed that information science was not progressing into an independent discipline, but rather was merely applying theories from other disciplines. Information science has also benefited systems development, however, because it has made learning from earlier developments possible, as well as unified theories and methodologies (Abdel-Hamid and Madnick 1989). Information science could be said to have been in a crisis for a long time, since it was unable to answer the question: "What is the core of information science?" (Benbasat and Zmud 2003). The value of information science–related research is in focusing on socio-technical phenomena, not just the behavioral or technological aspects (Baskerville and Myers 2002).

We also found from our review of the literature that there is a need for finding the socio-technological artifacts as the core of research, as they often disappear (Orlikowski and Iacono 2001; Hevner et al. 2004). The artifact can be material or abstract; for example, it can be a product, a database, or a model. According to Zhang et al. (2011), there are somewhat differing interpretations of the technological and socio-technological artifact within the work of information science scholars, but they all are instrumental and contextual and are applied in organizational and personal settings (Benbasat and Zmud 2003; Orlikowski and Iacono 2001; Hevner et al. 2004). Just like theory and methodology, the artifact itself is not unchallengeable, but rather is an ever-changing, resilient, "elastic" and mutable entity that can be conceptualized from many different perspectives. Even though the technologies are at the core, they cannot be totally separated from cultural and path-dependent natures (Orlikowski and Iacono 2001; Pirinen 2015).

Information system research is carried out in order to better understand the requirements for the information systems environment, and to be able to build, improve on, test, and create new systems. There are several research methods with which information system structure can be depicted. Design science strives to build tools with which information systems can be built. Design science creates and evaluates technological and socio-technological artifacts intended to solve identified organizational or actor-related problems (Hevner et al. 2004). Research can be made so that the building or improvement of the information systems should not be started from the beginning every time. Methodology describes how the process for building an information system works in a systematic manner.

The available possibilities and risks are evaluated in order to make the artifact as good as possible (Hevner et al. 2004). Design theory offers the possibility for more rigorous information management, and thus gives better requirements for building new systems (Gregor and Jones 2007). According to Gregor and Jones (2007), the goal of a design theory can be a product or a methodology. Walls et al. (1992) mention a system development life cycle to be one example, thus combining three of the four design artifacts (constructs, models, and methods) described by March and Smith (1995) and further by Hevner et al. (2004) under one label as "methodology."

Methodology offers researchers a conceptual framework with which they can better understand the research of others or to compare separate information systems. The DSRM consists of the research process and the methods used in the process, as well as tools that can be used. The method sets rules according to which the information system development process proceeds. Once the design process is defined, it is easier to compare studies and their results. The purpose of the conceptual framework is to form theories that can be utilized in developing new approaches and ideas for systems development. Representatives of different sciences can contribute to the method or theory according to their views and research findings (Peffers et al. 2008; Nunamaker et al. 1991). As the scientists are from different study fields, while, rules need to be followed, or the studies, theories, or methods cannot be interpreted in novel and systematic ways (Benbasat and Zmud 2003).

Research can be considered to be scientifically valid when it is systematic and produces new or more specified information on a phenomenon (Nunamaker et al. 1991). The system development process should be multidisciplinary; it should be looked at from several perspectives. Using only one branch of science does not offer a result that is good enough. The methods support each other, enabling the obtaining of a better understanding of the field of research. Design and related research is described as the heart of the research with which it is possible to find answers and solutions for complex questions emerging in research (Nunamaker et al. 1991).

Hevner et al. (2004) suggest seven features of a successful design research process to be used. The artifact must first solve the defined problem; it also must solve a problem that has not been solved before. It should be possible to evaluate the benefits, efficiency, and value of the artifact with different measures. The research has to be proven afterwards in scientific terms. When developing the artifact, the solution needs to be found by combining theory and practice, and finally the results need to be published to a suitable audience. Hevner and Chatterjee (2010) furthered the role of the consumers and actors for whom the design is intended, as well as the part of the focus group. This research can be understood to be extended by users' experience (Luojus 2010) and co-creativity aspects in Pirinen (2009 and 2015) in a deeper level; especially if focusing on more specific information systems and information-intensive services over authorities of national borders, and in the context of authorities' mutual trust-building by related critical systems (Rajamäki 2014) .

