GENERALIZATION IN QUALITATIVE IS RESEARCH

APPROACHES AND THEIR APPLICATION TO A CASE STUDY ON SOA DEVELOPMENT

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ABSTRACT

In qualitative information systems research, little methodological support has been provided so far for the generalization from empirical data. Generalizability, however, is a major concern in this field. It has been subject to a number of publications in recent years, but commonly accepted conceptualizations of generalizability and methodological guidance for the process of generalization are still missing. In order to address this problem, this paper investigates if and how generalization approaches from the literature and abstraction mechanisms from the field of conceptual modeling can be utilized to generalize from case study data. An explorative single case study on the development of service-oriented architectures provides the raw data for an exemplary application. The paper shows that abstraction mechanisms from the field of conceptual modeling can be used – in conjunction with generalization approaches from the literature – for the generalization of case study data and provides guidance on how to use these mechanisms. This increases transparency, traceability, and reliability of the generalization and might help to improve other qualitative research endeavors as well.

Keywords: Generalization, Case Study, Qualitative Research, Abstraction Mechanisms, Service-Oriented Architectures, Service Identification

INTRODUCTION

Generalizability is widely discussed in different kinds of research. Therefore, it also constitutes a major challenge in qualitative information systems research, and quite a few frameworks and definitions from this and other fields of research exist (Smaling, 2003; Walsham, 1995; Lee and Baskerville, 2003). So far, a widely accepted conceptualization of what generalizability means is missing. As Lee and Baskerville (2003) point out, "qualitative IS researchers (…) have not yet broached conceptions of generalizability appropriate to their own research" (p. 221).

However, generalizability of research results is extremely important. Usually, scientific readers do not want to learn about specific subjects that researchers observed in one case (Babbie, 2010). The interest is on what one can learn from a case and how to generalize the observations of a specific

subject in order to explain the findings from a theoretical point of view, to predict future occurrences, or to give guidance in terms of recommendations for similar situations that might occur in the future.

Due to accepted sampling procedures and data analysis methods, quantitative research is often considered more conducive to producing generalizable results (Stoddart, 2004). Babbie (2010) outlines three major problems qualitative researchers are faced with, i.e., the subjectivity of researchers, the small number of researched cases, and doubts about the representativity, and argues that they lead to an endless potential for biased sampling and abstractions.

However, prominent authors (e.g., Walsham, 1995; Lee and Baskerville, 2003; Yin, 2003) contend that generalization is desirable and possible, but that qualitative research must employ special kinds of generalization. In this respect, Williams points out that papers reporting on results of research using qualitative and interpretive methods frequently "will make generalizing statements about findings whilst not commenting upon the basis upon which such generalisations might be justified" (Williams, 2000).

Hence, to achieve status for their work, qualitative researchers should be more explicit about the way of generalization and adopt more formal methods.

In order to better argue for the generalization of case study data and to make traceable the basis upon which generalizations might be justified, this paper investigates various conceptualizations and approaches of generalization in qualitative research and their application in a research project. Furthermore, we propose and apply abstraction mechanisms from the research area of conceptual modeling to provide methodological support for generalization.

This paper will utilize a case study on the development of a service-oriented architecture (SOA) to demonstrate how generalization applying different approaches can be performed to develop several hypotheses and finally three model fragments.

The paper is organized as follows: Section 2 elaborates on case study research as part of qualitative research. Generalization is discussed regarding both qualitative research in general and our case study research in particular. The case analysis is presented in section 3. Section 4 discusses findings and limitations. Finally, section 5 presents the conclusions of this paper.

CASE STUDY RESEARCH AND GENERALIZATION

The Appropriateness of Case Study Research

We suppose that qualitative case study research can make a useful contribution to our research endeavor. Case studies are particularly relevant for research in its "early, formative stages" (Benbasat et al., 1987; Myers, 2009) which applies to the field of SOA (Luthria and Rabhi, 2009; Stebbins, 2001). Furthermore, Benbasat et al. (1987) state that case study research is especially appropriate for the study of information systems development, implementation, and use within organizations.

Our research goal is to understand and to explore how SOA development and service identification in particular are performed in real-life projects and to examine this in a real-life setting.

As a case study can be descriptive and explorative in nature, it is supposed to give insights into how SOA development is performed. Descriptions and explanations of why a phenomenon occurs are provided by giving insight into the "generative mechanisms at work" (Walsham, 1995) (p. 79) observed within the case data. With respect to our research goal, we derive hypotheses and models (model fragments) from the observations that have been made. Thus, this case study takes the first steps in developing theory.

Darke et al. (1998) distinguish single-case and multiple-case design (p. 277). A single case study might be appropriate for our purpose, but there are limitations to be considered. According to Darke et al. (1998), "where explanatory research is undertaken, a single case may provide the basis for developing explanations of why a phenomenon occurs, and these may then be further investigated by applying them to additional cases in other settings" (p. 281). Hence, in single case study research theoretical or analytical generalization is suitable, where case study results are used to develop theory (p. 278).

In our study the intention was not to generalize to another population but to a theoretical understanding and explanation. This resulted in models representing generic socio-technical processes. Since our case study is explorative in nature, it is well suited to show starting points for further research in this field.

It is intended to produce generalizable results. Hence, we will first outline different notions of generalization in qualitative research from literature (2.2). Thereafter, the approach to and conception of generalization applied in this case study is discussed (2.3) and the research process is described (2.4).

Generalization in Qualitative Research

In the discussion of generalization, we will first refer to the meaning of generalization in a colloquial sense. Thereafter, we are going to develop a framework describing the outcomes of generalization and different conceptualizations and ways to generalize that we identified in the literature. In subsequent sections, the discussion will refer to this framework.

According to Merriam-Webster's dictionary, "to generalize" means "to derive or induce (a general conception or principle) from particulars." Lee and Baskerville (2003) quote the Oxford English Dictionary which defines "to generalize" as "to form general notions by abstraction from particular instances." Hence, abstraction, derivation, and induction are closely linked to the phenomenon of generalization in a colloquial sense. They are typical activities or mechanisms within the generalization process, aiming at the development of general propositions which are "of a different kind from those developed on the first level of common-sense thinking which they have to supersede" (Schutz, 1954) (p. 270).

However, in science, there are different, partially conflicting notions and conceptualizations regarding the questions what generalization means and how to generalize (Byrne and Sahay, 2007). The most significant differences occur when qualitative and quantitative research is compared. Whereas the latter predominantly concentrates on statistical generalization, many authors deem this type of generalization inadequate for interpretative, qualitative research (Yin, 2003; Lee and Baskerville, 2003; Smaling, 2003). Even though Lee and Baskerville criticized researchers in the field of qualitative research (see introduction), sporadic attempts and a handful of approaches to conceptualize and apply generalization in research projects can be found in literature.

In the following, this section will provide a discussion of existing literature that deals with the outcomes and types of generalization (table 1). Throughout the paper, the authors will refer to table 1 where appropriate in order to show how different aspects of generalization are addressed and why some approaches have been chosen for our analysis.

Geertz (1973) promotes "thick descriptions" as the outcome of the research process. They provide details for phenomena in their specific context, are 'thick' because they embrace the meaning behind the mere observation, and thus might enable an assessment of similarities and differences between two or more cases. Yet, first and foremost, they do "not ... generalize across cases but … within them" (p. 26). This notion is akin to the "working hypotheses" introduced by Lincoln and Guba

(1985). They argue that transferability depends on the suitability of working hypotheses that represent tentative propositions of situations and their similarities.

Source	Major concept	
Outcomes of generalization		
Geertz (1973)	"Thick descriptions"	
Lincoln & Guba (1985)	"Working hypotheses"	
Popay et al. (1998)	(Logical generalization to a) "Theoretical understanding"	
Walsham (1995)	Concepts	Specific implications
	Theory	Rich insight
Types of generalization		
Lee & Baskerville (2003)	Type EE: Generalizing from data to description	Type ET: Generalizing from description to theory
	Type TE: Generalizing from theory to description	Type TT: Generalizing from concepts to theory
Klein & Myers (1999)	Contextualization	Hermeneutics cycles
Stake (1995)	"Naturalistic generalization"	
Smaling (2003)	"Analogical generalization"	
Eisenhardt (1989)	Grounded Theory techniques for data analysis; enfolding literature	
Yin (2003)	"Analytic generalization" / "generalizing to theory"	
Stoddart (2004)	Generalization about "generic social processes"	
Hedström & Ylikoski (2010) and Woodward (2002)	Generalization by detecting "causal mechanisms" / "causal generalizations"	

Table 1: Approaches to Generalization

Whereas Geertz as well as Lincoln and Guba are rather critical towards the possibility of generalization from a specific situation to others, Williams (2000) presumes that working hypotheses and thick descriptions at least "take the form of speculative generalisations" (p. 212) and are – what he calls – "moderatum generalisations". In this type of generalization, aspects of a situation "can be seen to be instances of a broader recognisable set of features" (p. 215). He distinguishes moderatum generalizations from statistical and total generalizations (total generalization means that one situation is an instance of a general deterministic law that governs another situation as well).

Popay et al. (1998) refer to the different outcomes of qualitative and quantitative generalization. In qualitative research, "the aim is to make logical generalizations to a theoretical understanding of a similar class of phenomena rather than probabilistic generalizations to a population" (p. 348). They

point out that in order to reach a theoretical understanding through logical generalization, one needs to apply methods different from the ones in quantitative research.

