WHO IS AFRAID OF THE BIG BAD WOLF - STRUCTURING LARGE DESIGN SCIENCE RESEARCH PROJECTS

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Abstract

Design Science Research is an important research approach that has gained increased attention over the past decade in the international scientific community. Recommendations and methodologies for design science-oriented research published in recent years provide good guidance for scientists to conduct and publish design science-oriented research. But little attention has yet been paid to the setup and structuring of large research projects. Such projects sometimes look like dangerous and greedy big bad wolves that threaten the innocent project participants. Large research projects are special because of the volume and complexity of the research scope and the interaction of participating project members. We look for solutions to tame the wolf and present a framework to confine and structure the content of large research projects into well-defined and individually manageable research segments. This framework is suitable for projects characterized by manifold research tasks and the involvement of many project participants. This article presents the designed framework and illustrates benefits, limitations and practical implications. Its application is illustrated by means of a research project case study that was carried out over a three year period with the participation of several research institutions and partner companies.

Keywords: Design Science, Research Process, Research Framework, Case Study
1 Introduction

Design Science Research (DSR) has gained increased attention over the last decade in the international scientific community as an important research approach (Vaishnavi and Kuechler, 2004). DSR is especially prevalent in German speaking countries (Wilde and Hess, 2007) where information systems research has traditionally been closely related to the natural and engineering sciences in contrast to research communities in Anglo-Saxon countries which show a tendency to positivist, behavioristic research methods (Schauer, 2011). Several publications on the role and interaction of design science, natural science (March and Smith, 1995) and social science (Gregor and Baskerville, 2012) have led to more clarity about the differences, relationships, and interactions between different research approaches in the scientific domain. Scientists have made valuable contributions on how to conduct DSR in a structured and rigorous manner (Hevner et al., 2004; Peffers et al., 2007; Österle et al., 2010; Hevner and Chatterjee, 2010) and for positioning DSR results in the academic arena (Gregor and Hevner, 2013). But little attention has yet been paid to the question of how large research projects can actually be structured and set up. Large research projects sometimes appear like hungry and dangerous wolves that threaten the frightened project participants because they do not know how to manage the voluminous research tasks appropriately to achieve the intended research goals. Projects get out of control, out of budget, out of time and consume valuable research resources without achieving the intended research objectives. The involved researchers feel eaten up, become frustrated and burn out. We describe a framework that can help to improve the research process by giving guidance as to how the research content and tasks can be structured and divided into manageable components.

Design science-oriented research in information systems research is defined by different steps (Peffers et al., 2007; Gregor and Baskerville, 2012) that commonly at least include the phases analysis, design, evaluation and diffusion (Österle et al., 2010). The completion of all phases is a resource- and time-consuming task. In comparison to purely descriptive science, DSR is characterized by the duality of the epistemological and the design objective (Riege et al., 2009). The objective of creating artifacts that are valuable for practical purposes (Hevner et al., 2004) requires the involvement and participation of project members from the application domain. Evaluation is an essential component in design science-oriented research projects (Riege et al., 2009; Venable et al., 2012). Many evaluation methods like simulations, lab or field experiments require instantiated artifacts that can be used in natural or artificial evaluation environments. The instantiation of designed artifacts is commonly a time-consuming task that requires different skills than the design phase. The necessity to include all necessary research phases and to conduct extensive evaluation for rigorous research results as well as the aim to create valuable research artifacts that on the one hand contribute to the scientific knowledge base but that can on the other hand also be applied in practice, commonly lead to large research projects that include the participation of multiple researchers, research assistants, different scientific institutions and partner companies from the application domain. The interaction of multiple researchers and participation of different interest groups contribute to the complexity of these projects.

Our research is guided by the question as to how the research content and tasks in large research projects can be structured to facilitate parallel research work by simultaneously encouraging mutual research efforts and synergies. We introduce a framework that can be used to structure large design science-oriented research projects. The framework allows the participants to divide the research content of a research project into small segments that can then be addressed individually to identify necessary research artifacts and appropriate research methods. We focus on design science-oriented research projects in the information systems science discipline because of the idiosyncratic characteristics of design science-oriented research. The duality of the epistemological and design objective in these projects leads to research activities that are different compared to other research approaches.