Germonprez et al. (2011) have criticized many of these articles. They find that the user should be included in the design process, and even claim that the user is also a designer. They call it "secondary design" since the user normally has a more specific role after the first developed system is published, which can then affect the next version. Nunamaker and Briggs (2011) are contributing to making DSR distinctive from other disciplines by highlighting the information technology–related artifacts, but the information system and its user cannot be totally separated. That is because every information system or service needs to offer value addition and real-world impact for its users in order to fulfill the users' requirements. Thus, one focus in designing the systems must be user-computer interactions and user needs.

Pirinen (2015) proposed a continuum-focused methodology of information systems research, in which the utilization of outcomes of research and design development are continuums of the following subjects: understanding, innovating, demonstrating, building, testing, improving, experiencing, evaluating, implementing, and disseminating. The research findings of Pirinen (2015) were that continuums and the path-dependency of studies, entities, and mechanisms, and the sustained novelty of analysis of research outcomes, are imperative for high-value, real-world impacts through systematic research programs, integrative models, co-creativity, co-design, focused university strategies, multi-methodological approaches, and inheritance of research consortiums' results. The study by Pirinen (2015) addressed the realization and analysis of the real research and development projects (n=13) of the European Union and the Finnish Programmes for Research and Innovations.

Improvement suggestions for the DSRM process

According to this study, the description of a revised DSRM process as proposed is presented in Figure 1. This refers to principles of the research setting for system development, the practical means for doing research, and the instructions on how to do it. The proposed DRSM process model is based on the triangulation of existing research data (appendix), and is consistent with the literature. It offers a mental model upon which the DSR can be built, as well as the evaluation and representation of the results. The revised DSRM process contains six phases that cover the parts of the system design-development-dissemination process.

The design and development of the system begins with identifying the problem. The problem is something that needs to be solved by developing a new information system, or by changing an existing system. The problem usually arises from several reasons, which are divided into six subcategories. One category of problems is the needs that arise from corporate strategy: the activities need to follow the path of the strategy. Another reason for creating a new information system (or to improve the old system) is the need to have more efficient and effective systems. These are usually incorporated with financial savings in employment expenses or better quality (cf. Ryan and Harrison 2000).

The third category is the demands that arise from the corporate environment, such as amendments or changes in regulations that make the old system useless. The fourth category is risk management or risk minimization. Information systems can contain, for example, breaks in information security that over time can prove to be very risky. The fifth category is the usability of the system. This is partly a question of efficiency (cf. Maguire 2001), but can be seen as a separate matter because of its importance. Issues associated with poor usability can take a large share of a worker's working hours every day, and systems that don't interact with each other cause vast quantities of manual work to be done in order to move information from one system to another (cf. Dedeke 2012). The sixth reason for developing the information system is innovation to bring competitive advantage in the market, and economical value returns. Competition is stiff, and every firm wants to be the best in its own segment. Creating something that is missing from other firms' offerings can bring in a great deal of cash flow.