Along these lines, Tsoukas (2009) refers to Znaniecki and points out that while both forms tend to reach general and abstract truths, quantitative/statistical induction abstracts by generalization, whereas qualitative/logical induction generalizes by abstracting.

Walsham (1995) presents four types of generalization from case studies which are also outcomes in the aforementioned sense: Development of concepts, generation of theory, drawing of specific implications, and contribution of rich insight. They encompass fairly different results that can be obtained from case study data. On the one hand, he is explicit about the characteristics of these outcomes when he points out that they "should be viewed as 'tendencies', which are valuable in explanations of past data but are not wholly predictive for future situations," and they are "explanations of particular phenomena (…) which may be valuable in the future in other organizations and contexts" (p. 79). On the other hand, he does not elaborate on the process of generalization in his paper and an extension (Walsham, 2006).

Whereas literature provides different descriptions of different outcomes of the generalization process, it does not offer a clear picture of how to generalize. A methodological guidance for the way the mentioned outcomes can be obtained or how to abstract, derive or induce in different situations is missing. However, we can identify hints, and orientation in the related literature that helps to develop a frame of understanding.

In order to structure the ways generalization can be performed, Lee and Baskerville (2003) develop a framework of four different generic types of generalization. On the one hand, empirical statements are generalized to either other empirical statements (Type EE: Generalizing from data to description) or to theoretical statements (Type ET: Generalizing from description to theory). On the other hand, theoretical statements are generalized to either empirical statements (Type TE: Generalizing from theory to description) or to another theoretical statement (Type TT: Generalizing from concepts to theories), respectively.

Klein and Myers (1999) offer a generic description in their principle #4 "The Principle of Abstraction and Generalization:" They describe the way of generalizing as "relating the idiographic details (…) to theoretical, general concepts" (p. 72). To do so, they recommend "contextualization" and "hermeneutic cycles" (their principles #1 and #2) as two important means. Since Klein and Myers's aim is to propose a useful set of principles, along with their philosophical rationale, there is no detailed description provided.

Even though the principles and generic types are described in some detail and various illustrative examples are given, Lee and Baskerville as well as Klein and Myers do not intend to give guidance in terms of an applicable research method.

Based on the relationship between the reader's experience and the case study itself, Stake (1995) argues for an empirically-grounded generalization that he calls "naturalistic generalization." Accordingly, the case data can be understood and interpreted by readers more comprehensively if it matches their experience. In this case, the generalization emerges when the reader recognizes similarities in the case study details and finds descriptions that resonate with his own experience.

Smaling (2003) deals with the problem if and how findings from one case study can be transferred to another. He argues that "analogical generalization" – in contrast to inductive generalization – is "plausible when there are solid arguments that, when a particular researched case has characteristics which are relevant for the research conclusions, another case that has not been researched also has these relevant characteristics" (p. 57). This includes case-to-case generalization as well as exemplary generalization. Smaling makes one important assumption, namely that generalization is more firmely

based "for the more one knows about similarities and differences between a case that has been researched and one that has not" (p. 55). His approach is partially in line with the notion of Lincoln and Guba (1985) and their idea of transferability and fittingness.

Eisenhardt (1989) provides useful procedural knowledge (a "roadmap"). She describes a process of building theory from case study research. However, regarding the most important step analyzing data she points out: "Analyzing data is the heart of building theory from case studies, but it is both the most difficult and the least codified part of the process" (p. 539). She advocates the application of grounded theory techniques and approaches to qualitative data analysis in order to support the emergence of theoretical categories and concepts. In addition, she recommends "enfolding literature" to improve the generalizability of the research findings by "tying the emergent theory to existing literature" (p. 545).

Accordingly, Yin (2003) suggests an "analytic generalization" with the goal "to expand and generalize theories" (p. 10). He argues that single case studies "are generalizable to theoretical propositions and not to populations or universes" (p. 10). This corresponds with the "Type ET Generalizability" in Lee and Baskerville (2003) and the "logical generalization to a theoretical understanding" of Popay et al. (1998). Following his approach, theory also becomes a vehicle for generalization. This, of course, is only applicable where appropriate theories exist.

Stoddart (2004) criticizes "folk notions of science (…) entwined with the positivist tradition" and advocates the idea of "generic social processes." Based on previous work by Becker (1990) and Prus (1994), he abandons claims to generalizability about populations. Instead, he focuses on generalizing about "generic social processes" in order to "see how they play out in potentially diverse social settings" (p. 308).

In newer social science, some authors pursue a similar idea (Hedström and Ylikoski, 2010; Tsoukas, 2009). This attempt to generalize is the delineation of causal mechanisms. Generalization occours by "opening up black boxes and making explicit the causal cogs and wheels through which effects are brought about" (Hedström and Ylikoski, 2010) (p. 54). In this approach, researchers attempt to identify possible mechanisms and to turn them into a plausible mechanism through the collection of empirical evidence about the assumed entities, activities, relationships, etc. "What separates proper mechanism-based explanations from mere mechanism-based storytelling is this kind of rigorous checking of the assumptions upon which the mechanism schemes rest" (Hedström and Ylikoski, 2010) (p. 53). In this domain, Woodward (2002) puts forward the idea of "causal generalizations" by providing an account of explanatory relevance.

These ideas seem to be very similar to Bhaskar's "generative mechanisms" which have been adopted by Walsham (1995) but, interestingly enough, attract considerable interest in modern sociology.

In the following sections, we apply different approaches to generalization presented in table 1. In addition, we introduce techniques from conceptual modeling for methodological guidance in qualitative research.

Research Paradigm and Generalization in Our Case Study

There is a commonly drawn distinction in case study methodology between positivist and interpretivist research (Doolin, 1996; Darke et al., 1998). Even though this distinction is commonly used, there seems to be a loss of clarity in what makes the difference. Weber (2004), for example, argues, that "many, if not all, of the alleged metatheoretical differences between positivism and interpretivism are spurious" and that the real differences "lie more in the choice of research methods" (p. x). Others contradict this claim by explicating the "functional outcomes of research," which is basically the distinction between "understanding" and "explanation" (Hovorka and Lee, 2010).

Understanding, which is associated with interpretivism, is conceptualized in a subjective fashion. Researchers should develop an understanding of the subjective understanding of the participants' own understanding (Lee, 1991). In doing so, he or she is closely connected to the thoughts and motivations of the human objects under study and, in addition, offers an interpretation of and for human conduct (Doolin, 1996), which is also called "interpretive understanding of the subjective understanding."

In contrast, explanation in positivism refers to an observing researcher's formal position and is guided by the criteria of the natural science model (Darke et al., 1998; Lee, 1989). Accordingly, the constructs and variables used belong to the researcher and are not part of the subjects' experience (Hovorka and Lee, 2010). This leads to a positivist understanding, providing explanation of the empirical reality.

Despite these basic differences, scholars argue that the two perspectives can be mutually supportive, rather than mutually exclusive (Lee, 1991) and that the choice of techniques and methods to improve scientific knowledge should be based on their specific strengths and weaknesses (Weber, 2004). For that reason, Hovorka and Lee (2010) and Lee (1991) demonstrate how the two approaches can be integrated and how the linkage between explanation and understanding can be used to improve knowledge creation. Basically, this integration is viable because the interpretative understanding may provide the basis on which to develop the positivist understanding. Thus, the positivist interpretation of the interpretive understanding will lead to a different theoretical explanation.

However, it also has to be mentioned that previously interpretative researchers have already argued in a similar manner: Insofar as research begins with statements of particulars and ends with a general statement (a theoretical explanation), this reasoning process is a form of generalization. "Hence, generalizability is an essential feature of interpretive research that endeavors to provide theory and not just description." (Lee and Baskerville (2003); with reference to Geertz (1973) and Yin (2003)).

In our case study, we make use of the two perspectives, as they are mutually supportive, to analyze data and elaborate on patterns and mechanisms, and hereby to generalize by formulating hypotheses and designing model fragments. According to Lee (1991), "understanding has at least two specific meanings. In its first sense, understanding refers to "understanding" as the process by which people in everyday life come to interpret and, therefore, to understand and guide themselves in their world. However, the observing social scientist is also one such person, albeit with different cognitive motives" (p. 348). Thus, the subjective meanings that give rise to the behavior of the people that are studied play a significant role in our research process. They are reflected throughout the whole research process and can be traced in section 3. However, with every generalization, the researchers more or less move away from subjective meanings in order to structure the self-perception of the project members.

Our conceptualization of generalization for the case study at hand is as follows: Our goal is to reach a higher level of abstraction by identifying theoretical, general concepts in a first step. This is done by relating the idiographic details and the subjective understanding to concepts in order to get from data to observations and – in a second step – from observations to theory which is in line with Lee and Baskerville's (2003) approach (table 1). Our notion of theory is adopted from Gregor (2006), who defines theory as "statements providing a lens for viewing or explaining the world" (p. 4).

A critical issue remains how data and concepts can be related. The approaches presented in table 1 propose that these relationships can be drawn by "naturalistic generalization" (Stake 1995) or "analogical generalization" (Smaling, 2003). The former is not used because we do not agree that the interpretation and generalization should be made by the reader alone. The latter approach refers to case-to-case generalization, which is not our primary goal. An "analytic generalization" as proposed by (Yin, 2003) is not chosen because there are no commonly accepted theories in this field of research.