The overall objective of presenting our framework is to enable researchers to confine and structure the content of research projects in such a way that research segments are well separated from each other to
allow distributed and parallel research work on different segments but also to enable the research group to keep track of the whole research process and to benefit from the interrelations of participating researchers and the mutual research efforts. The framework focuses on setting the scope of a research project and for dividing its content into small and well-defined parts that can be addressed by different researchers. It should not be regarded as a project management framework. Project management is a complex process and recommendations and guidance on project management is for example available in relevant national and international standards (International Organization for Standardization, 2012; Deutsches Institut für Normung, 2009; Project Management Institute, 2013; Great Britain and Office of Government Commerce, 2009). The presented framework should be seen as a useful tool in the setup and operational phase of a project to promote the assignment of research tasks to the involved researchers. Our research results are derived from a large design science-oriented research project that was carried out in cooperation with four private companies and two research institutions over a three year period. It included the participation of several senior and junior researchers, research assistants and representatives of the participating companies. The presented framework was developed and used during this research project. The application of the framework and the insights from its practical usage - which is included as a case study - illustrates the benefits and limitation of the presented framework.

2 Methodology and Research Structure

The work presented in this paper follows a DSR approach. DSR addresses research problems that originate from the application domain and its aim is to develop useful artifacts that can be applied in practice (Hevner et al., 2004). The application domain of our research work is the field of information systems research itself. We relied on a DSR approach in order to create an artifact that can improve the research process in large research projects and hence the proximity of the research question to practical problems in daily scientific practice. The presented research work follows the research phases described by Osterle et al. which consist of analysis, design, evaluation and diffusion (Österle et al., 2010). The analysis of the problem domain is described in section four within the case study. The main focus of this paper is the presentation of the designed model for structuring and confining research projects which is addressed in section five. Section six continues with a discussion on lessons learned based on the described case study, identified benefits, limitations and evaluation aspects. The diffusion of our research results as the last phase in DSR is already addressed by the publication of this article. A major challenge in scientific endeavors is the selection of an adequate research method (Gal- liers and Land, 1987). A variety of well-established research methods is available for researchers in information systems science (Palvia et al., 2003; Palvia et al., 2004; Wilde and Hess, 2007). The selection of a research method should follow the intended research objective. The objective of our research lies in the development of a framework that can be used by scientists to structure and confine the research content in large research projects. We reviewed relevant frameworks in the information systems science discipline and amalgamated different models to construct a new framework useful for the purpose at hand. This approach is comparable to method engineering (Brinkkemper, 1996). Method engineering is used to construct methods based on already existing methods and method fragments. But instead of merging existing method fragments we used a model engineering approach by referring to model components that have already been proven useful in the information system research discipline for creating a novel solution.

Research projects are complex undertakings that include the interaction of many individuals with differing or sometimes even opposing motivations. The development of a framework for structuring research projects needs to consider the complex social settings in research projects. We used the developed framework in a real research project which is illustrated as a case study in this paper. Case study research is a common research method in information systems research (Chen and Hirschheim, 2004). It is a special form of qualitative-empirical research methods (Wilde and Hess, 2006) that involves the close examination of people, topics and issues (Hayes, 2004). It is especially suited to investigate complex phenomena in their natural environments and can be used for behavioral or design-oriented re-
search (Wilde and Hess, 2006). Case study research is commonly criticized for the lack of generalizability due to the uniqueness of the investigated case. But Yin points out that similar concerns can, for example, also be applied in the contexts of single experiments (Yin, 2008). Furthermore the objective of our research is of exploratory nature and not empirical evaluation.

3 Related Work

Scholars have highlighted the need for structured and commonly agreed research processes in the DSR community (Leist and Rosemann, 2011). Peffers et al. present a research methodology for DSR in the information systems community (Peffers et al., 2006; Peffers et al., 2007). The authors present a research framework that consists of six phases: (1) identify problem and motivate, (2) define objectives of a solution, (3) design and development, (4) demonstration, (5) evaluation and (6) communication. Their framework is based on a review of existing scientific publications on the research process in the information systems and related research disciplines. The research framework is composed of process elements that have been identified by different scholars working in the information systems (Takeda et al., 1990; Nunamaker et al., 1991; Walls et al., 1992; Hevner et al., 2004; Cole et al., 2005) and engineering (Archer, 1984; Eekels and Roozenburg, 1991) discipline. It is interesting that the continental European research community is mostly neglected by the authors although the design science discipline has a long lasting tradition especially in German speaking countries (Winter, 2008). Österle et al. as representatives of this community suggest four phases for DSR: (1) analysis, (2) design, (3) evaluation and (4) diffusion (Österle et al., 2010). Gregor and Baskerville examine the research process from a philosophy of science perspective with the objective to provide a framework for the combination of design science and social science research. The presented research process consists of the phases (A) construct and test artefacts, (B) formulate prescriptive knowledge and theory, (C) study artefact(s) in use, (D) test knowledge of artefacts in use and (E) formulate descriptive knowledge (Gregor and Baskerville, 2012). All authors explicitly emphasize the iterative relationship between the different research steps in each model. Alturki et al. present a more detailed model that consists of 14 research steps. The authors also present an extensive summary of relevant literature (Alturki et al., 2011).

