Outline of a Design Science Research Process

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ABSTRACT

Discussions about the body of knowledge of information systems, including the research domain, relevant perspectives and methods have been going on for a long time. Many researchers vote for a combination of research perspectives and their respective research methodologies; rigour and relevance as requirements in design science are generally accepted. What has been lacking is a formalisation of a detailed research process for design science that takes into account all requirements. We have developed such a research process, building on top of existing processes and findings from design research. The process combines qualitative and quantitative research and references well-known research methods. Publication possibilities and self-contained work packages are recommended. Case studies using the process are presented and discussed.

Categories and Subject Descriptors
H.1.0 [**Models and Principles**]: General.

General Terms
Design, Theory.

Keywords
Research process, design science, qualitative research, quantitative research.

1. MOTIVATION

While information systems (IS) research has been conducted for many years and individual research methods are well established, we believe that the application of only one research method is not sufficient to obtain viable results in design science considering the relevance and rigour criteria mentioned in [32]. However, in information systems as well as in management research [64], it remains unclear how to combine different research methods for design science. This paper proposes a research process for conducting design science in information systems research. The process combines qualitative and quantitative research methods used in IS studies [36] to guide the overall research process. Therefore, the process is not a research method on its own, but a formalised combination of existing methods.

We suggest phases and steps and indicate where an involvement from practitioners or researchers is needed. Thus, a better role understanding between research and the business world is established. The scope of the process is to provide concrete steps instead of discussing research perspective variations as already done in [47; 51].

Our motivation stems from our plan to create a method factory that specialises in method engineering. The method factory will provide knowledge about construction, documentation, evaluation and configuration of methods to individual method construction projects. For each project, we plan to involve experts in the respective field to develop the method content. To follow a consistent process for method construction in each project and thus assuring method quality, we felt the need to define a detailed design process. In addition, we believe that a defined process is fundamental to create new insights, as only then results from different projects become comparable. As the process is designed for design science, it provides support for other design artefacts as well.

This paper is organised as follows: First IS is introduced as a scientific discipline. Its research approaches and methods as well as the foundations of design science in different disciplines are described. In the second section, the research process is described. The third section specifies publication variations of the research artefacts obtained and describes work packages that are self-contained parts of the process. Applications of the process are presented in the fourth and fifth section. Finally, the results are discussed and an outlook is provided.

1.1 The science of information systems research

Discussions about IS and its positioning as a discipline [7], its artefacts [32] and methods [36; 44] have been going on for a long time, so far without breakthrough achievements towards a common understanding. A lot of confusion about the IS body of knowledge (as defined in [47]), specifically the research domain [12; 33] and the research methods [44], can be noticed.

The confusion is caused by IS being rooted in multiple disciplines such as computer science, management, system theory, sociology, finance, economics and anthropology [1; 4; 7] . While Benbasat

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and Zmud [12] argue for a uniform research domain, Galliers [24] argues for a more trans-disciplinary view. The discussion often references Kuhn [37] who stated that science can only progress when it has a paradigm to be able to choose the research phenomena, ground a theory and state a framework. This view has already been challenged [27].

Among IS theorists, the statement of diversity of IS research is usually accepted [15; 18; 53; 62]. There are scientists who defend the heterogeneity [3], but there are also claims for uniform fundamental concepts [10]. An evolution can be seen in the claim of IS itself to be a reference discipline [7].

Orlikowski and Baroudi [51] identified three perspectives used in IS research: positivist, interpretative and critical. Mingers [44] argues that a mixture of the perspectives and their associated research methods can be used to provide necessary insight into the area observed, since every perspective provides an insight to a problem from a different point of view [27; 36; 69]. Mingers [44] also legitimates the use of research methods separately from the perspective they emerged from.

This current state of the discussions is a motivation for the authors to develop a pragmatic research process for IS design science. It would ensure relevance and scientific rigour by the interaction of practitioners and researchers, thereby improving the quality of created artefacts [32]. The process also covers considerations and results from research using other IS theory types like explanation and prediction [28].

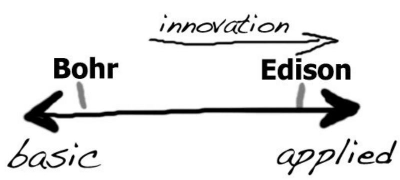

Figure 1. Linear model of research [58; 59]

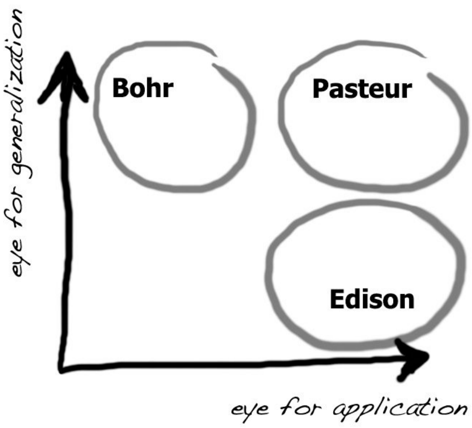

Figure 2. Four-quadrant model of research [58; 59]

1.2 Design research

IS is not the only field where design is relevant. For over 40 years the field of design research has been investigating how design is done and how design and research can be combined [16]. The focus of the discipline is on design in general with a tendency toward industrial design. While it might seem far-fetched to compare IS design science to design research at first glance, there are interesting parallels. Both disciplines examine the design of the artificial [56]. That means that the object of research and the research process are somewhat similar. In design research, the definition of design science is not clear. Cross writes: "So we might conclude that design science refers to an explicitly organised, rational and wholly systematic approach to design; not just the utilisation of scientific knowledge of artefacts, but design being in some sense a scientific activity itself" [17]. Even though this view is controversial, it sounds similar to the IS design science approach.