Instead, we apply techniques of the grounded theory methodology and interpretative techniques; in later phases, we also compare our findings with conflicting and similar literature (see 2.4). This corresponds to logical generalization aiming at the development of a theoretical understanding and a mode of induction described by Znaniecki as "generalization by abstraction."

Additionally, in search for guidance and methodological support, we identified abstraction mechanisms of conceptual modeling as a helpful means because they aim at identifying "useful abstractions of the similarities of classified phenomena" (Parsons and Wand, 2008), an aim very similar to the one of qualitative research. Abstraction mechanisms are generic relationship types with a defined semantic. This helps with linking data and concepts residing on different levels of abstraction.

We argue that in qualitative research these mechanisms will support the grouping and structuring of details and concepts. Hence, in terms of Eisenhardt (1989), abstraction mechanisms are "structured and diverse lenses" which help to identify concepts and categories and transparently structure "similarities and differences" (Geertz, 1973; Smaling, 2003).

Literature offers a range of abstraction mechanisms (Goeken, 2006; Olivé, 2007; Mattos, 1989; Analyti et al., 2007). Two of them will be applied to the case study data in the following sections:

- Classification relates instances with a type, or to be more precise, it consists of determining the types which an object is an instance of (semantic: "has type"/"type of"). Instances have common properties and are assembled into a new entity type for which uniform conditions hold. Hence, a type is an abstraction representing instances on a higher abstraction level.
- Aggregation (composition) defines part-whole structures by describing that the whole is a composite formed by parts. Hence, aggregation is an alternative way of forming an abstraction (on a higher abstraction level) with the semantic "part of" (also called meronymic relationship/holonymic relationship).

The application of other abstraction mechanisms that we do not utilize in this paper (e.g., specialization (semantic: "kind of"/"is a"); grouping (semantic: "member of"); roles (semantic: "role of"); materialization (semantic: "materializes") will be subject of future research.

In the following, we will use aggregation and classification as a means to abstract from idiographic details and concepts to categories. Furthermore, the induction of categories ("types" and "aggregations") supports inferences about non-observed properties. As they are abstract placeholders, they enable and guide the derivation of alternative concepts that could not be observed in the original data. In doing so, researchers leave the firm empirical foundation. However, by making this procedure as transparent as possible, the creation of abstract types, and thus the generalization by abstraction, becomes traceable and can be justified.

One further goal is to identify generic socio-technical processes - comparable to "generic social processes" and "causal generalizations" (see table 1) - which are abstracted formulations of social behavior and the interplay of social and technical aspects. These can be interpreted as "middle range theories" because they are sufficiently abstract to be applied to different contexts but do not offer a set of general laws (Hedström and Ylikoski, 2010) (p. 61). Middle range theories allow contextual explanations and "lie between the minor but necessary working hypotheses that evolve in abundance during day-to-day research and the all-inclusive systematic efforts to develop a unified theory that will explain all the observed uniformities of social behaviour, social organization and social change" (Merton, 1967) (p. 39).

In order to prevent excessive overestimation of generalizability, the main findings of our research (e. g., hypothesis and model fragments which form the "generic social processes" and "causal

generalizations") "should be viewed as 'tendencies', which are valuable in explanations of past data but are not wholly predictive for future situations" (Walsham, 1995) (p. 79). Subsequently, developed theories should not be seen as "proven statements" but rather as "well founded but as yet untested hypotheses" (Lee and Baskerville, 2003). This parallels the notion of "moderatum generalization" (Williams, 2000 and section 2.2).

Research Process of Our Case Study

Following Eisenhardt (1989), we designed a research process for the study at hand which is depicted in figure 1.

The process commences with the explication of "a priori constructs." Furthermore, the first activity includes creating an initial research question and more specific questions of investigation (see section 3.2). This is an important first step to guide the case analysis and focus efforts.

In a second activity, an appropriate case has to be selected. Since the objective of this case study is to enhance understanding and develop theory rather than testing it, the chosen case does not have to be representative. One goal of this study is thus the generation of theory and not its justification through testing. A theoretical sampling though is "particularly suitable for illuminating and extending relationships and logic among constructs" (Eisenhardt and Graebner, 2007). Hence, we intentionally choose an extreme case that will be described in section 3.1. As outlined in table 1, a detailed description and comprehensive background information is important to support the "empirically-grounded" and "naturalistic generalization" promoted by Stake (1995) and to support the principle of contextualization by Klein and Myers (1999).

Multiple data collection methods such as interviews and analysis of documentation are used in the third activity (see section 3.3). In order to have a solid basis to build upon, collected data has to be gathered from multiple sources of evidence to underpin the completeness and correctness of data. This triangulation of data is important for the reliability of the case study's outcomes (Yin, 2003). Flexible and opportunistic data collection methods allow for reacting to emergent themes by adjusting data collection when necessary (Eisenhardt, 1989).

The fourth activity – analyzing data – begins with the grounding of our observations, as described in section 3.4. This is followed by the shaping of hypotheses through generalization, which is the subject of section 3.5. In the presentation of our research, we distinguish between observations and hypotheses (analyzing data and generalization, respectively) in order to enhance transparency and traceability of the procedure, even though they are closely interwoven.

Activity four is dedicated to properly grounding concepts and relationships. Their identification is conducted by employing techniques from grounded theory (see Eisenhardt (1989) in table 1) and interpretative techniques (see Walsham (1995) and Boland et al. (2010) for hermeneutical exegesis in IS). Even though we do not use the coding techniques to their fullest extent, the general approach and respective tools support the assignment of statements from the interviews and documents to concepts. The goal is to detect relevant particulars within the idiographic details and to discover underlying reasons for why concepts, relationships or patterns exist.

This activity results in observations which are judgments or inferences from what we observed (adapted from Merriam-Webster). These judgments are a first abstraction from the raw data, labelled "first-order concepts" by van Maanen (1979). Second-order concepts (the concepts forming our observations) are "notions used by the fieldworker to explain the patterning of the first-order data" (van Maanen, 1979). Hence, they move away from the subjective understanding (Hovorka and Lee, 2010) and 2.3).

While concepts and observations are still closely linked to the idiographic details, in activity five (generalization), we generate hypotheses consisting of abstract categories. Extending van Maanen's terminology (1979), we might label these categories, which form hypotheses, third-order concepts, which thus represent abstractions of abstractions of first-order data. We generate these hypotheses by relating concepts described in the observations to categories applying abstraction mechanisms adopted from conceptual modeling. The categories and relationships between them should apply to multiple situations and hereby reach a higher level of generality.

The sixth activity consists of a comparison with related work, so called "enfolding literature" (Eisenhardt, 1989).1 It aims at comparing opinions and positions found in related literature with the observations we made and improving the hypotheses. This results in hypotheses "with stronger internal validity, wider generalizability, and higher conceptual level" (Eisenhardt, 1989). In doing so, we try to turn possible mechanisms into plausible mechanisms (Hedström and Ylikoski, 2010) (p. 52).

Analyzing data (4) and generalization (5) are closely interwoven and both supported by the analysis of literature. According to Gadamer (1976), "the harmony of all the details with the whole is the criterion of correct understanding" (p.117), and in a number of iterations "a complex whole of shared meaning emerges" (Klein and Myers, 1999). This is represented by the iterative layout of activities four to six which accords to the hermeneutic cycles promoted by Klein and Myers (1999). The focus is on constantly comparing hypotheses, data, and competing and similar literature iterating towards a set of hypotheses which closely fits the data (Eisenhardt, 1989).

Finally, activity seven integrates several hypotheses to build model fragments (section 3.6). Through another generalization, these fragments have an even higher level of abstraction and are thus more remote from the first-order data.

Figure 1 illustrates the increase of abstraction with each activity performed moving from left to right. Considering semantic levels, model fragments encompass both the level of instances and the level of types. They incorporate categories used in our hypotheses and also concepts – including those we were not able to observe in our case study.

GENERALIZATION IN AN SOA CASE

Case Description

In the context of the project "Ad-hoc DAta Grids Environments" (ADAGE), researchers at the University of New South Wales (UNSW) implemented a service-oriented architecture for SIRCA, a data provider. The authors of this paper did not participate in the actual SOA implementation project but analyzed data about it ex post as described in the following sections. The project aimed at providing customers an easier retrieval and analysis of heterogeneous data from different sources (grid environment) spontaneously in an ad-hoc fashion. SOAs were not the focus of this software implementation project but service orientation was chosen as the preferred architectural paradigm. Thus, services (and their identification) were used as a means to meet the company's requirements rather than being the subject of analysis themselves.

[1] Due to the focus on generalization, the extensive discussion of literature related to every hypotheses and model is omitted in this paper. It can be found in Börner et al. (2012).

SIRCA provides a huge data repository containing historical financial market data such as news and trading data. Its aim is to supply this data to researchers especially at Australian and New Zealand universities.