It is interesting to note that researchers from the information systems discipline rarely refer to project management literature. Available knowledge on project management that has been standardized in international (International Organization for Standardization, 2012) or national (Project Management Institute, 2013; Deutsches Institut für Normung, 2009; Great Britain and Office of Government Commerce, 2009) guidelines has rarely been considered yet, although research work exhibits all the characteristics that are also associated with projects (vom Brocke and Lippe, 2010). Vom Brocke and Lippe are among the few authors that build the bridge between research processes and project management. They point out the need to tailor existing project management guidelines for research projects and identify eight characteristics that distinguish design science-oriented research projects from traditional project types (vom Brocke and Lippe, 2010). We are not aware of quantitative research on project management in the field of information systems science.

The aforementioned literature provides useful insights into the research processes in design science-oriented research. But little has yet been published that provides guidance as to the effective structure and set up of large DSR projects. To do exactly that is what we intend with the presentation of the research results in this article.

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1 The term methodology is interpreted ambiguously in information systems science (Mingers, 2001). Peffers et al. refer to a methodology as a combination of methods independent of a single research project and intend to present a methodology that serves as a commonly accepted framework for carrying out design science research.
4 Case Study

The research project that is described as a case study in this article was concerned with research questions from the field of financial audits. Companies prepare financial statements to provide interested parties with financially relevant information. The correctness and reliability of this information are a key requirement for stakeholders to direct their decisions. National laws and regulations mandate the audit of financial statements by an independent third party to prevent the distribution of false financial information because of its paramount role for the well-functioning of economic markets. These audits are carried out by public accountants. Accounting scandals in recent years have shown that auditors have not been able to prevent these scandals or at least indicate any violations before the actual collapse. A common problem in financial audits is an imbalance between automated transaction processing of partly huge data volumes on the companies’ side and traditional and manual audit procedures on the auditors’ side (Werner et al., 2012). Companies use information systems to support and automate the operation of their business processes. Auditors primarily rely on traditional audit procedures like interviews and manual inspections of available documents to achieve the necessary audit comfort. But these procedures become inefficient or even ineffective in environments where the processing of transactions is highly automated and includes the handling of large data volumes (Werner and Gehrke, 2011). A solution to decrease this imbalance would be the application of automated audit procedures. Business processes play a significant role in financial audits. The audit of business processes and internal controls that affect the processing of transactions are an important part of financial audits (International Federation of Accountants, 2012). The rationale for considering business processes is the assumption that well-controlled processes will lead to complete and correct entries on the financial accounts. The objective of the described research project was the development of methods and tools that support the auditor by automating parts of the procedures that are necessary to conduct process audits, and to thereby make these audits more efficient and effective. The fundamental idea was to use innovative data analysis techniques for automating the discovery of process models and to automatically assess the design and operating effectiveness of internal controls by analyzing relevant control data. The overall research question was formulated as follows:

- How can data analysis techniques be used to automate the audit of business processes in the context of financial audits?

Process mining provides powerful methods and tools that can be used to reconstruct process models based on the analysis of recorded event logs (van der Aalst, 2011). For designing the desired tools and methods the following more detailed research questions had to be answered.

1. How can reliable process models be automatically reconstructed by analyzing data stored in information systems that process financially relevant transactions?

2. How can process models be automatically assessed from an audit perspective by integrating control data that is stored in the source systems?

3. How can process models be graphically represented to display information that is relevant to auditors and that can be applied in real audit environments?