One interesting point in design research is its view on science. In the second half of the 20th century, the general understanding of research was that it can be differentiated between basic science on one side and applied science on the other (figure 1). According to this model, research is either basic and has no application, or is applied, in which case no new insights are produced. In 1997, D. Stokes published that this view is too simplistic [59]. There is research that is applied and at the same time produces insights. According to Stokes, it should be differentiated between generalisability and applicability (figure 2). Basic research is highly generalised, while applied research is of relevance for practice, but both are independent dimensions. It is possible for research to be applied and generate general insight at the same time. Design research sees itself working in this quadrant [58; 59]. The same seems to hold true for design science in IS research. Throughout the paper, we'll encounter lessons from design research.

1.3 Research frameworks and related work

A research process "is the application of scientific method to the complex task of discovering answers (solutions) to questions (problems)" [47]. Frameworks are more generally used to establish a research base and contribute to the augmentation of the knowledge base through scientific investigation [68]; they may include a research process. Multiple IS research frameworks have been proposed [2; 29; 34; 43; 67]. The framework proposed by Nunamaker et al. [47] includes a research process for systems development. It is similar to the design cycle as proposed by Vaishnavi and Kuechler [63], which the presented process builds upon. Frameworks for action research were proposed by Lau [38] and Baskerville [6], design science frameworks occur in Takeda, Veerkamp, Tomiyama and Yoshikawa [60], Vaishnavi et al. [63] and March and Smith [42]. The difference between design science and action research is discussed in [14; 52].

Lau's [38] framework for action research is mainly based on literature study and describes methodological details of a research process. Baskerville [6] defines a circular research process situated in a client-system environment. The focus of this process is on a close cooperation between researchers and practitioners. The client-system environment defines restrictions and provides legitimacy for research and practical actions. No specific means for achieving rigour of the research results are mentioned while relevance is provided by an active exchange with practitioners.

In the Hevner et al. [32] Information System Research Framework, roles and techniques that can be used in IS research are specified in the form of seven guidelines. These are meant to achieve better understanding, executing and evaluating of IS research and its results. Rigour is ensured by applying suitable methodologies and foundations. Relevance is ensured by feedback from application in the appropriate environment. Possible artefacts of the research process are described. Artefacts can be "constructs (vocabulary and symbols), models (abstractions and representations), methods (algorithms and practices), and instantiations (implemented and prototype systems)" [32].

March et al. [42] propose a two-dimensional framework for information technology research. Its first dimension is based on broad types of design and natural science activities; the second dimension is based on broad types of outputs produced by design research. Rigour of research results can be provided by methods used in natural sciences. No interaction with practitioners is required.

		Steps of the iterative **micro process** of learning / designing			
		research	**analysis**	**synthesis**	**realization**
Domains of design inquiry, steps / components of the iterative **macro process** of designing	**ANALYSIS** "the true" how it is today	How to get data on the situation as it IS? → data on what IS	How to make sense of this data? → knowledge on what IS	How to understand the situation as a whole? → worldviews	How to present the situation as IS? → consent on the situation
	PROJECTION "the ideal" how it could be	How to get data on future changes? → future-related data	How to interpret these data? → information about futures	How to get consistent images of possible futures? → scenarios	How to present the future scenarios? → consent on problems / goals
	SYNTHESIS "the real" how it is tomorrow	How to get data on the situation as it SHALL BE → problem data	How to evaluate these data? → problem, list of requirements	How to design solutions of the problem? → design solutions	How to present the solutions? → decisions about "go / no go"
	COMMUNICATION "the driver"	How to establish the process and move it forward? How to enable positive team dynamics? How to find balance between action/reflection? How to build hot teams? How to enable equal participation? → focused and efficient teamwork			

Figure 3. Generic Design Process Model [35]

Peffers et al. [52] compare different design research processes and propose their own model based on these. Works of Takeda et al. [60] and Vaishnavi et al. [63] were especially valuable for building the research process presented here. They illustrate a research process in design science, its knowledge flows and its artefacts. Rigour of results is provided by the evaluation process step; though there is no explicit proof of relevance in this process cycle. While Takeda et al. [60] had an important influence on the presented design process, it does not include work packages and publishing proposals for intermediate process results.