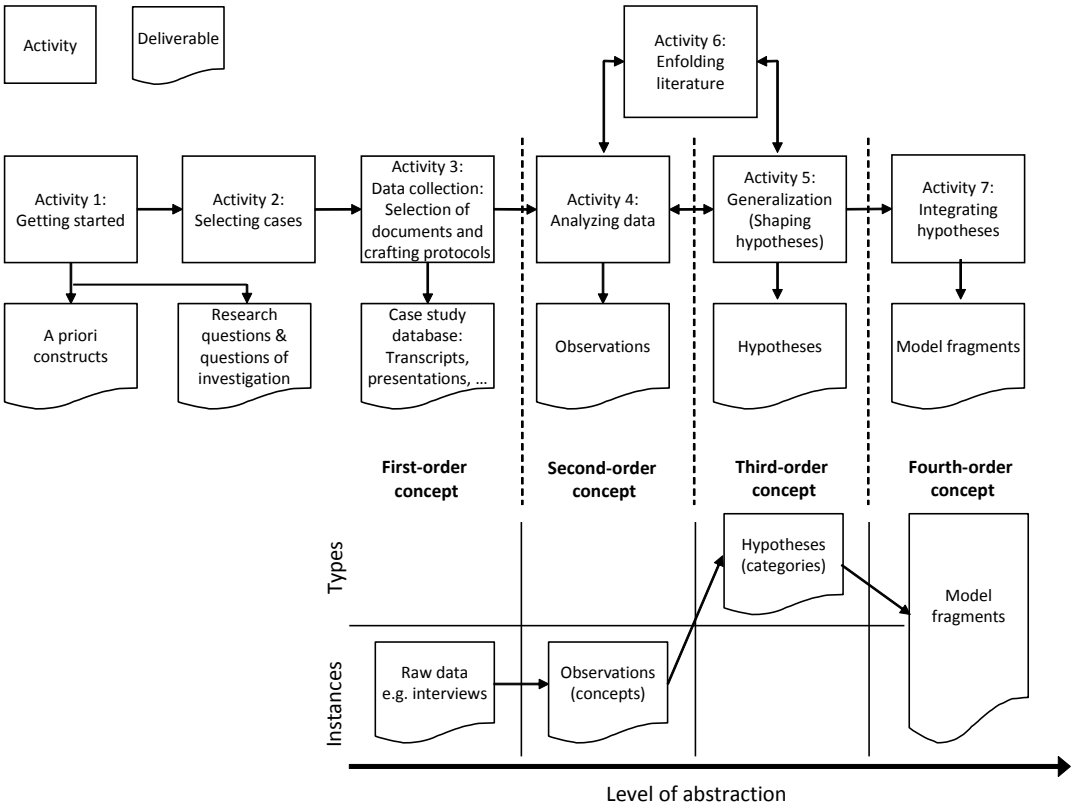

Figure 1: Research Process and Deliverables of the Respective Activities

In ADAGE, services were created based on the available data. This implied a technical understanding of services. The company's employees were not thinking in terms of business processes, so that no model that could have been analyzed in the course of service identification was delivered. The company's management, however, had some requirements in mind that should be fulfilled by services. Unfortunately, these were not documented, which makes traceability difficult. Requirements were communicated to the project team in scheduled weekly meetings and workshops. Service candidates were identified on the basis of these meetings and prototyped. In an iterative and incremental approach, the functionality of these candidates was adjusted to finally meet the company's requirements. A close collaboration between the SIRCA's research and development department and the university's project team was a key to ensure the successful identification of services.

First and foremost, the search for services was driven by the idea to retrieve and integrate data from different sources. In a second step, project members identified which services could support researchers in analyzing data, e.g., building time series of financial data. Clearly, this was a requirements-driven bottom up approach. Goals included the provision of a graphical user interface

(GUI) to customers, enabling them to directly invoke services in an ad-hoc fashion to analyze financial market data. Certainly, SIRCA's case is not a typical example of service identification projects. Due to its rather extreme character, it helps to identify possible instances of situational factors that usually cannot be found in typical cases.

Since this paper focuses on methodological aspects, we partly omit more detailed descriptions of the case study data. A comprehensive discussion and description including interview guidelines, transcripts, the raw data leading to our observations, etc. can be found in Börner et al. (2012).

Getting Started

As illustrated in figure 1, outlining the theoretical background in the sense of "a priori constructs" is the first step of our research process. Since the research question is the foundation for the analysis of every case study (Eisenhardt, 1989), our research process continues with the formulation of a research question. Shortly after the beginning of the case study, it became obvious that a single focus on service identification might not deliver satisfactory results in the ADAGE case. Thus, we extended the scope of our analysis to the early stages of the SOA lifecycle, namely the design and development of services and the service-oriented architecture in ADAGE.

Some authors have already developed methods to support identification, design, and development of services (for an overview see Börner and Goeken (2009b), Kohlborn et al. (2009b) and Birkmeier et al. (2009)). However, little is known about service identification and the early stages of the SOA lifecycle in real-life projects. Thus, in order to guide us through the analysis, we formulate the following initial research question:

How does SOA development and service identification work in real-life projects?

The rather generic nature of our research question necessitates the formulation of further, more specific questions, the questions of investigation. These help to focus our analysis and support, for example, the hermeneutic analysis of the interview transcripts. The following questions of investigation are reflected by the guidelines used for the conducted interviews.

- Which circumstances influence the proceeding of the service identification process?
- Did the understanding of services change/develop in the course of the project? Was there a change of the skill level of the project participants?
- How was the SOA implemented technically? Which software development techniques had been used?

Data Collection

Written documentation, i.e. various sorts of electronic files, and interviews are major sources of our data collection process. 19 presentations that were held between December 2006 and November 2009 provide a good overview of the general proceeding, achieved objectives, and next steps required at the time of the presentation. Furthermore, official progress reports give a structured overview of how the project was proceeding. Due to their much more formal character, these reports offer fewer insights into actual work practices, such as the identification of services.

A considerable number of published and unpublished papers have been authored by project team members in the course of the project. The variety of publications in which the papers have appeared shows the scientific and practical value of the project's outcomes. Additionally, various websites about the project or involved parties are used to retrieve background information. Some newspaper articles about the project could be found as well and are added to the case study database.

In order to retrieve additional information, particularly about the identification of services in the ADAGE project, four interviews are conducted. Three of the interviewees are project team members at the university. All of them were involved in identifying and designing services in the project. Another interviewee is a representative of the company that implemented the SOA.

The interview questions are open-ended. However, guidelines with questions are used in each case. For the three project team members at the university, the same question guideline applies, whereas a different one is used in the interview with the company's representative. The interviews serve as a valuable means to capture subjective meanings that are essential to our interpretivist approach. All labels of concepts used in our observations are retrieved verbatim from the interviews.

Analyzing Data

Based on the collected case study data, we first strive to investigate the subjective understanding of the project members. From this understanding, observations residing on a higher level of abstraction are induced (second-order concepts). Due to space limitations, we cannot give detailed insight into the subjective understanding. This is done in a working paper (Börner et al., 2012) incorporating a plethora of quotations from documents and interviews.

The ADAGE project members perceived themselves as rather innovative and archaic in a creative environment with little constraints. Due to the project setting, i.e., a public private partnership, the pressure regarding time and budget was comparably low. The developers used their freedom to follow a flexible free-style approach based on their available skills. According to the members' perception, they were able to compensate for the absence of any formal method in their development process through extensive communication. Furthermore, based on the mainly technical skills of the project members, the proceeding in the project was seen as a creative technically-driven trial-and-error endeavor.

Our observations attempt to structure the subjective meanings that were found in the raw data and support the perception of the project situation. Grounded in document studies and interviews, we arrive at several concepts that we consider as being of importance in the course of the ADAGE project, e.g., we regard the subjective understanding mentioned above as the concept "absence of a formal method." In doing so, and applying the contextualization principle (see table 1), we seek to present the subject matter in its context "so that the intended audience can see how the current situation under investigation emerged" (Klein & Myers, 1999) (p. 73).

All 16 observations describing the concepts and their relationships are shown in table 2 and are the result of activity four.

Shaping Hypotheses

In this next activity we further abstract the observations by generating hypotheses consisting of categories which are based on the concepts observed.

The concepts we identify in the observations can be regarded as instances, and thus we can use abstraction mechanisms to generalize from these observations. The resulting types or compositions form the components of our hypotheses. Hence, by applying abstraction mechanisms, we create abstract categories on the type-level, the 'third-order concepts' (figure 1) we have labeled categories (e.g., we can classify the concept "fine-grained services" as an instance of the category "granularity"). In so doing, we utilize mechanisms from conceptual modeling that guide the generalization by abstraction which we regard as a logical generalization.

As the categories are abstract placeholders, in other settings they will have different concepts than those we have observed in our case study. Granularity, e.g., also has the instance "coarse-grained

services." By incorporating alternative concepts, we clearly move beyond the details observed and further generalize the findings (see section 3.6).

Observation
1. The generous funding significantly influenced the way of service identification.
2. The company's small size significantly influenced the way of service identification.
3. People's skills significantly influenced the way of service identification.
4. The implemented SOA satisfied users, although no formal method for the identification of services was used.
5. Little SOA experience led to a technical understanding of services.
6. Personal communication was vital to meet user requirements.
7. A technical understanding of services led to very fine-grained services.
8. A technical understanding of services led to a bottom up direction of analysis.
9. The implemented fine-grained services provided flexibility for users and developers at the same time.
10. Fine-grained services supported reusability.
11. Orchestration of services significantly contributed to flexibility.
12. Fulfilled user requirements led to user satisfaction.
13. Identification and development of services were incremental and iterative processes that supported fulfillment of user requirements.
14. The flexibility provided by services led to user satisfaction.
15. User satisfaction was a success measure.
16. Reusability was a success measure.