These questions needed to be answered in order to develop research artifacts that are able to close the research gap and that are also valuable for the application domain. A main component of the project was the development of a software prototype. The design of the prototype was on the one hand desired for the creation of a valuable artifact for the application domain but also for evaluation purposes in the research process. The project members consisted of two research institutions and four partner organizations. A software company was responsible for the programming and instantiation of the software tool. A large auditing company supported the requirement analysis, design and testing phase and provided necessary data. A small auditing and consulting company was included to reflect the requirements from small and medium sized companies. A public association for board members contributed...
as a project partner to diffuse the research results into the broader application domain and by providing information about aspects required by the board level. The project members consisted of three PhD students and two professors from the information systems area, three software developers, several research assistants and about 20 contact persons from partner companies who were contacted during the research project. Concerns arose at the beginning of the research work about how the overall project should be structured. Each project participant had a different motive to take part on the project. The partner companies needed a software artifact for practical use. The junior researchers were eager to advance in their PhD studies and the senior researchers were concerned about resources and had to keep in mind the overall progress of the involved scientific institutions. There was the risk that research work on specific tasks would be conducted redundantly and other research tasks be neglected due to uncoordinated research activities and deviating motivations. A framework was necessary to identify which research outputs would be critical for the success of the research project, how these related to each other, which scientific approach would be adequate for the development and evaluation of research artifacts and which researcher would fit best to accomplish different research tasks according to available expertise and skills. It was also necessary to decide on the roles and responsibilities for the communication with the project partners for specific research aspects such as the requirement analysis, software development and evaluation approaches.

5 Segmentation Framework

This section deals with the description of the framework for structuring large design science-oriented research projects that was developed in the project mentioned above. The objective of the presented research was the development of a tool that allows the confining and separation of the research content and tasks. The first step to design a useful framework is the identification of distinguishing features that can be used to categorize different research contents. The main subjects of interest in information systems research are information technologies and the man/machine interaction. Gregor points out that the distinguishing characteristic of the information systems area is not only the consideration of both worlds - technology and humans - but also the investigation of phenomena that emerge from their interaction in socio-technical systems (Gregor, 2006). A framework for the structuring of research content should therefore take into account the technological and human-interaction aspects. Categorizations for different levels of information technology and human interaction can be found in various models. A common model from the field of information management is presented by Krcmar (Krcmar, 2010). He distinguishes between three different levels of management tasks. These are accompanied by independent leadership tasks which are relevant for all levels. Figure 1 shows a graphical representation of the model. The lowest level contains tasks for the management of the technical infrastructure that is necessary for the use of information and communication technology at the higher levels. The second level deals with the management of information systems and includes the management of data, processes, applications and their life-cycles. At the highest level reside the tasks for the management of the information economy. The main objective of the tasks at this level is the management of the resource information, its supply, demand and usage. The lower two levels are mainly concerned with the technical aspects of information management. The human aspect is considered at the highest level where the requirements for the lower levels are defined on the basis of the needs of human information recipients and users of the applications, processes, data and technology that is provided by the lower levels. The model of information management addresses both elements that are subject to research in information system science: information systems and human interaction in socio-technical systems. It is therefore a useful starting point for the categorization of research content because each researched artifact in design science-oriented research can be characterized if it addresses one or more of the different levels, infrastructure, applications and usage. The original model represents applications, data and processes at the same level.
Figure 1 Model of Information Management (adapted from Krcmar 2010 p.50) \(^2\)

Prominent conferences in the information systems science area like the Business Process Management conference (BPM, 2014), comprehensive publications (Weske, 2012) and extensive reviews (van der Aalst, 2012; van der Aalst, 2013) show that business processes are a key component in information systems research. We therefore considered it appropriate to divide the level of information systems into the two levels of software applications and processes. The process level is the connecting layer where process participants use components from the lower application level to satisfy information demands from the higher level. The requirement to include this additional level also became obvious in our research project because it was not sufficient to consider relevant software applications and how information was consumed at the usage-level but also how relevant information was created within business processes and how these relate to the financial statements that serve as information input for stakeholders at the highest level. The resulting four levels as shown in Figure 2 represent the first dimension for categorizing research content.

The presented levels are very broad. Although they can be used to distinguish research content on a technical vs. human-interaction dimension experiences from our case study showed that they are not sufficient to divide the research content into manageable segments. The usage of the four levels as the single separation criterion would mean that researchers would only be concerned about the assigned level which is not a suitable solution because interdependencies between the different levels would be neglected. Furthermore it became obvious in our research project that such a broad separation was not adequate in practical settings when considering the motivation and skill sets of individual researchers.