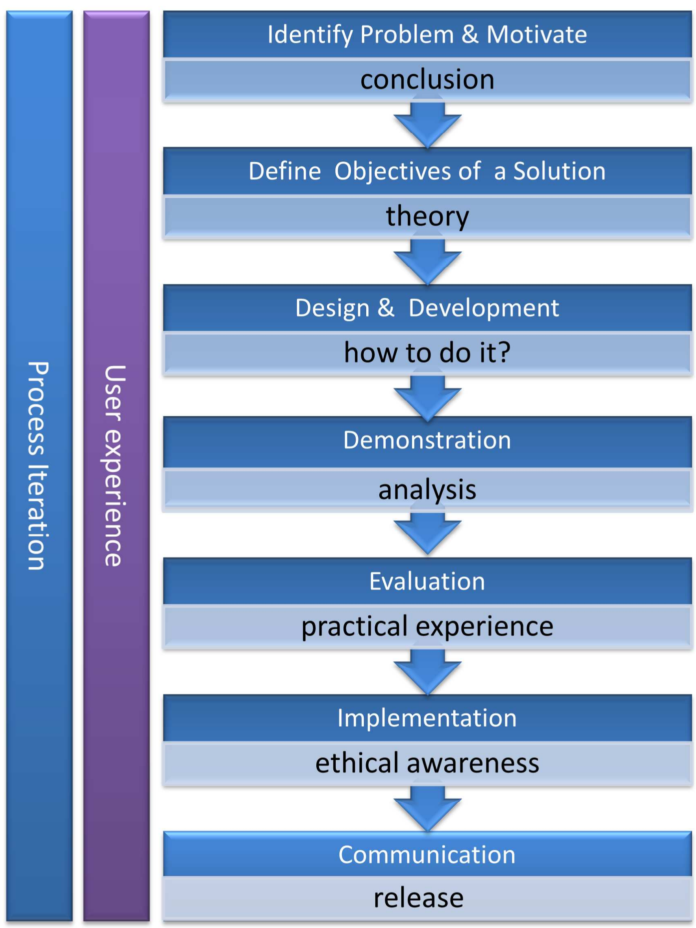

Figure 1. Revised DSRM Process

In the second phase of the DSRM process model, researchers define the objectives of a solution. This phase is based on examining the current situation and understanding it thoroughly. In this phase, traditional research methods, interviews, observation, and measuring can be quite useful. After gaining an understanding of the current state, the rigorous designing and modeling of the new, improved artifact can begin. In this phase of the DSRM process, the preconditions for budgeting and scheduling are taken into account.

In the third phase, the artifact is designed and developed. To do this efficiently, it is imperative that the preceding phase has been implemented carefully. The third phase concentrates on weighing the options: what are the possibilities, and what would best apply to this purpose? Mapping the possibilities requires a lot of information retrieval. The basis consists of scientific publications, literature, and knowledge, and the experiences of corresponding information systems. Nunamaker et al. (1991) recommend designing a couple of options, and then choosing the best one; based on the best option, a system or a prototype for testing the operability is designed. Equally, Nunamaker et al. (1991) and Walls et al. (1992) emphasize the significance of the theoretical foundation in DSR.

The fourth phase, demonstration, represents the functionality of the information system. In this phase, the users can try the new artifact. In addition, the performance, integrations to other systems, and the usefulness can be evaluated, and emerging problems can be fixed.

In the fifth phase, the feasibility of the solution (compared to the original goal) is evaluated (cf. also Hevner et al. 2004). Here, the functionality of the old and new systems are evaluated in order to find out whether it solves the defined problem. The evaluation phase also offers the chance to test for mapping information security, integration, and usability.

In the sixth phase, communication, the contributions of the study are announced to the public in different publications. This is important because only after the new knowledge is out in the world can others also utilize it (cf. Peffers et al. 2008).

The findings of this study are that the DSRM process model can be further modified: first, it can better take users into account, which was described in the left-hand side of Figure 1, when planning new information systems or when the system is changed, even fundamentally. Second, it can include a ready-made system or service into the process or the phase for which it is designed. In this setting, the research findings are that the basic thought in the DSRM process is that too often, only the designer knows the purpose for which the system is built; the difficulty here is that the designer alone may know the process and procedures, thus making the participation of the user unnecessary and unmotivated.

According to this study, usability and confidence are vital parts of any information system, and the user and the user experience should be considered when designing a system or information-intensive service. Users should be involved throughout the whole design process, thus making them more committed and giving confidence to the deployment of the artifact. The theories in design and DSRM can be used in engineering, but they also need to offer services and solutions for the actual users, actors, and authorities in the sense of confidence and trust-sharing, as well as the support of co-creativity aspects (cf. Pirinen 2013; Rajamäki 2014).

The findings of this study are in line with those in the literature: that many systems and services fail because technical experts do not fully understand the complicated processes and requirements of the users and actors (cf. Nunamaker and Briggs 2011). This study has revealed that even a poorly designed system can function for a long time if it fulfills user needs. The study found that with information systems research methods and models, it is still possible to learn to contribute to the design process of information systems and services (cf. Nunamaker and Briggs 2011; Abdel-Hamid and Madnick 1989). The difficulty of the methods can also be that these methods only use what has been done before; they confer path-dependency of development and knowledge transfers in legacy systems (Pirinen 2013). The focus should also be in creating something new, supporting co-creativity, and making the methods and literature (which might be outdated) better in the process (Nunamaker and Briggs 2011; Pirinen 2009).

According to this study, the DSRM process can be revised such that users and user participation are important in every part of designing the information system (cf. Kuechler and Vaishnavi 2012; Vaughan 2014). Within co-operation, users make it possible to create systems and services that are pleasant to use, and the users are ready to put in the effort necessary for learning and validation of the system (Maguire

2001; Vaughan 2014). If we take a look again at the DSRM model (Peffers et al. 2008), the users' view can be focused in all process iterations. Therefore, in this study, the DSRM model is added as a perspective for each phase.