Table 2: Observations from the Case Study

In the following, we present our hypotheses and describe how the generalization and the merging of the observations is performed, applying the abstraction mechanisms described in section 2.3. Table 3 illustrates our observations and the resulting hypotheses. Due to space restrictions, only hypotheses 1, 3, 5 and 6 will be described in detail because they are further used in the models that will be developed in section 3.6.

Hypothesis	Observation
1. Context factors significantly influence the way of SOA development and service identification.	1. The generous funding significantly influenced the way of service identification.
	2. The small company size significantly influenced the way of service identification.
	3. People's skills significantly influenced the way of service identification.
2. Not using a formal method for service identification does not necessarily lead to a failure of SOA projects.	4. The implemented SOA satisfied users, although no formal method for the identification of services was used.
3. SOA project experience leads to a different understanding of services and thus affects success measures.	5. Little SOA experience led to a technical understanding of services.
4. Personal communication can substitute utilization of formal methods.	6. Personal communication was vital to meet user requirements.
5. The understanding of services affects both the granularity of services and the direction of the service identification approach.	7. A technical understanding of services led to very fine-grained services.
	8. A technical understanding of services led to a bottom up direction of analysis.
6. The right granularity of services can affect multiple success measures and depends strongly on the project at hand.	9. The implemented fine-grained services provided flexibility for users and developers at the same time.
	10. Fine-grained services supported reusability.
7. The success of SOA projects is expressed through technical and business-oriented success measures.	15. User satisfaction was a success measure.
	16. Reusability was a success measure.

Table 3: Hypotheses Related to Observations

Figure 2 shows how the relation between concrete concepts (observations) is mapped to an abstract view that generalizes from the ADAGE case. While the lower part links instances through observations, the upper part shows the relation between types and the resulting hypotheses. Concepts (e.g., fine-grained services, reusability) that could be observed in our case study are linked through observations (table 2), e.g., O10 "Fine-grained services supported reusability". On the next abstraction level, categories such as granularity are related through hypotheses like number 6 "The right granularity of services can affect multiple success measures and depends strongly on the project at hand." These categories reflect phenomena that can be found not only in the ADAGE case but in SOA implementation projects in general. In addition, they represent „causal mechanisms" and „causal generalization" (Hedström and Ylikoski, 2010). Thus, the hypotheses are a generalization of our observations as shown in table 3.

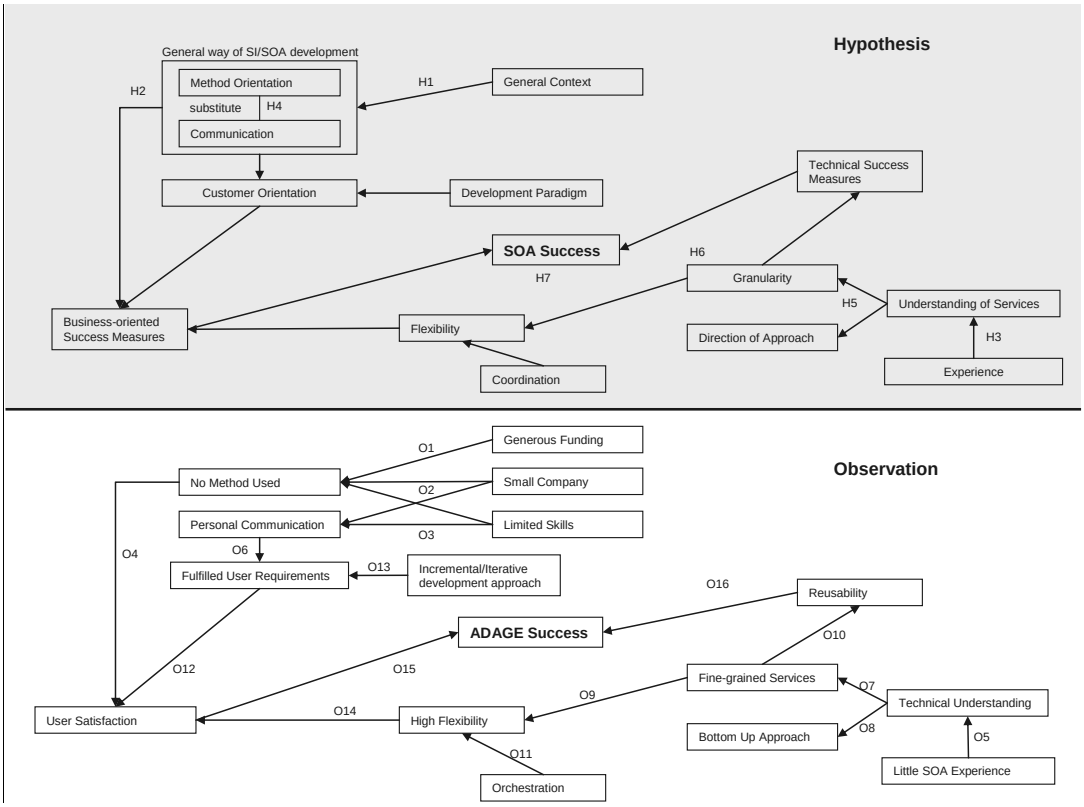

Figure 2: Interrelationships of Observations and Hypotheses

Hypothesis 1: The general context significantly influences the method of SOA development and service identification.

Certainly, there are many factors that affect the approach to service identification in general and the choice of certain methods in particular. Those factors that cannot be influenced by the project team are commonly called context factors (Bucher et al., 2007). We identify generous funding, small company size, and limited skills in ADAGE to be such context factors (observations 1 to 3).

At first, we use the abstraction mechanism ***aggregation*** to subsume the identified concepts under the new concept *ADAGE context*. Thus, generous funding, small company size, and limited skills have an "is-part-of" relation to *ADAGE context* as shown in figure 3. On the level of abstract categories these relations apply, respectively.

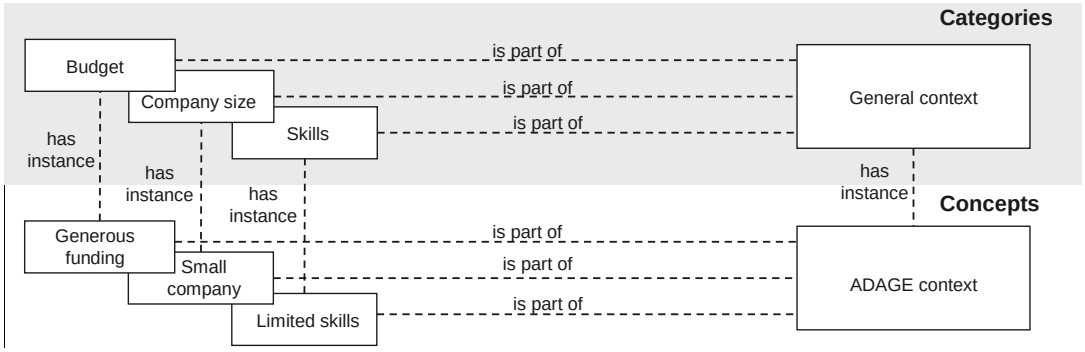

Figure 3: Applying Abstraction Mechanisms to Hypothesis 1

Applying the abstraction mechanism classification, we can generalize our concepts (instances) by determining abstract categories (types). For example, the category company size is the result of classification from the observed concept small company. Thus, there is a has-instance- (instance-of-) relationship between these two. Budget and skills are the other two categories that were directly derived from our observed concepts described in observations 1 to 3. The concept ADAGE context that is created by aggregation is transformed into the category general context by classification. All categories are related to respective concepts by "has-instance" relations. Particularly, the aggregation that sums up several concepts to the ADAGE context necessarily moves away from subjective meanings that served as the starting point for our analysis.

Our observations show that the combination of a small company and employees with limited skills (trumping the opportunities of a generous budget) leads to an absence of formal methods in service identification. This is in line with the subjective understanding of the project members (see 3.4) and certainly an extreme case. However, it seems to be plausible to assume that context factors significantly influence the way of service identification and, in the following, we will discuss the underlying mechanisms. Thus, we can e.g., tentatively hypothesize that large companies with highly skilled employees will use different methods for SOA development and the identification of services.

Hypothesis 3: SOA project experience leads to a different understanding of services and thus affects success measures.

In ADAGE, we observed that little SOA experience accompanied with the dominance of IT specialists resulted in a technical understanding of services (observation 5). Classifying the concepts observed, we assume that the level of experience influences the understanding of services. We therefore hypothesize that companies with a track record of service implementation tend to involve business departments early in the process of service identification. Therefore, the understanding of services is much more process-oriented. Through multiple cause-and-effect relationships shown in figure 2, success measures such as reusability are affected.

The task of planning a service-oriented architecture should be tackled by both business departments and an organization's IT division (Börner and Goeken, 2009b). Implementing an SOA is primarily a technical challenge. We assume that – like in the ADAGE case – many SOA projects underestimate the importance of properly planning an implementation. Hence, consideration of business processes is often poor, and employees of the IT division take the lead in these projects. Especially in companies that have little or no experience with the nature of services, the dominance of IT specialists usually leads to a technical understanding of services. More experience in this field might result in different outcomes. A project team might decide to use a process-oriented approach, a user-oriented approach,

or even choose a technical approach if suitable. The most significant difference is that an experienced project team with a broader understanding of SOA is free to choose an adequate approach from a range of options. Unfortunately, this makes a prediction almost impossible. The only cause-and-effect relationship that can be established here is that more experience allows for different opportunities whereas little experience most certainly leads to a technical understanding.