It is interesting to see that design research proposes a process model that has similarities with process models from IS design science. A process from design research can be seen in figure 3 (in the figure, "IS" is an emphasised "is"). The generic process includes a macro process, consisting of the steps "analysis", "projection", "synthesis" and finally "communication". The first three steps each contain a micro process, consisting of "research", "analysis", "synthesis" and "realization". In design research, for each of the 12 top boxes, methods and tools are developed to support the steps. For each design project, adequate methods are selected for each step. This results in a large number of possible paths through the process. Research is to be found in inquiries in single domains of knowing or even single process steps. There, methods of scientific research become relevant [35]. For IS design science, it seems that methodology hasn't advanced as far as to propose different methods for each process step.

Building upon the frameworks and research processes, as well as on practical experience, we developed the research process proposed in this paper. Its aim is to provide a transparent guidance and roadmap for IS researchers in design science. Artefacts, methods and roles are described to guarantee rigour and relevance of the research achievements. Therefore, not only the use of but also a contribution to the IS knowledge base is achieved.

We do not want to get involved into the discussion about the research domain of IS. Taking a design science approach, we state the research goal for the process to be the improvement of IS usage for companies or government by artefact design. We differentiate from IT consulting in the respect that the existing body of knowledge has to be used and that solutions must be generalised and evaluated to ensure the fulfilment of the promised improvement.

2. APPROACH

Gregor identified five theory types in IS research [28]. The research process proposed by us is focused on "design and action", also called "design science". The main requirements on design science are rigour and relevance [11; 32; 54]. The process strives to fulfil the requirements. Like in social sciences, data has to be derived from complex systems with a significant amount of hidden and tacit knowledge. Therefore, we believe that empirical evaluations are best suited for generating accurate insight. Assumptions should be verified empirically and presented to the observed practitioner to keep in touch with current developments. This is empirical grounding according to the classification from [26].

The process for research in design science we propose is shown in figure 4. It combines different research methods used for qualitative and quantitative IS research. The process is structured in three main phases "problem identification", "solution design" and "evaluation" that can interact with each other within the research process. Each phase is divided into steps. The arrows indicate a transition from one step to another, dotted lines indicate less used transitions. The steps are not always executed

Table 1. Comparison of design science research processes

	Peffers et al. 2008 [52]	Takeda et al. 1990 [60]	Nunamaker et al. 1991 [47]	March and Smith 1995 [42]	Vaishnavi and Keuchler 2004/5 [63]	Process presented here
Problem identification	• Problem identification and motivation • Define the objectives for a solution	• Enumeration of problems	• Construct a Conceptual Framework		• Awareness of Problem	• Identify problem • Literature research • Expert interviews • Pre-evaluate relevance
Solution design	• Design and development	• Suggestion • Development	• Develop a System Architecture • Analyze & Design the System • Build the System	• Build	• Suggestion • Development	• Design artefact • Literature research
Evaluation	• Demonstration • Evaluation	• Evaluation to confirm the solution • Decision on a solution to be adopted	• Observe & Evaluate the System	• Evaluate	• Evaluation • Conclusion	• Refine hypothesis • Expert survey • Laboratory experiment • Case study / action research • Summarise results

sequentially; they often refer back to each other. The execution of this process produces design science research results.

A comparison of other design processes with the proposed process is presented in table 1. The table is roughly guided by the comparison presented in [52]. However, Peffers et al. also include publications that do not proposed a process themselves [14; 21] and research frameworks that do not explicitly state a process [32; 67] in their comparison. We do not include these publications; instead, we added March et al. [42] and Vaishnavi et al. [63] who do present design science processes. From the table, a link from the process proposed here to other processes can be derived.

2.1 Problem identification

In the first phase of the research process, a problem is identified. It has to be ensured that the problem has practical relevance [11; 54] or might be of relevance once solved. Criteria for problem relevance are reviewed in [11]. The research question may arise from a current business problem or opportunities offered by new technology. A desire to increase business process efficiency may also act as a trigger for new approaches and research areas. The equivalent phase in the generic design process model (figure 3) is "analysis".

The phase is divided into the following steps: "identify problem", "literature research", "expert interviews" and "pre-evaluate relevance". It specifies a research question and verifies its practical relevance. As a result of this phase, an IS research question is defined. Its relevance is validated by experts. The state of the art in research in the observed area is analysed. Thus, this phase offers a solid and important foundation for the further research process.

2.1.1 Identify problem

A problem has to be identified. It will be refined in the course of the current phase, to assure its relevance and understanding. A solution to the problem is to be found in the course of the research. The problem should be in the domain of information systems research [12]. The problem should be of interest to more than one entity (e.g. company, government department). An overly specific problem should be generalised to make it relevant to more entities [40]. Literature research and expert interviews are the most prevalent tools that can be used, even though equivalent tools may be applied.

2.1.2 Literature research—part I

To identify a problem, literature research can be used. Unsolved problems could be mentioned in scientific publications as well as in practitioner reports. Practitioner reports have the advantage of assuring practical relevance, even though the degree to which the results can be generalised could be limited. Literature research is also needed to review the state-of-the-art concerning the identified problem or to analyse possible obstacles and difficulties for its solution. Scientific publications coming from the explanation and prediction theory approach can provide additional insights into a possible artefact design.