Hevner et al. present a research framework for information systems research that provides an illustration how different concepts that are relevant for research projects relate to each other (Hevner et al., 2004). The framework is presented in Figure 3. It shows the relationships between the main research

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\(^2\) The model refers to the reference model that was originally introduced by Wollnik. The three levels of the information management model relate to the levels of information usage, information and communication systems and infrastructure of the information processing and communication in Wollnik’s reference model (Wollnik, 1998).
activities for design science (build and evaluate) and behavioral science (develop and justify) research, the environment and the knowledge base. The environment or application domain defines the problem space. The phenomena of interest for design science-oriented research should be derived from the environment. The knowledge base represents the already existing pool of research results that have been explored. Each research project should consider already existing knowledge to execute the research activities, provide useful artifacts to the application domain and add additional generalized knowledge to the knowledge base.

**Figure 3 Information Systems Research Framework (adapted from Hevner et al. 2004 p. 80)**

DSR projects are characterized by the duality of the epistemological and design objective which is illustrated in the model through the feedback loops from the research activities to the environment and the knowledge base. The distinction between the research contribution target domains can be used as a second dimension for the categorization of research content. Figure 4 shows the integration of the application domain and knowledge base as a second dimension.

**Figure 4 Integration of the Research Contribution Dimension**

**Figure 5 Integration of the Research Question Dimension**
Each research project addresses an overall research question. The research questions in large research projects are, as a rule, complex. Otherwise it would be questionable if such a project indeed has the characteristics of a large project. Complex research questions can usually be divided into detailed lower-level research questions. These research questions can be used as a categorization criterion for a third dimension as shown in Figure 5. The application of all three dimensions as shown in Figure 5 illustrates how separate segments emerge based on the different dimension categories. Each segment can now be considered separately. And groups consisting of segments from different dimensions can be assigned to different researchers. This ensures that researchers do not just focus on an isolated segment but that they consider requirements from and interrelationships with different dimensions. The division into research segments can be seen as a ‘divide and conquer’ approach. The overall research project is broken into manageable components that can be conquered individually. Figure 6 illustrates a single segment of the overall model.

Artifact
Research Methods
- Analysis
- Design
- Evaluation

Table 1 Segment Description

Artifacts in design science-oriented research should be developed by using suitable research methods. For each segment it is now possible to identify and describe the relevant artifact(s), the research methods for the analysis, design and evaluation as well as the diffusion type. A template for such a description is illustrated in Table 1. Evaluation methods for a single artifact can for example be chosen by relying on available frameworks (Venable et al., 2012), whereas the type of diffusion can for example be determined by referring to the knowledge contribution level of design science-oriented research (Gregor and Hevner, 2013).

Each segment should be associated with one (or more) artifact. March and Smith define four types of research artifacts: constructs, methods, models and instantiations (March and Smith, 1995). Gregor argues that design theories should also be regarded as an important outcome of design science-oriented research (Gregor, 2006). Many research methods exist for analysis, design and evaluation purposes. Table 2 illustrates exemplary research methods that have commonly been cited by renowned scholars. The superscripts a) to e) disclose the origin of the listed methods that are described in Footnote 3.

The benefit of applying the segmentation framework becomes obvious when it is illustrated with examples. Figure 7 shows an instantiation of the reference framework for the described case study. The research question domain was separated into three categories that represent three different research questions. These were derived from the overall research question and objective (compare section 4). The primary application domain for the research project was financial audits. Business process management and business intelligence were perceived as being the most important scientific disciplines that form the knowledge base for conducting research in the project.
Table 2 Overview of Research Artifacts, Methods and Diffusion Types

One segment in the framework is highlighted. It is located on the process-level because the objective of this segment was the creation of process models that are useful in the context of financial audits. The research task of this segment was the development of a mining algorithm that is able to reconstruct process models that comply with the requirements of the application domain. The designed algorithm exploits the specific structure of financially relevant transaction data to create process models (Gehrke and Müller-Wickop, 2010) and uses the data perspective to model the relationship between financial accounts and process activities (Werner, 2013). The requirements for developing this algorithm were derived from interviews with experts that showed that the data perspective is of utmost importance in the field of financial audits for illustrating the relationship between business processes and the financial accounts (Müller-Wickop et al., 2013). The technical requirements were investigated by analyzing the relevant data structure in ERP systems. The mining algorithm was designed by using components and research results from already existing mining algorithms following a method engineering approach (Brinkkemper, 1996).