In phase 1, the user is the one who can define the problem and knows best why it must be solved. The designer can help with the details, but cannot know what the actual problem is (Maguire 2001). In phase 2, the user first gets to try how the system works. In the ideal case, the problems with different functionalities would be noticed as early as possible, preferably in phase 1 or 2. The later the problems in the processes are found, the more expensive they are to fix. Several articles do not mention taking users and usability into account at all, even though an information system has no value if it is not usable and users do not use it. In order to be understood, designing usability needs to be done together with the users and their needs and satisfaction (cf. Ode 2014).

According to this study, it would be wise to get the users involved as early as possible, because the bigger the change is, the harder it is for the users to accept it, and the more effort needs to be made in internal marketing; otherwise, the resistance can be remarkable (Ryan and Harrison 2000). In many firms, the employees' ability to accept changes are not acknowledged, or the work and stress caused by changes are underestimated (Vaughan 2014). The worst situation is if the change involves changing the working processes and the users are not aware of the situation. Change management can be really demanding in these cases, and needs to be taken into consideration when planning the changes in information systems. The change process can be predicted, and with good leadership and change management it can be alleviated. If the users are committed to the designing of the information system in the early phases, it can greatly affect achieving a better outcome, as Vaughan (2014) anticipated.

Discussion

Orlikowski (1993) has discussed the levels of changes according to the impact they have on the users and their work processes. These impacts can be minor or major, depending on whether they change the workflows a little or the whole process. In all of the cases in the environment of this study, user participation throughout the process is essential for a successful project, but the relevance grows with the level of change; this is in line with the work of Orlikowski (1993). These issues and scopes also need to be understood in the research, because they are crucial for gaining the best possible benefits of the system improvement or new system.

It is always a risk for a firm to deploy a new system (Vaughan 2014). It can be discussed as a question: Is an information system too often deployed without asking the users? The implication of this study is that change management is the key to successful deployment of a system; a well-managed change process will make it possible for the users to commit to the process; and the support and commitment of the management is essential. If the users need to abandon the familiar system and jump into a new, unknown world, they will resist the change. With effective communication, however, these issues can be overcome. Our study is in line with the following: it is virtually impossible to inform the users too much of the new system and its features (Maguire 2001); in addition, Keen (1981) emphasizes the meaning of personal interaction and participative leadership in the deployment of a new system.

Ode (2014) and Maguire (2001) represent a possible reasoning for why system design-development projects sometimes fail. According to these authors, the most common reasons are that the software does not contain the expected features, it is difficult to use, or it is not suitable for the demands of the tasks it should be used for. It is likely that these reasons are directly proportional to the failure of designing the information system, because the project has failed to listen—or "co-create and co-design of continuums and feasibility" (Pirinen 2015)—with the user enough during the project.

This study revealed that another obvious reason for failure is the inadequate training of the users. The training is always arduous, time-consuming, and demanding of a high level of resources. Even if the training is carefully completed, there is no guarantee that the users have internalized what they have been taught. During the deployment process, the users should have the time and possibility to go through their work tasks in order to omit the tasks that are no longer needed. The deployment process should not be hurried, even though there is usually a very strict schedule for getting the production up and running. Training is one of the necessary phases in deployment, and the trained employee is valuable to the firm, because users would use the system more effectively, make fewer mistakes, and accomplish better results.

These reasons can be influenced by user participation in the design-development phase (cf. Maguire 2001).

These facts apply even if we are not considering the usability of the system. The more usable the system, the easier it is for the users to adapt to it. The efficiency and effectivity of the changes will probably not be realized if the user cannot use the system in the right manner. Usable systems can increase productivity, reduce errors and training, and support and improve user acceptance; these are all reasons that firms consider when making decisions on information system development. Due to the matters mentioned above, the user, usability, and design-deployment of the system should be at least as continuous to DSRM, and these elements should also be confirmed in the DSRM process. Information systems are always made for the users and actors, and therefore users cannot be neglected in system design-development phases. Implementing the changes and deploying the system are also important parts of the design process, and should go side by side with usability.

One candidate for future study related to the DSRM process would be the value and value concentration theme of the information systems and services (Nunamaker and Briggs 2012; Pirinen 2015). This future research scope is also mentioned in Peffers et al. (2008, p.28-33), and it is more widely discussed in Peffers et al. (2003). These aspects could contribute to DSRM, however, since the value of the system (and thus also the value of the methods used to design the system) depend on the users and how they can utilize the different features of the systems, and how the firms benefit from the changes made. Therefore, it is important to take also the issues of usability into theoretical consideration, as well as how the deployment-dissemination of the system or service can be done. In the environment of this study, the terms "PreOperational Validation" (POV) and "PreOrder Validation" are discussed.