2.1.3 Expert interviews

Interviews with practitioners and experts in the field can be conducted to identify relevant and addressed problems. They are conducted with more than one recognized expert in the research question's domain. Interviews are lead in workshops or one to one.

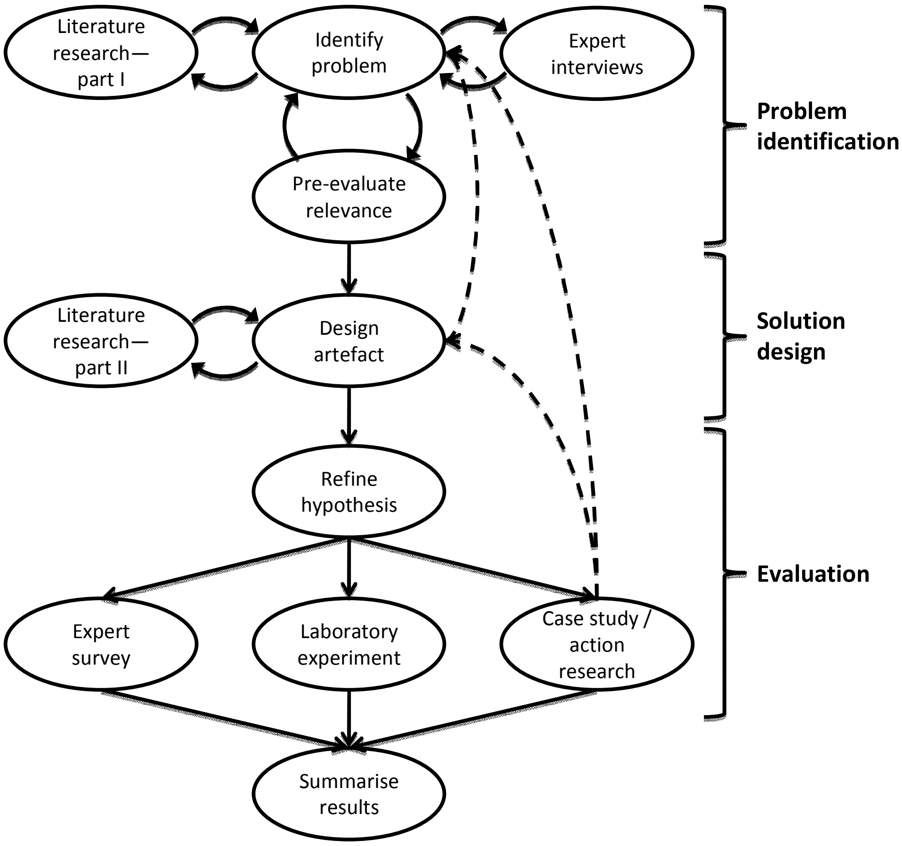

Figure 4. Proposed research process

2.1.4 Pre-evaluation relevance

Once a suitable problem is identified, a pre-evaluation on the relevance has to be conducted. This includes creating a general research hypothesis in the form of a utility theory [65], postulating a link between the solution space and the problem space. The hypothesis should have the form: if a solution to the problem is applied, some observed aspects will be changed in a way which ultimately helps the entities. E.g. (supposing word processors were not yet invented): "If in companies word processors are used instead of type writers, secretary productivity will increase, which ultimately will increase company productivity". The hypothesis is continuously adjusted during the research process. It has to be evaluated and represents the result of the entire research.

The pre-evaluation on the relevance of the hypothesis is conducted by asking several practitioners from different backgrounds (e.g. different companies) if they agree with the hypothesis and what pre-assumptions can be realistically made to support it.

2.2 Solution design

In the second phase, the solution is designed. It is divided into the steps "artefact design" and supporting "literature research". After identifying a problem and pre-evaluating its relevance, a solution has to be developed in the form of an artefact. Within this phase, research rigour has to be ensured by using all related work available.

2.2.1 Design artefact

Artefact design is a creative engineering process. Not much guidance is provided in IS literature. General approaches and definitions have been published by Simon [56] and Eder, Hubka and Hosnedl [20]. Existing solutions and state-of-the-art have to be taken into account. During artefact design, the problem can be restated. In that case, the activities starting from "identify problem" are iterated. Design decisions should be documented, possibly using suggestions from [25].

For design research, Chow developed the MAPS (Matching Analysis, Projection & Synthesis) tool that provides methods for each of the 12 top boxes of figure 3 [13]. The tool contains a total of 258 methods. Some of these are specific for industrial design, but some might be applicable to IS design science. Especially methods from the synthesis phase might be used for artefact design. Further investigation is needed to provide a list of applicable methods.

2.2.2 Literature research—part II

Like during the first phase, the existing knowledge base including state-of-the-art has to be taken into account to ensure research rigour [32]. In contrast to literature research—part I for problem identification, the focus of this step should be put on relevant scientific publications. For the German-speaking community, a ranking of international scientific journals is available from WKWI [72]. It is important to keep track of ongoing current activities to be able to react on changes on IT markets as well as in research findings.