Table 3 Example Description

<table>
<thead>
<tr>
<th>Artifact</th>
<th>Financial Process Mining Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Methods</td>
<td>Structured Interview Data Analysis</td>
</tr>
<tr>
<td>Analysis</td>
<td>Method Engineering Prototyping</td>
</tr>
<tr>
<td>Design</td>
<td>Simulation Case Study</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Journal</td>
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</table>

3 a) (Österle et al., 2010), b) (Wilde and Hess, 2007), c) (Palvia et al., 2003) d) (Venable et al., 2012), e) (March and Smith, 1995), f) (Gregor, 2006)
The mining algorithm was implemented as a prototype and evaluated by using test data for simulations (Werner et al., 2013). The evaluation also included a case study in a real world scenario. Table 3 summarizes the research methods and diffusion type for the designed artifact.

Figure 8 shows a second example and illustrates two research segments. It demonstrates the relationship between segments that are related to the same level on the technical vs. human-interaction dimension but address different knowledge contribution categories on the knowledge contribution dimension. Table 4 lists the relevant artifacts and summarizes the research methods and diffusion types. A data extraction module was designed for the extraction of the event log data from the source ERP systems. The inspection of the extracted event logs revealed that they are not suitable for traditional mining algorithms. Financially relevant process instances do not exhibit strict linear control flows as assumed by traditional process mining algorithms, their execution behavior includes divergent and convergent behavior on the business process instance level (Werner and Nüttgens, 2014). It was necessary to develop a pre-processing algorithm that transforms non-linear event logs into linear event logs to be able to compare the mining results of the designed Financial Process Mining Algorithm with other mining algorithms (Mueller-Wickop and Schultz, 2013). The extraction module is an artifact relevant for the application domain because it allows the extraction of event log data for specific ERP systems in real world scenarios. The pre-processing algorithm is an artifact that is not specific to the application domain but can be applied in a variety of application scenarios for transforming non-linear event logs into linear event logs and can therefore be considered as a generalized contribution to the process mining knowledge base. Both artifacts needed to consider the ERP systems that are used in organizations for processing business transactions. The designed artifacts needed to be able to interact with these information systems and provided the input for the process mining algorithm described in the first example. It was therefore sensible to locate these artifacts on the application level of the human-technical dimension.

<table>
<thead>
<tr>
<th>Artifact</th>
<th>Research Methods</th>
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<tbody>
<tr>
<td>Data Extraction Module</td>
<td>Analysis</td>
</tr>
<tr>
<td></td>
<td>Design</td>
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<td></td>
<td>Evaluation</td>
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<tr>
<td></td>
<td>Diffusion Type</td>
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<tr>
<td>Pre-Processing Algorithm</td>
<td>Experiment</td>
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<td>Method Engineering</td>
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<td>Simulation</td>
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<td>Conference</td>
<td>Conference</td>
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The framework is further useful for the identification of dependencies between individual segments and the grouping of interdependent segments. Each group can be assigned to the involved research project participants based on motivational preferences and skill sets. Figure 9 shows the research scopes that were assigned to the three PhD students that were involved in the research project. The figure illustrates different aspects. First it is notable that not all possible segments are covered. This was intended and can be attributed to the research objective and scope of the research project. Research on the infrastructure-level was explicitly excluded from the project scope because it was not crucial for the achievement of the overall research objective. Not covered segments provide opportunities for additional and subsequent research. The illustration shows a second aspect. It can be seen that overlaps occurred in some segments. These overlaps were important. A basic requirement in large
research projects is the clear separation of research tasks. But it is also important to have overlaps that create a common knowledge base that is fundamental for all research tasks, from preventing completely isolated research efforts and the emergence of ‘Chinese Walls’ within the project.

A certain degree of overlap is necessary to encourage communication, mutual research effort and the creation of research synergies. Too much overlap leads to redundant and unproductive research work. Finding a balance between separation and overlap is difficult but crucial for the success of the research project.