Anderson et al. (2005) argue that the extent to which the enterprise architects, service developers, and operations project staff in the IT department are skilled (i.e., their experience and subsequently their understanding of services) is a critical factor for web service implementation. Looking at our observations 5, 7, and 10, we can further hypothesize that SOA experience indirectly influences reusability of services. This is confirmed by Baskerville et al. (2005), who show that "very few web services could be reused exactly as originally implemented" (p. 7) and thus, experience is essential for SOA implementations. Becker et al. (2009) state that "especially in the early phases of SOA maturity [i.e., with little experience] there is no experience about [what] a reusable service would look like" (pp. 7-8). This is another hint that SOA project experience tends to change the understanding of services and enhances reusability.

Hypothesis 5: The understanding of services affects both the granularity of services and the direction of the service identification approach.

In the ADAGE project, a technical understanding of services led to very fine-grained services and a bottom up approach stressing technical aspects of the underlying (data) infrastructure (see observations 7 and 8).

In order to develop our hypotheses, a classification leads to the abstract categories understanding of services, direction of approach and granularity. The category granularity, e.g., is the abstraction of fine-grained service, the instance that we are able to observe.

Firstly, we can hypothesize that a different understanding of services leads to different granularities. Moving on a scale from technical to business-oriented understanding, the identified services might become coarser-grained along this line. From a business perspective, services should support business processes or at least sub processes. Hence, they encompass more functionalities than an elementary service that, for example, extracts an address from a database. The latter will more likely be the outcome if service identification is conducted from a technical point of view.

Secondly, the direction of the approach is influenced by this understanding. Again, moving along the above scale will result in the application of bottom up approaches on one side and top down approaches on the other side. It is unlikely to end up with a pure instance of any of the approaches. Even in the ADAGE case, a very technical understanding did not result in a pure bottom up approach. However, the share of techniques that are typically assigned to top down approaches (such as strategic analyses) will increase with a business-oriented understanding of services. Accordingly, in their comparison of service analysis approaches, Kohlborn et al. (2009a) differentiate two types of SOA concepts, i.e., understandings of SOA. One of them is rather technical and, thus, delivers so-called software services while the other (business-oriented) one results in business services.

Hypothesis 6: The right granularity of services affects multiple success measures and depends strongly on the project at hand.

In service-oriented architectures, granularity of services is a widely discussed issue among researchers and practitioners alike. Our observations 9 and 10 indicate that fine-grained services positively contributed to both reusability and (indirectly) user satisfaction in the ADAGE case. Thus, we hypothesize that granularity indeed plays a major role for the success of SOAs in general since it potentially affects more than one success measure. The categories granularity, flexibility, and success

measures that constitute hypothesis 6 were developed by classification. They all abstract the instances and concepts observed and, thus, have "is-instance-of" relationships to the concepts fine-grained services, high flexibility, user satisfaction, and reusability.

Whereas the ADAGE case shows clear advantages of fine-grained services, coarse-grained services might be the better choice in other settings. Some customers might not be interested in the flexible composition of services every time they use them. If they simply want to outsource part of a business process, they might prefer a coarse-grained service that encompasses all necessary functionalities and delivers a comprehensive result. Accordingly, Elfatatry (2007) argues that "the appropriate level of granularity for a service and its methods is relatively coarse. A service generally supports a single distinct business concept or process." (p. 38) In the ADAGE case, fine-grained services enhanced both reusability and user satisfaction, i.e., technical and business-oriented success measures, respectively. In other cases, the granularity of services might be a trade off because effects on these two kinds of measures could be converse.

We argue that, due to different preconditions, the right granularity of a service has to be elaborated depending on the situation at hand. There is no silver bullet for right-sizing a service without considering the context of service implementation. Thus, a situation-specific approach to the choice of methods is important to provide for an adequate granularity.

Integrating Hypotheses

Through generalization of our observations, we create hypotheses as illustrated in figure 2. This is done by applying classification and aggregation, two abstraction mechanisms with a clear semantic (instance-of/part-of). Since they are applied upwards (e.g., a concept 'is instance-of' a category), the investigation is based on and refers to observed instances and respective concepts. Hence, both the resulting observations and hypotheses are still closely linked to the primary data we retrieved from documentation and interviews.

In the following, we will describe phenomena that move beyond this data and reach another level of abstraction. By performing another generalization and looking at causal mechanisms between concepts, we arrive at model fragments that were not necessarily obvious beforehand. Due to the fact that the categories are abstract placeholders and the hypotheses show possible and plausible causal mechanisms, we can now reason about further conceivable concepts in terms of alternative instances. This is supported by applying the abstraction mechanisms downwards (a category 'has instance' non-observed concept). Since we assume that the hypotheses describe plausible mechanisms and the placeholders as well as the abstraction mechanisms guide the derivation, this is not arbitrary but another generalization by abstraction. Because the observed concepts as well as the categories in the different hypotheses overlap, we are also able to combine the hypotheses in a model or in a small set of model fragments.

The model fragments we present in this section can best be interpreted as middle range theories (see section 2.3) because they have limited scope and are applicable to limited conceptual ranges, as they only grasp phenomena from the systems development / SOA domain. Furthermore, they refer to selected aspects in the realm of SOA development because we focus our analysis on the questions of investigation presented in 3.2. Our model fragments allow for further detailing and the formulation and discussion of alternative theories. They correspond to the "theories" introduced by Walsham (table 1), and are causal generalizations. In the following subsections, three model fragments which present an external, internal, and a success perspective are elaborated.

Contingency Model (CM)

Context factors such as budget, company size, and people's skills are consolidated in hypothesis 1. All of them ("general context") influence the application of methods, communication, and the general approach to implementing SOA projects. The contingency model in figure 4 includes our observations from the ADAGE case (underlined concepts) and alternative concepts which are derived by conceivable instantiation of the categories applying abstraction mechanisms. We assume that alternative instances of the mentioned categories will result in different ways of SI/SOA development, as depicted in figure 4.

In our model, the list of categories constituting the contingency model is limited to those we were able to derive from observed concepts. We assume that the category "general context" can also be extended by non-observed concepts and resulting categories. For instance, in a more business-driven SOA implementation project, the choice of a BPM software tool could influence the way of SI/SOA development. Since there is no BPM tool used in our case, we are not able to observe such an impact. Accordingly, the way of SI/SOA implementation will most likely include more categories than method orientation and communication which we are not able to observe.

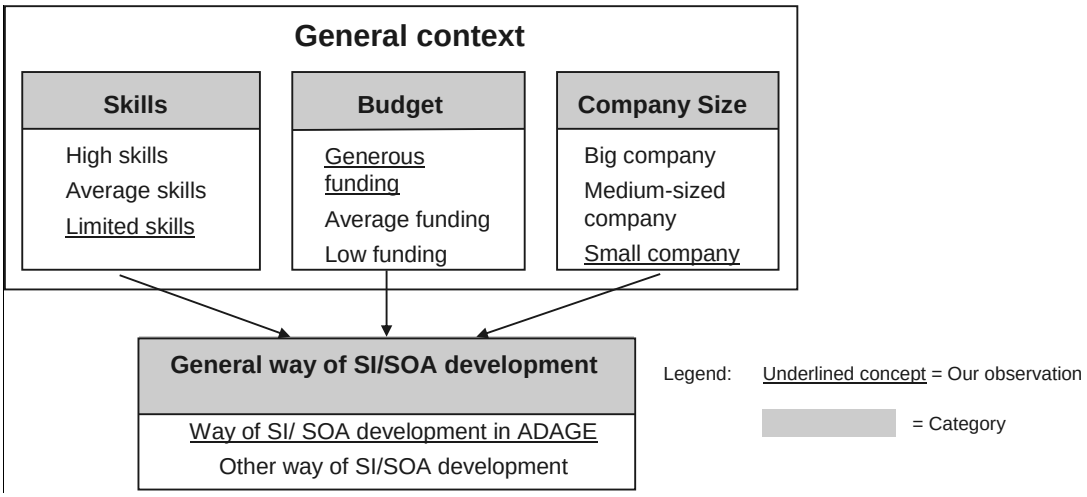

Figure 4: Influence of the General Context on the Way of SI/SOA Implementation (Contingency Model – CM)

The generalization in this contingency model follows Stoddart's (2004) notion. The general way of SI/SOA development is a socio-technical process and we generalize this process by abstracting from the observed instances. Due to the single case study design, we are only able to observe one way of SI/SOA development, i.e., the one in the ADAGE case. Subsequently, it is difficult to define more instances (concepts) of the category general way of SI/SOA development whereas additional instances for skills, budget and company size are easier to derive.

To the best of our knowledge, there are neither frameworks/models nor empirical studies that analyze situational factors in the realm of SOA. A first step towards a comprehensive list using more case studies has been made by Börner et al. (2011). Further empirical as well as conceptual research should strive to extract and develop models and causal patterns with respect to this category.

Model of Soft Factor Transition (MSFT)

The model fragment which ties together hypotheses 3, 5, and 6 is depicted in figure 5. Our observations (underlined concepts) and the resulting cause-and-effect chain show that a team with only little SOA experience produced a highly flexible service-oriented architecture and highly reusable services. In our hypotheses, experience leads to a distinct understanding of services (H3). This results in different granularities and directions of approaches (H5) and subsequently in a certain degree of flexibility and reusability (H6). Hence, the experience of project teams influences flexibility and reusability as well as the direction of the identification approach through a chain of cause-and-effect relationships as depicted in figure 5.