2.3 Evaluation

Once the solution reaches a sufficient state, its evaluation can be started. It is possible to iterate back to "design artefact" or even "identify problem" if necessary [63]. Evaluation is to be achieved by the means of a case study or action research (shows applicability in practice), by arranging a broad expert survey (shows general interest) and by laboratory experiments or simulations (used to compare different approaches).

2.3.1 Refine hypothesis

Usually, the general research hypothesis is difficult to evaluate as a whole. Therefore, the hypothesis is refined by "smaller" hypotheses with a more constricted but more precise scope. The refined hypotheses should be mutually exclusive and collectively exhaustive (MECE) in regard to the general hypothesis. E.g. “Automatic spell correction (as part of a word processor) enhances orthographic quality”. If all refined hypotheses are supported, the general hypothesis should be supported as well.

2.3.2 Case study / action research

Case studies [9; 19; 39] and/or action research [5; 8] should be performed on the general hypothesis or at least on an important refined hypothesis. Because of the nature of action research, iterations back to “design artefact” or “identify problem” are relevant. By this step, practical relevance and applicability is tested.

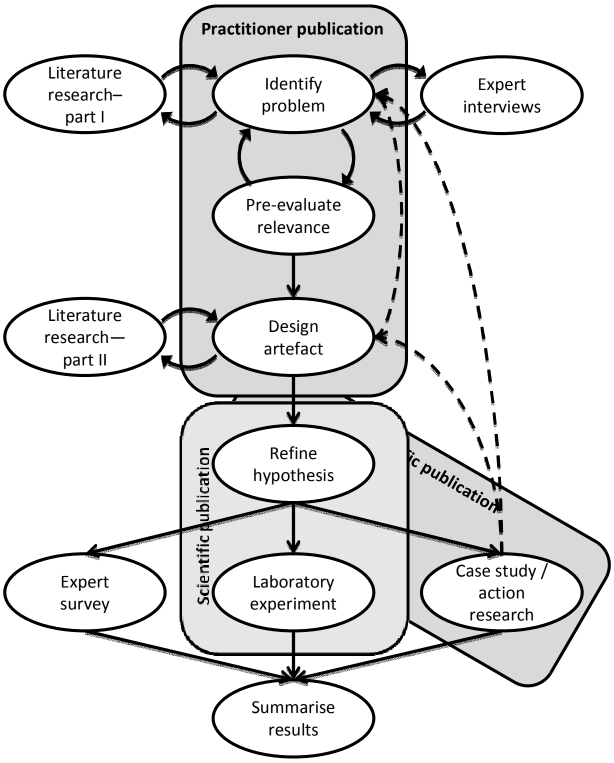

Figure 5. Publication opportunities

2.3.3 Expert survey

As case studies and action research work on a very limited sample size, an additional expert survey is performed on the general hypothesis to show that there is general interest in the solution. This can be done by presenting the problem and its solution to practitioners during lectures or workshops. Afterwards a survey is performed to evaluate perceived viability. The survey might contain the question: “Do you think the presented artefact provides a viable solution to the problem?” Additionally, the survey might include a question on the relevance of the problem, even though relevance has already been tested during problem identification.

2.3.4 Laboratory experiment

Refined hypotheses are evaluated using laboratory experiments or if possible field experiments. Here sample sizes are considerable as samples may be taken from students or if possible from practitioners. Thereby, the newly designed artefact can be compared to existing solutions. Analysis is done using well-known quantitative research methods like descriptive statistics. This step ensures rigour. Statistical significance with respect to relevance can best be achieved in a company environment if a highly repetitive application in a controlled environment is possible. Institutionalised partnerships between industry and research institutions provide a valuable environment for this, even though neutrality has to be assured.

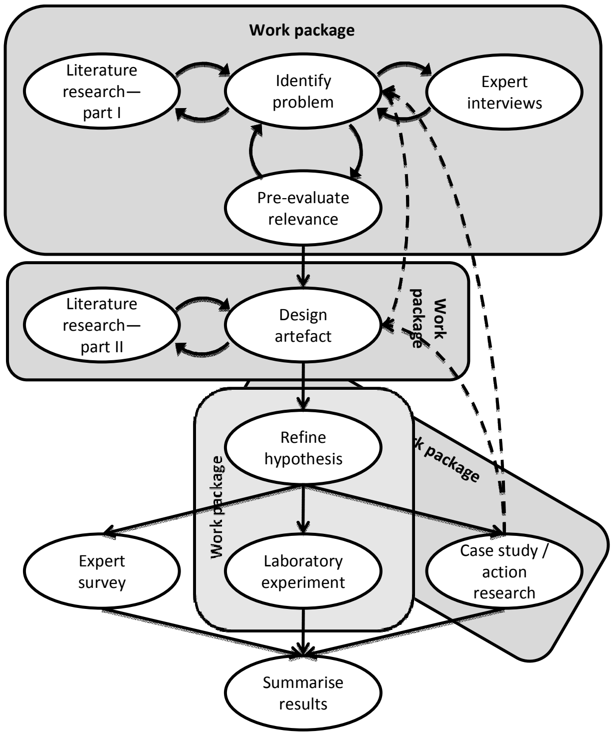

Figure 6. Self-contained work packages

2.4 Summarise results

At the end of the research process, results are summarised and published. This could be in form of a PhD thesis, journal or conference article. There is also a possibility to publish individual results and intermediate data. Thus an early feedback on the research results can be gained.