6 Discussion

The previous section describes a framework for the structuring of large research projects. It was applied in a research project that is presented as a case study in this article. Its application proved to be useful for the described case. Not all research objectives that were identified in the initiation phase of the project could be achieved but the main research questions were answered with the design and evaluation of relevant research artifacts and their instantiations. The research results were published in 21 peer-reviewed publications and the project was finished on time and budget with an instantiated software prototype that included the majority of the developed methods. The provided framework played a significant role in the research process for the coordination of the research activities of the participating researchers. The application of the framework showed that several aspects are crucial for the successful application. A major obstacle was the development of a mutually agreed understanding of terms and definitions regarding the research artifacts and used research methods among all involved parties. The understanding of specific constructs deviated quite significantly between researchers and practitioners but also within the researcher group. The mutual research in specific research segments was beneficial to create a common agreement on fundamental concepts and terms. Another crucial success factor was the development of, agreement on and also implementation of the research and publication plans that can be developed on the basis of the applied framework. But if these plans are not followed strictly by all individuals the risk of rivalry and counterproductive activities increases. The implementation of designed artifacts in a software prototype was an important part of the project. A lack of commonly agreed documentation standards led to additional programming efforts when software implementations initially developed for one segment had to be used for another one. A suitable way to prevent such detrimental developments are mandatory continuous project meetings on a formal level for the discussion of the project progress but also on an informal level to encourage the mutual research efforts among different research segments and also to minimize communication barri-
ers between the involved researchers. Dependencies between segments should be considered when planning the sequence of research activities and to identify synergies that can be realized if an analysis method for one segment can for example also be used for identifying requirements for another segment. A crucial outcome from our project was the insight that is counterproductive to assign segments to project participants that do not fit to the latters’ motivation and skill profile of a participant. It is for example disadvantageous for the project progress to assign research tasks that require software implementation to project participants that lack relevant programming skills or the willingness to acquire these. (Brooks, 1987) stressed that a critical success factor in software development projects is the selection of top designers. A similar success factor for large DSR projects is the selection of project participants that fit to the identified research segments or segment groups in terms of motivation and skills.

Although we believe that the presented framework has the potential to facilitate the structuring and management of large research projects a major limitation is its limited evaluation. A case study has been chosen to demonstrate the applicability and usefulness of the presented framework. Such studies investigate cases for the purpose of illumination and understanding (Hays, 2004). But single case studies have the disadvantage that it is questionable if the creation of generalized knowledge is possible based just on one single observation. Extensive evaluation to strengthen the reliability of the created research results in the context of research processes is difficult due to the relative long run-time of research projects and the limited possibility to receive data for evaluation purposes. Although the limited evaluation might be seen as a constraint for the generalizability of the presented results it should be kept in mind that the purpose of this article is of exploratory nature. Our intention is to provide researchers a useful tool that assists in structuring research projects and therefore improving research processes and outcomes. The presented framework is a designed model that is not only applicable to an individual situation but that can be used as a reference model (Heinrich et al., 2004) to structure the content of any DSR project. The model can be seen as an improvement of existing tools for project management in the scientific area. Like in software engineering there is no single solution that fits all possible project scenarios. Defining and grouping research tasks and assigning them to suitable project participants is a big challenge. The provided framework can be used as a tool to facilitate this task.

7 Summary and Outlook

DSR is an important research approach in the international information systems science community. A variety of publications exist that provide guidance on how to conduct design science-oriented research. DSR differs from social science research due to its normative nature and the duality of the research objective. DSR does not only aim at generating generalized knowledge as a contribution to the scientific knowledge base but also intends to develop artifacts that are useful for the application domain. This duality leads to research activities like the instantiation of designed artifacts and evaluation types that are idiosyncratic to DSR compared to other research approaches. Large DSR projects can appear like dangerous wolves hungry to eat up the helpless project participants and research resources. This paper presents a framework that can be used to structure the content of research projects by dividing the overall research tasks into manageable segments and thereby tames the wolves. The use of the framework allows the coordination of parallel and mutual research work of the participating researchers necessary to conduct large and complex research projects successfully. The applicability of the framework and the benefits that can be gained by its application have been described by means of a case study. Research on the management of research projects in information systems science is still scarce. Further research efforts will be made to evaluate the presented framework in future research.

Many aspects of project management in the information systems science discipline, e.g. concerning the portfolio management of research projects have not been investigated yet and empirical research is almost absent. We hope that this field of research will be addressed more closely also by other researchers.
8 References