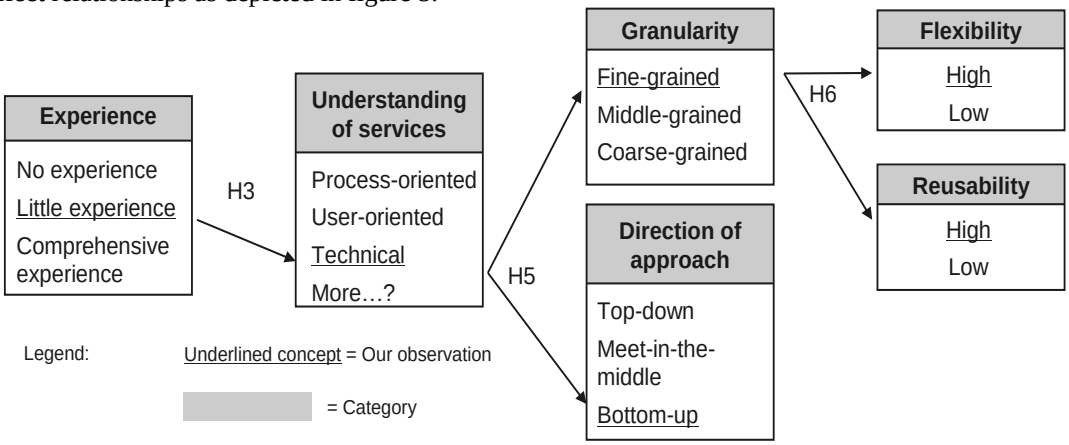

Figure 5: Causal Link of Experience and Flexibility/Reusability (Model of Soft Factor Transition – MSFT)

Finding further plausible and alternative instances for this MSFT is easier than in the case of the contingency model. The ***classification*** that is used to abstract categories from concepts is now inverted to identify new instances, i.e., concepts that could not have been observed in the case study. Again, as shown in figure 1, this step moves back from the type to the instance level but still increases the degree of abstraction from the raw data.

Outlining conceivable and alternative instances, we are able to describe project patterns as shown in figure 6. However, these patterns are not proven theories but rather hypotheses in terms of plausible tendencies. Theoretically, the number of possible patterns equals the number of all combinations of concepts. However, an identification of plausible patterns will be a contribution itself. Certain combinations of concepts might not be found in any pattern due to either conflicting goals (e.g., coarse-grained services and high flexibility) or incompatible preconditions and goals (technical understanding of services and top-down approach for their identification).

All major concepts of every category should be included but at the same time restricted in number as far as possible. Only those concepts that help to differentiate one project from another should be part of the framework. Identifying pattern could be impeded if concepts are too granular (e.g., a scale from 1 to 7 for reusability instead of "high" and "low") or not disjunct (e.g., "technical" or "functional" understanding of services).

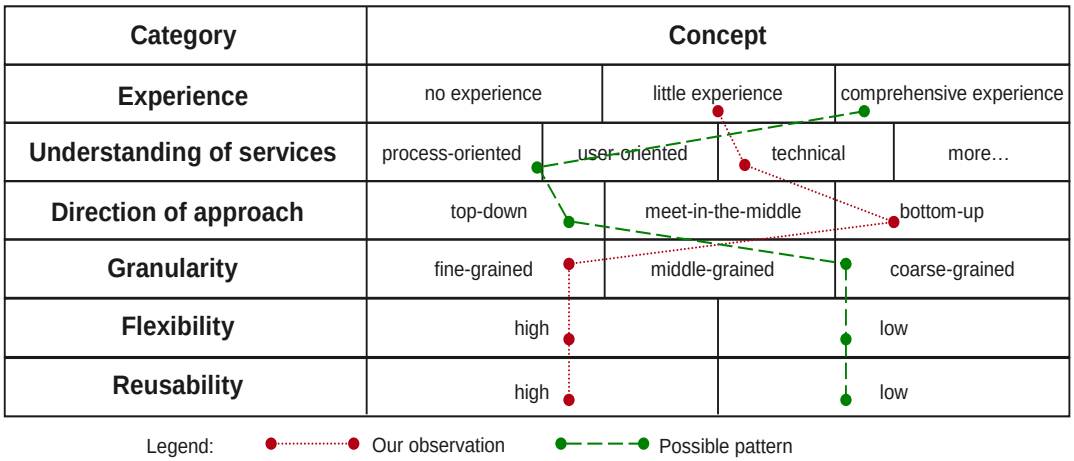

Figure 6: Project Patterns

Teams with little SOA experience and limited knowledge regarding business functions and processes are forced to rely on the experience they have, which is basically technical. We assume that developing an SOA based on the knowledge stemming from experience made with traditional, more technically-driven software engineering paradigms, for example, object-oriented programming or modules, results in fine-grained services. The understanding of services can be seen as the generative mechanism in this model fragment.

We could assume that a very experienced team might have a process-oriented understanding which leads to rather coarse-grained services that provide less flexibility. Since flexibility is regarded to be a big advantage of SOAs, this causal link is counter-intuitive. We would expect an experienced team to be able to reap the benefits of SOAs, including an enhanced flexibility. Figure 6 illustrates our observed pattern (dotted line) and the assumed possible pattern described above (dashed line).

However, we have to keep in mind that more experience does not necessarily lead to one specific understanding of services but enables an adequate choice of approach and understanding, as argued in hypothesis 3. A comprehensive experience, for instance, is not closely knit to a process-oriented understanding and could as well produce middle-grained services. A large number of patterns are thus conceivable. We argue that – depending on situation-specific circumstances in projects – the resulting patterns represent certain types of projects. An identification of such project types could lead to a targeted application of methods supporting SOA development and the identification of services. Project types can define situations in the sense of situational method engineering and would subsequently contribute to a more sophisticated service identification through the use of situational methods (Bucher et al., 2007).

Observations 7 and 8 show that the technical understanding of services in the ADAGE project lead to fine-grained services and an almost pure bottom up approach for identifying services. In this regard, the lack of experience once again leads to a rather object-oriented thinking which reveals another generative mechanism at work in our case study. In hypothesis 5, these observations are generalized. Undoubtedly, there is an effect of this understanding on granularity and the direction of service identification approaches. Actually, the question of granularity continues to be an open issue among scientists and practitioners alike and constitutes an active research area (Artus, 2006).

Success Model (SM)

Many observations and hypotheses are bound to the notion of success. Naturally, the primary objective of every project is to be completed successfully. This is also true for SOA implementation projects. But how can you evaluate the success of such a project? Our observations and hypotheses utilize several success measures that are influenced by a number of different concepts in our model illustrated in figure 2. In our observations, we find success factors such as reusability and user satisfaction. They are classified to technical and business-oriented success measures, respectively. Both success factors can be aggregated to the category SOA success. However, they take different view points and usually represent interests of different stakeholders.

On the one hand, reusability is a rather technical aspect. Subsequently, in most cases, it is pursued by the IT department that implements an SOA. The number of business processes that invoke a service and the frequency of invocation can serve as a unit of measurement. If the IT department can prove that a service is reused frequently in many processes, it is easy to argue that maintenance and development of this single service is more cost efficient than having the same functionality provided by multiple applications scattered across the organization.

On the other hand, user satisfaction is clearly a business goal. Users have little interest in cost savings or technical demands on the company's side. Instead, they appreciate flexibility and a timely satisfaction of their demands. Hence, business processes must be flexible and agile to guarantee a certain degree of user satisfaction. As argued before, a successful SOA can cater to these demands.

A number of success measures can be employed (see, e.g., the framework by Börner and Goeken (2009a)). All of them would serve as further instances of our success categories. Business departments can thus consider flexibility and time-to-market as important factors. From the technical side, autonomous services or a high degree of standardization might be important. In both cases, the measurement of success factors is far from trivial, and appropriate measures will have to be defined to operationalize the measurement of SOA success. To which extent technical and business-oriented success factors are aligned or not is an interesting question that is left to further research. Based on a literature review and expert interviews, Lee et al. (2010) identify 20 critical success factors in SOA implementation. However, their interrelationships and contribution to success are not clear.

FINDINGS AND IMPLICATIONS

In our analysis we identify factors and aspects (concepts and categories) relevant in the ADAGE project. With respect to our research questions our findings for SOA development projects are the following:

- We identified circumstances *(context factors)* that influenced the proceedings of the project. We were able to observe how some of these factors (e.g., funding) affected an SOA project and incorporated these observations into our hypotheses and model fragments.
- We found that the *understanding of services* and related skills significantly influence the way of SOA development. Several hypotheses and our models show that concepts such as granularity or the direction of the identification approach are more or less directly affected by the understanding of services (which is usually subject to change with increasing experience).
- Due to the absence of a method for service identification, we were not able to observe a stringent application of *software development techniques*. Software development was mostly intuitive and bound to few developers because of the limited scope of the project. An astonishing finding is that the "absence of a formal method" apparently has had no negative impact.

Overall, we have made 16 observations and subsequently developed seven hypotheses and three model fragments. Limitations stem from at least two sources:

- Due to the *single case study design*, our hypotheses and model fragments are limited and it has to be taken into account, that there are different concepts and categories to consider in more comprehensive models. To extend the models, further research is desirable.
- Additionally, the model fragments and hypotheses *must be seen as tendencies*, explaining plausible mechanisms. Their strength is that they describe possible cause-effect-relationships and give insight into the generative mechanisms at work. They are limited insofar as they are not tested yet. Hence, we neither can be sure that they are representative; nor do we know about the magnitude of relationships of concepts and/or categories.