3. PUBLICATIONS & WORK PACKAGES

3.1 Publication opportunities

For publications, we recommend three subparts of the research process (see figure 5). The problem together with the artefact that solves the problem should be published for practitioners. This provides knowledge transfer to the potential users of the artefact. Additionally, case studies and/or action research could become possible due to a practitioner reading about the research.

For scientific publications, we recommend publishing the results of laboratory experiments and of case studies/action research. If possible, several case studies or action research iterations should be presented in one paper. Thereby it is demonstrated that problem and solution apply to more than one entity. Publications of the artefact designed are referenced to save (often limited) space for the description of the laboratory experiment or case studies/action research. Reviews of scientific papers can provide valuable input for further research iterations.

3.2 Self-contained work packages

The research process also provides individual work packages. There are four kinds of work packages (see figure 6):

- Problem identification
- Artefact design
- Laboratory experiment
- Case study/action research

Work can be planned along these packages and be distributed among participants. We suggest to hand artefact design and laboratory experiment to different persons in order to ensure neutrality. Due to the high work load of case studies, it might be a good idea to distribute several case studies performed in parallel to different scientists.

4. CASE STUDY: SOA METHOD AND TOOL

The following case study describes the application of the research process. In the period of summer 2006 until summer 2008, we have constructed a method and a supporting tool to design application systems according to service-oriented architecture (SOA). During the course of the research, we have applied the research process.

First, method and tool are introduced. Then, the course of the research is described along the process to demonstrate its usefulness.

4.1 SOA method and tool

The SOA method (SOAM) has been developed based on the existing methods. It has a high integrity and consistency regarding the constituent elements and supports the architecture realms “workflow management”, “application architecture” and “enterprise application integration”. It is vendor-independent and explicitly states the architecture goals, which is not the case with any other method. The six phases of SOAM contain all relevant activities, various activities containing several steps. Every activity is specified with executing roles, input and output artefacts.

The sequence of phases can be seen in figure 7. The method uses the top-down approach and the bottom-up approach in parallel. Company requirements are analysed following the top-down approach. Required service operations are discovered based on this. Following the bottom-up approach, legacy systems are identified and analysed regarding data and/or functionality that can be wrapped. Top-down requirements and bottom-up findings are then consolidated. Finally, services are designed and service properties ensured. Processes are prepared for execution.

The tool that supports the method enables the modelling of organisational charts, data objects and business processes. Available Web services can be loaded into the tool. During the consolidation, activities from business process models are matched to Web service operations. A matching result can be seen in figure 8. Then, an executable business process description is generated. An overview over the system can be found in [22].

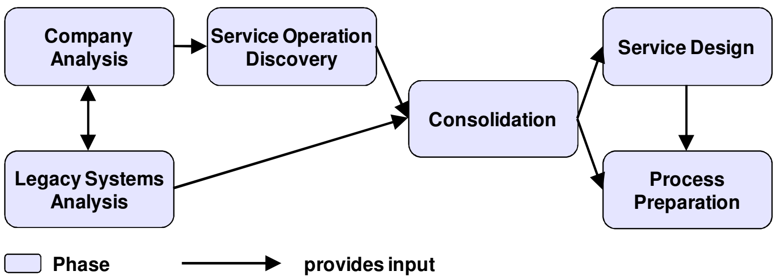

Figure 7. Phases of SOAM

4.2 Problem identification

Problem identification was started due to requirements of an industrial research project financed by a major German provider of telecommunication services. The research project was supposed to develop a toolset for integrated and automated SOA software development. In this context it became evident that a method to design SOA software systems was needed that would give direction to the tool development and that could later be used by practitioners. Therefore, the first idea for the design research came from industry requirements.

Next, extensive literature research was conducted to find out which SOA methods already existed. Additionally, the market of SOA tools was screened. It was discovered that a considerable number of methods were available, but that the quality of the published method descriptions varied heavily. Additionally, most methods were published by practitioners. There was only one method published by research, but even for that method no scientific evaluation was available. The tool landscape in 2006 was still poorly developed; all available tools lacked required functionality.

The general research hypothesis formed during that phase was: “If SOAM and the tool are used to design SOA systems, results are superior to results for other SOA methods/tools.” A pre-evaluation was renounced, since not many companies that have used any SOA method existed at that point in time. Instead, a hypothesis in the form of “If a method/tool is used for designing SOA systems, architecture quality increases” was used. It was argued that the number of SOA methods published by practitioners and the tools available are an indication that they are seen as helpful in practice.