Conclusions

According to this study, users, usability, and design-development-deployment-dissemination issues of the systems and services are central factors for systems utility, confidence, and trust-building, and therefore they should be taken into account at every step of the system design-development-dissemination process. The changes made in the system should be managed as a novel way so that the users can commit to the changes, which may also affect work processes. A solid communication is of great importance, as the means of implementing the change—the managers—must also commit deeply to it. The earlier the users participate in the design-development process, the easier the realization of the system will be; the users will accept the new system, as well as the new working processes.

So far, even though the user is not at the heart of the technological DSRM literature, the user view is too easily put aside in the behavioral sciences, with possible ties to related information systems research; users and actors, however, cannot be forgotten. The DSRM thus should include the user and co-creativity. There is no point in making information systems, services, or theories if the essential users-actors space is missing. The realization of the system is very much tied to the users' and actors' trust and confidence.

References

Abdel-Hamid, T. K., and Madnick, S. E. 1989. "Lessons Learned from Modeling the Dynamics of Software Development," *Management of Computing* (32:12), pp. 1426-1436.

Alter, S. 2008. "Defining Information Systems as Work Systems: Implications for the IS field," *European Journal of Information Systems*, (17:1), pp. 448-469.

Baskerville, R. L., and Myers, M. D. 2002. "Information Systems as a Reference Discipline," *MIS Quarterly* (26: 1), pp. 1-14.

Baskerville, R., and Wood-Harper, A. T. 1998. "Diversity in Information Systems Action Research Methods," *European Journal of Information Systems*, (7:2), pp. 90-107.

Benbasat, I., and Zmud, R. W. 2003. "The Identity Crisis Within the IS Discipline: Defining and Communicating the Discipline's Core Properties," *MIS Quarterly,* (27: 2), pp. 183-194.

Campbell, D. T., and Fiske, D. W. 1959. "Convergent and Discriminant Validation by the Multitrait-Multimethod Matrix," *Psychological Bulletin*, (56), 81-105.

Dedeke, A. 2012. "Improving Legacy-System Sustainability: A Systematic Approach," *IT Pro,* January/February.

Germonprez, M., Hovorka, D., and Gal, U. 2011. "Secondary Design: A Case of Behavioral Design Science Research," *Journal of the Association for Information Systems*, (12:10), pp. 662-683.

Gregor, S. 2002. "A Theory of Theories in Information Systems," *Information Systems Foundations: Building the Theoretical Base*, S. Gregor, and D. Hart (eds.), Canberra: Australian National University, pp. 1-20.

Gregor, S., and Jones, D. 2007. "The Anatomy of a Design Theory," *Journal of the Association for Information Systems* (8:5), pp. 312-335.

Hanseth, O., and Lyytinen, K. 2010. "Design Theory for Dynamic Complexity in Information Infrastructures: The Case of Building Internet." *Journal of Information Technology*, (28), pp. 1-19.

Hevner, A. R., and Chatterjee, S. 2010. *Design Research in Information Systems. Theory and Practice,* Springer, New York.

Hevner, A. R., March, S. T., Park, J., and Ram, S. 2004. "Design Science in Information Systems Research," *MIS Quarterly* (28:1), pp. 75-105.

Keen, P. 1981. "Social Impacts of Computing Information Systems and Organizational Change," *Communications of ACM,* (24:1), pp. 24-33.

Kuechler, W., and Vaishnavi, V. 2012. "A Framework for Theory Development in Design Science Research: Multiple Perspectives," *Journal of the Association for Information Systems* (13:6).

Lincoln, Y. S., and Guba, E. G. 1985. *Naturalistic Inquiry,* Beverly Hills: Sage Publication.

Luojus, S. 2010. *From a Momentary Experience to a Lasting One: The Concept of and Research on Expanded User Experience of Mobile Devices,* Doctoral dissertation, A559. Department of Information Processing Science, University of Oulu.

Maguire, M. 2001. "Methods to Support Human-centred Design," *International Journal of Human-Computer studies* (55:1), pp. 587-634.