Using multiple case studies is one possibility to find supporting or contradicting evidence for the generated hypotheses. This would enable a cross-case pattern search and underpin the validity of the results (Eisenhardt, 1989). Further interviews and document examination could be a basis for qualitative or (in large numbers) even quantitative cross-sectional analyses.

In the following, we will discuss key findings and limitations of the models and their possible interplay.

In our contingency model, we capture the influence of a number of context factors on the way of SI/SOA development. An extension of the list of factors, which form part of the general context, will be left to future research and can be achieved for instance through further case studies or expert interviews. Accordingly, more categories (and relating concepts) such as a management commitment (with the possible instances 'high', 'medium', 'low') might be discovered and it should be analyzed, if this influences the way of SI/SOA development e.g. by inducing top down approaches incorporating strategic aspects.

Moreover, based on only one case study, it is impossible to determine the extent to which a single factor contributes to certain outcomes. After conducting more case studies, a factor analysis could help to understand more reliably how the combination of identified factors affects the use of methods. Since there is already a large body of literature that provides a comprehensive list of context factors for domains different from SOA, future research should concentrate on identifying those that have a significant impact on SOA implementation projects and, in doing so, reason about the mechanisms more deeply. Quantitative research should aim at validating the resulting hypotheses and models.

The model of soft factor transition links experience with SOA design and implementation aspects (flexibility and reusability) and provides a description of a generative mechanism which is likely to be at work. One question for future research that arises from this model is if a technical (resp. business-oriented) understanding of services necessarily leads to fine-grained (resp. coarse-grained) services and a bottom up (resp. top down) approach. Most likely, more experience would enable the project team to flexibly adapt granularity, create services on different levels of granularity, or apply a top down (resp. a hybrid) approach. Further case studies would help to shed light on these cause-and-effect relationships.

Another intriguing question is whether one of these mindsets yields more success, and if this is the case, by which measure? According to most literature, business orientation is crucial for successful SOA implementations because only this focus ensures that services can support business processes. However, the ADAGE case shows that an almost pure bottom up approach and very fine-grained services stemming from a technical understanding still can result in a successful SOA implementation. Of course, the ADAGE architecture is far from being business process-oriented. Nonetheless, it can be considered a success. Since case studies can be used for generating hypotheses (like in this paper) and testing hypotheses (De Vries, 2005), a multiple case study could be useful to investigate correlations of service understanding and success in SOA projects.

Since relationships and interdependencies in our model fragments are designed based on the evidence retrieved from the ADAGE project, they might be incomplete. Literature e.g. argues that experience is one possible source to improve skills (see, e.g., Adelson and Soloway (1985), Dokko et al. (2009), Guile (2002)). Thus, further empirical evidence might support interdependencies found in literature and make an adjustment of our model necessary.

Our success model shows that multiple concepts more or less directly influence success of an SOA. This success can be viewed from different perspectives, i.e., technical or business-oriented. A model illustrating how these success factors contribute to the overall success of an SOA implementation could be a result of further empirical research.

Currently, the success measures in our model are not well operationalized. Future research should improve the conceptualization of success measures as well as their measurement. It is necessary to describe how to measure these factors and which units to use. Finally, an evaluation of the importance of a single concept (e.g., the direction of approach) and to what degree it influences the success of an SOA would be desirable. Such quantification could be achieved by a factor analysis of context factors. Practitioners would be able to identify the setting of their specific project in advance and subsequently adjust or influence certain conditions (i.e., concepts) in order to improve the outcomes of their project. A framework giving advice on which measures could improve a project's results based on its setting is another objective for future research. A targeted application of methods based on identified project patterns (figure 6) could thus improve the probability of success for SOA projects.

The model fragments cannot be treated as being independent. On the one hand, there are evident relationships that can be traced in figure 2. Obviously, the notion of success which is operationalized by certain measures integrates the CM and the MSFT. On the other hand, there are most likely more links that have not been observed in our case. The concept of skills in the CM is probably related to what is called experience in the MSFT. Moreover, the way of SI/SOA development in the CM might be influenced by the direction of the identification approach, which is currently not part of the contingency model but of the MSFT. Hence, we assume that there are more causal links on several levels of our proposed model so that the latter will have to be adjusted after more elaborate work on this topic is performed.

DISCUSSION, LIMITATIONS AND FURTHER RESEARCH

Our research endeavor presented in this paper can be characterized against the background of the conceptualizations of generalization we presented in section 2.2.

Regarding the types of generalization presented by Lee and Baskerville (2003), we used the two types concerned with generalizing from empirical statements because there are no appropriate theories in this field of research yet. Firstly, by formulating our observations in activity four, we generalized from data to description. Secondly, in activities five and seven, we generalized from description to theory. This second type was applied twice, namely in generating hypotheses and in developing model fragments.

The types of outcomes that are described by Walsham (1995) provided us with guidance to distinguish the results of our research. Concepts and categories on different levels of abstraction are the main elements of observations, hypotheses, and model fragments. These main elements are similar to the *concepts* that Walsham considers to be an outcome of qualitative research. However, he does not draw the distinction between different levels of abstraction. The *generation of theory* is reflected in several steps of our research process. Firstly, we developed hypotheses as an abstraction

from our observations. Secondly, three models describing cause-and-effect relationships are presented as middle range theories.

By following Popay et al. (1998), our intention was to g*eneralize logically to a theoretical understanding*. In doing so, we omitted other approaches like statistical, naturalistic, analytical, and analogical generalization (see 2.3). The resulting limitations of this generalization approach are discussed in section 3.7. The generalization approach following "*generic social processes*" (Stoddart 2004) or socio-technical processes and the idea of *mechanism-based explanations* (causal mechanisms and causal generalization (see Hedström and Ylikoski 2010 and Woodward 2002)) fostered a more procedural perspective resulting in cause-and-effect relationships

In order to structure the research process, we adopted the sequence of activities from Eisenhardt (1989). Furthermore, we utilized her idea of "enfolding literature" to underpin the validity and to reach a higher conceptual level in a field where theories do not exist. This supported the logical generalization.

In addition, we extended this methodological basis stemming from the literature by the utilization of abstraction mechanisms from conceptual modeling. To the best of our knowledge, abstraction mechanisms have not been used in the realm of qualitative research yet. We believe that they provide a stable set of well described (and in some way formalized) ways to abstract from instances to types and, hence, to relate different levels of abstraction applying a clear semantic. Thus, they might reduce biased abstractions. In this respect, it could be argued that these mechanisms reduce creativity and limit abduction in the qualitative data analysis. However, we consider the guidance an advantage rather than a limitation. In all likelihood, these mechanisms have been used implicitly by researchers before, but an explicit description of the abstraction mechanisms intends to add rigor to the abstraction process to better justify the findings and to better support logical generalization and generalization by abstraction.

From our point of view, this backing in methodological work enhances reliability and traceability of our proceeding and of the findings in the case study analyses. Furthermore, it adds transparency to the basis upon which generalizations can be made and justified. On the other hand, it is useful in revealing limitations. It makes clear that usually generalization about populations is not possible. In addition, it reveals that the findings are untested theories and tendencies, "moderatum generalizations" (p.215) as Williams (2000) puts it.

The application of different approaches and conceptualizations enabled us to develop a basis upon which we can identify and justify the possibilities and limitations of generalization. Nevertheless, one can argue that this is rather an eclectic approach to enhance traceability and reliability. Hence, further research in the realm of qualitative methodology should be directed toward developing comprehensive and integrated frameworks, synthesizing different viewpoints of generalization. Sound frameworks may provide valuable guidance for endeavors in qualitative research.

As described previously, there are more abstraction mechanisms in the literature of conceptual modeling. We assume that they might be useful for qualitative research approaches as well, but a more detailed elaboration, e.g., the development of an appropriate framework for the use of abstraction mechanisms in qualitative research requires further intensive methodological work.

CONCLUSION

Since a common understanding of generalization in qualitative information systems research is missing, this paper offers an overview of existing approaches and conceptualizations. Different types and outcomes are described in table 1 which is referenced throughout the paper to classify the

methods used and the results generated. We extended the notion of generalization by introducing abstraction mechanisms of conceptual modeling.

From a methodological perspective, we showed that abstraction mechanisms from the field of conceptual modeling can be successfully applied in conjunction with existing approaches in the realm of qualitative information systems research. In this respect, the paper represents an attempt to bring some clarity to the many different conceptualizations in the methodological discourse on generalizability and to discuss and demonstrate their applicability.

From another point of view, the paper contributes to the empirical research in SOA, especially in SOA development and service identification. Based on an explorative single case study, we developed hypotheses and model fragments that abstract from the subjective understanding of the project participants and observations made by the researchers. By referring to the aforementioned conceptualizations and mechanisms, we tried to make the research process transparent and traceable, so SOA researchers could appraise the reliability of the results.

Further research is needed and desirable regarding both perspectives. The model fragments and hypotheses described are based on case data of a single case study and should be complemented by more cases in order to extend the models. Further research should also aim at verifying and supporting the results applying qualitative and/or quantitative methods. The methodological discourse on generalizability in qualitative research should lead to comprehensive and integrated frameworks giving sound guidance to research projects in this area.

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