4.3 Solution design

Based on the results of the problem identification phase, a method and a tool were chosen as the design artefacts. Before starting to design the SOAM, all existing methods were studied in depth and compared. The aim was to identify weaknesses and strengths in existing methods. The results of the comparison are partially published in [50]. Additionally, best practices in method documentation were collected. This led to the decision of using the Eclipse Process Framework Composer (which implements OMG’s Software Process Engineering Metamodel) for method

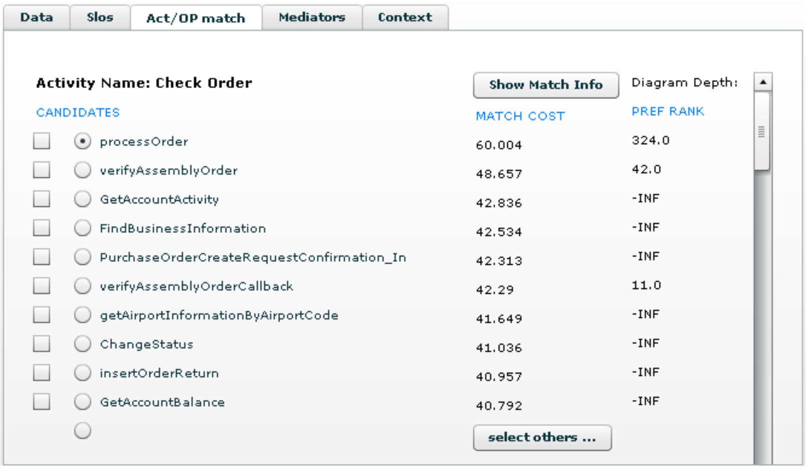

Figure 8. Business process activity to web service operation matching

documentation. The SOAM is published in [48] and [49]. An overview of the supporting tool is given in [22].

4.4 Evaluation

Evaluation was split in three parts: A laboratory experiment, action research in four companies and presentation of the SOAM in workshops with company representatives and on practitioner conferences.

4.4.1 Refine hypothesis

For the evaluation, the general hypothesis was split into smaller hypotheses that were simpler to evaluate. The following hypotheses were developed:

- The SOAM is better than other methods for SOA.
- The SOAM is usable in practice.
- The SOAM is useful for practitioners.

We presume that the general hypothesis is supported if all of the refined hypotheses are supported.

4.4.2 Laboratory experiment

To support the first hypothesis, a laboratory experiment was conducted with students. Sufficiently well specified methods were applied on predefined company scenarios. The advantage of this setup is that different methods can be used under the same conditions. The disadvantages are that graduated computer sciences and information system students and not practitioners are used and that it can not be guaranteed that all relevant factors are captured in the predefined scenarios. On the other hand, in real companies it is rarely possible to apply more than one method. Few companies are prepared to provide the resources necessary and conditions in companies can change rapidly, limiting comparability of results.

For each method used, the students had to fill out a questionnaire. To construct the questionnaire, it first had to be determined what "better" means for methods. Criteria were taken from a general method evaluation framework [45] and from SOA quality criteria [23; 31]. The answers were evaluated statistically using standard quantitative instruments. Results will be published at ECIS 2009.

4.4.3 Action research

To support the second hypothesis, action research has been carried out in four companies. In each case, the aim was to ensure applicability in practice as well as to improve the method's quality by including solutions to problems encountered in the documentation. This is in line with the action research cycle [6].

In each case, a project member of the company's team was instructed in the usage of the method and tool. This team member was taking the double role of practitioner and researcher, documenting the usage of the method as well as the results. The results were evaluated according to the predetermined quality criteria. As these criteria were used during method construction, quality was usually high. Usage experience was evaluated qualitatively and fed back into the method. Action research at Vattenfall Europe is published in [48].

4.4.4 Expert survey

An expert survey could have been used to evaluate the third hypothesis. For SOAM, the expert survey and further quantitative evaluation will be part of future work. The method was presented on several SOA practitioner conferences and during individual workshops with seven companies. No survey on the perceived usefulness has yet been conducted. Therefore, there are no quantitative results available to support the hypothesis.

4.5 Summarise results

The complete results will be published in the form of a PhD thesis. As too many results have been generated for a single journal or conference publication, one publication can only focus on one or a few aspects. A practitioner publication is available in [49]. Action research has been published in [48]. The results of a laboratory experiment will be published at ECIS 2009.

5. CASE STUDY: BUSINESS RULES DERIVING AND IDENTIFICATION METHOD

Business-IT alignment is an eagerly discussed topic in the information systems community [41; 57; 71]. In the practitioners community this problem has been already observed and is gaining steady attention. Governance approaches and management frameworks were developed [61; 70]. The aim of one of our ongoing research projects is therefore to show that there are major differences between process perception between business and IT employees. A hypothesis is made that identification and modelling of the business rules helps to provide a homogenous understanding of the process and therefore a better realisation of its requirements. For extraction and identification of the business rules, a method was developed and evaluated within a laboratory experiment. This project is conducted according to the proposed research process for design science and is now finishing the phase of evaluation by the laboratory experiment.