March, S. T., and Smith, G. F. 1995. "Design and Natural Science Research on Information Technology," *Decision Support Systems,* (15:4), pp. 251-266.

Markus, M. L., Majchrzak, A., and Gasser, L. 2002. "A Design Theory for Systems that Support Emergent Knowledge Processes," *MIS Quarterly*, (26:3), pp. 179-212.

Miles, M. B., and Huberman, A. M. 1994. *Qualitative Data Analysis: An Expanded Sourcebook*. Thousand Oaks: Sage Publications.

Nunamaker, J. R., Chen, M., and Purdin, T. 1991. "Systems Development in IS research," *MIS Quarterly* (7:3), pp. 89-106.

Nunamaker, J. R., and Briggs, R. O. 2011. "Toward a Broader Vision for Information Systems," *ACM Transactions on Management Information Systems* (2:4), pp. 1-12.

Ode, F. J. 2010. "Why Users are the Key to Success," Available at: http://www.foundationsoft.com/fsi/pdf/articles/2010_07_CFMA_Users-Are-Key-To-Succes-With-Software-Implementation.pdf [2014, 11/30].

Orlikowski, W. J. 1993. "CASE Tools as Organizational Change: Investigating Incremental and Radical Changes in Systems Development," *MIS Quarterly* (9:1), pp. 309-340.

Orlikowski, W. J., and Iacono, C. S. 2001. "Research Commentary: Desperately Seeking the 'IT' in IT Research— A Call to Theorizing the IT Artifact," *Information Systems Research* (12:2), pp. 121-134.

Patton, M. 1990. *Qualitative evaluation and research methods* (2nd ed.). London: Sage Publications.

Peffers, K., Gengler, C. E., and Tuunanen, T. 2003. "Extending Critical Success Factors Methodology to Facilitate Broadly Participative Information Systems Planning," *Journal of Management Information Systems* (20:1), pp. 51-85.

Peffers, K., Tuunanen, T. Rothenberger, M., and Chatterjee, S. 2008. "A Design Science Research Methodology for Information Systems Research," *Journal of Management Information Systems* (24:3), pp. 45-77.

Pirinen, R. 2015. "Towards Continuum-focused Methodology for Information Systems Research and Development," *IEEE Global Engineering Education Conference (EDUCON)*, Tallinn, Estonia, pp. 167-175.

Pirinen, R. 2013. *Towards Realization of Research and Development in a University of Applied Sciences*. Doctoral Dissertation, Forestry and Natural Sciences, Publications of the University of Eastern Finland, 108.

Pirinen, R. 2009. "Research Framework of Integrative Action," Americas Conference on Information Systems, Association of Information Systems (AIS), San Francisco.

Rajamäki, J. 2014. *Studies of Satellite-Based Tracking Systems for Improving Law Enforcement*, Doctoral dissertation, Jyväskylä Studies in Computing, 192.
Robson, C. 2002. *Real World Research* (2nd ed.), Oxford: Blackwell Publishing.
Ryan, S., and Harrison, S. 2000. "Considering Social Subsystem Costs and Benefits in Information Technology Investment Decisions: A View from the Field on Anticipated Payoffs," *Journal of Management Information Systems* (16:4), pp. 11-40.
Simon, H. 1996. *The Sciences of the Artificial*. Cambridge: MIT Press.
Vaughan, P. J. 2014. "System Implementation Success Factors: It's Not Just the Technology," Available at: http://net.educause.edu/ir/library/pdf/CMR0122.pdf [2014, 12/7].
Walls, J., Widmeyer, G., and El Sawy, O. 1992. "Building an Information System Design Theory for Vigilant EIS," *Information Systems Research,* (3:1), pp. 36-59.
Weber, R. 1987. "Toward a Theory of Artifacts: A Paradigmatic Base for Information Systems Research," *Journal of Information Systems* (1:1), pp. 3-19.
Zhang, P., Scialdone, M., and Ku, M. 2011. "IT Artifacts and the State of IS Research," *International Conference on Information Systems, Shanghai.*

Appendix

The data collection of this study was cumulative, from real-world projects that the authors participated in during the course of 15 years, and data collection was systematically used for analysis. The data collection included the following themes: data of real implementations (n=9); management data (n=52) files, which includes specifications, strategies, and legislation; data of development days (n=50) files, which includes data displays, notes, development proposals, and reports (including test reports); and feedback data from users' (n=15) description files; and detailed literature in review (n=40) references.