5.1 Problem Identification

Aligning business and IT was stated as a problem within a research project concerning the business rules approach in an enterprise. Many supporters of the business rules approach state that business rules help system and software developers to enhance collaboration between business and IT sectors within a project both sides are involved in [30; 46; 55; 66]. Business-IT alignment can also play an important role in the areas of governance and change management. In search of empirical studies concerning this topic, no study but single statements of practitioners and researchers that document this problem were found by the authors. This lack and an extensive literature research led to the urge to evaluate the hypothesis that says that the understanding and perception of system requirements differ depending on the working area of an employee. A further hypothesis is that identification and documentation (here the documentation is realised by modelling the business rules) of business rules can be used to provide homogeneity of understanding. The hypothesis can therefore be formulated as follows: "If representatives from business and IT domains have a homogenous understanding of system requirements, quality of multidisciplinary projects increases." The second hypothesis is formulated as: "If the concept of business rules is used during the requirements formulation phase, homogenous understanding of system requirements for business and IT representatives can be reached."

5.2 Solution design

Based on the results of the problem identification phase, method design was chosen as the design artefact. Before starting to design a method for business rules extraction and identification (BRM), existing methods and approaches were studied in depth and compared. The aim was to identify weaknesses and strengths in existing methods. Thereafter a method for business rules derivation and bridging the business-IT gap within multidisciplinary projects was developed taking in account the revised approaches and methods.

5.3 Evaluation

Evaluation is split in two parts: an (ongoing) laboratory experiment and action research in companies. The exact number of companies the action research will be performed in is still to be defined.

5.3.1 Refine Hypothesis

For the evaluation, the general hypotheses were split into smaller hypotheses that are simpler to evaluate. The following hypotheses were developed:

- Business rules extraction enhances a homogenous process understanding regardless of the project member's field of expertise (business or IT).
- BRM provides better support for business rules derivation than other reviewed methods.
- BRM can be used in practice.
- Use of BRM provides added value for the projects in practice.

We presume that general hypotheses are supported if all of the refined hypotheses are supported respectively.

5.3.2 Laboratory experiment

To support the first refined hypothesis, a laboratory experiment was conducted with students. The class was divided into two groups: a business and an IT group. Their members were graduate business and computer science students respectively. Their task was to model a given business process using a process description and an open source Eclipse-based Business Process Modeling Notation (BPMN) tool. The goal of this part of the experiment was to identify different scopes of the process perception depending on the field of expertise of the student. Then the concept of business rules was introduced and the groups were again divided into two subgroups. One subgroup was able to use the BRM while the other group was to solve the given task without methodological support. A business rules modelling tool was used by all the students to express the identified rules.

For further experiments criteria for a successful collaboration in projects involving business and IT are defined. These criteria will help to evaluate the impact of the business rules oriented approach within the project and its impact on more homogenous understandings among business and IT project members. A case study will be lead in companies to validate these criteria and evaluate the impact of business rules oriented approach on the collaboration within multidisciplinary project according to these criteria.

5.3.3 Further proceedings

The ongoing project is guided according to the suggested design research process. Therefore, after evaluation of the laboratory experiment results, action research is going to be completed in several companies to finish the evaluation stage. Results will be summarised, discussed and published.

6. DISCUSSION AND OUTLOOK

While the presented research process aims to provide a best suitable research approach for IS design science, it also has some critical points that have to be kept in mind. The chosen research topic could be new to practitioners. In that case conducting a pre-evaluation becomes very difficult or even impossible. On the other hand, a goal of research is to identify new areas in their domains and analyse their utility for practitioners, combining the research goals of utility and truth.

Finding a stringent focus in literature research may be challenging. The IS research community has multiple information channels ranging from vendors magazines, practitioner journals through scientific and practitioner conferences to scientific journals and books. It means that literature research must be well planned and adjusted properly to the research topic beforehand. The MECE approach for evaluation of the research hypothesis may be difficult to realise, as it is not given that the general hypothesis can be divided into smaller hypotheses that can be supported individually. In some cases, the principle of mutual exclusion of the partial hypotheses has to be neglected.

In this paper, an approach to design research in the area of information systems was presented. It is divided into phases that consist of steps that one can refer to. A way to derive a research problem and main attention points were introduced and suggestions about the research process were given. Recommendations about publication and evaluation activities were described and work packages defined. Case studies to illustrate the usage of the process were described and discussed.

While the individual research methods referenced are not new to IS researchers, the focus of the proposed process lies in the combination of qualitative and quantitative research methods and their timing. With the process we aim to position information systems research in the world of both science and business by assigning exact roles to each party in the research process. Scientific methods are essential to evaluate the resulting solution on an abstract level. This is necessary to assure a general applicability of findings in the field and to guarantee high quality of the artefacts designed. We are planning to apply this research process to 30-40 design science projects for method construction within the next 2-3 years. By this, we hope to evaluate it empirically and refine it.

For future research, we think that it might be helpful to provide a selection of methods for each process steps, similar to the methods that are available in the MAPS tool for design research. For each design science research project, the methods are combined along the research process according to the requirements. The methods used in design research might be a starting point for creating a set of methods for design science in information systems research.

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