Association for Information Systems
AIS Electronic Library (AISeL)

ICIS 2010 Proceedings

International Conference on Information Systems (ICIS)

2010

BROKERING SITUATIONS IN DATA WAREHOUSE DEVELOPMENT PROJECTS: AN EXPLORATORY STUDY

Helena Vranesic
Goethe University, vranesic@wiwi.uni-frankfurt.de

Christoph Rosenkranz
Goethe University, rosenkranz@wiwi.uni-frankfurt.de

BROKERING SITUATIONS IN DATA WAREHOUSE DEVELOPMENT PROJECTS: AN EXPLORATORY STUDY

Research-in-Progress

Helena Vranesic
Goethe University
Frankfurt, Germany
vranesic@wiwi.uni-frankfurt.de

Christoph Rosenkranz
Goethe University
Frankfurt, Germany
rosenkranz@wiwi.uni-frankfurt.de

Abstract

Data Warehouse (DWH) projects bring together different communities of practice to create one body of knowledge and help increase the competitive advantages of companies. In this paper we concentrate on the role of DWH professionals as a spanning community in DWH development projects. We argue that each time DWH professionals engage in a spanning activity towards neighboring communities of practice, representatives from these communities take spanning roles as well. As a result, a brokering situation resides within the social structure created by bridging multiple communities together, building a brokering community. In order to observe the roles of DWH professionals within these brokering situations more closely, we conducted interviews with experienced DWH professionals in two interconnected phases. Based on the results gathered, we argue that the selection of the community's representatives with experience in the boundary communities can improve brokering situations.

Keywords: Data Warehouse, Communities of Practice, Boundary Spanning, Boundary Objects

Introduction

Informally speaking, boundary spanning is the activity of bridging gaps in the communication and knowledge transfer between two groups, e. g., different departments in a company. Studies of boundary spanning often draw on theories of organizational learning to define and elaborate information management activities within an organization and towards its environment (Aldrich and Herker 1977, Tushman 1977, Ancona and Caldwell 1998). According to Aldrich and Herker (1977, p. 218) information from external sources enters into an organization with the help of individuals called *boundary spanners*, whose specific boundary role links organizational structures to environmental elements, either by processing of incoming information from outside the organizational borders or by presenting information to the environment. Meanwhile, boundary spanning has emerged as an important concern in the context of knowledge sharing across *communities of practice* (CoPs) (Carlile 2002). CoPs are characterized as shared histories of learning (Wenger 1998) and emerge through mutual engagement of its participants around a joint enterprise. Most formal organizations do not consist of a single, but rather of overlapping and independent CoPs (Brown and Duguid 1998). CoPs are known to create discontinuities between the ones who participate in the community's work and the ones who do not (Wenger 1998). These discontinuities are also revealed in the development of data warehouses (DWHs).

The development of a DWH, which requires huge capital spending and also consumes a good deal of development time, has a very high possibility of failure (Hwang et al. 2004). Fundamentally, most DHW development projects are large-scale IT projects with a significant and complex software component. Such information system (IS) development projects are inherently complex (Xia and Lee 2005, p. 46). Their complexity stems from the broad scope, the large size, the heterogeneous IT infrastructure, and a multitude of different participants from different CoPs (e. g., DWH experts, operational source system specialists, or managers and decision-makers). However, next to the acquisition and integration of information from a wide range of sources and stakeholders, DWH projects also pose challenges not often found in other IS projects. These projects have to face the challenge of determining organizational competencies and putting the identified competencies to use in order to achieve a competitive advantage on the market (March and Hevner 2007, p. 1034). Consequently, developing a DWH is a complex team activity involving multiple CoPs, each contributing specific knowledge (e. g., IT-specific knowledge or experience-based organizational knowledge) that needs to be integrated in the DWH specification (March and Hevner 2007, p. 1035). DWH development can thus be understood as a knowledge exchange process between different CoPs. Nevertheless, despite a growing amount of research on DWH project management (e. g., Vassiliadis et al. 2001) or on success factors of DWH development projects (e. g., Watson and Haley 1997, Chen et al. 2000, Wixom and Watson 2001, Shin 2003, Hwang and Xu 2008), we still lack a thorough understanding how interaction between these CoPs influences the development process per se.

In this paper we concentrate on the role of the DWH professionals' CoP whose members take on spanning roles by connecting other participating CoPs. We therefore refer to the DWH professionals' CoP as a *spanning community*. Furthermore, opposed to the general assumption that boundary spanners are rooted only in spanning communities (Gopal and Gosain 2009, Drach-Zahavy 2010), we argue that each time DWH professionals engage in a spanning towards neighboring CoPs, whereas representatives from these CoPs take spanning roles as well. As a result, each time participants from different CoPs meet, a *brokering situation* resides between them. The social structure that is created by this bridging of multiple CoPs represents a *brokering community*. We further propose that, in many important aspects, our perception of a brokering community does not differ from a traditional perception of a project team. However, we suggest that successful brokering communities could with time develop into CoPs. The central questions guiding this study are:

1) *How significant is the selection of the community representatives for an improvement of brokering situations in DWH development projects?*
2) *How significant is the resulting brokering community as a whole for improving the DWH development process?*

In order to address these questions and to closely investigate brokering situations, we present the results of expert interviews that we conducted with experienced DWH professionals. The results of this exploratory approach help us understand the phenomenon of brokering situations and explore existing issues that emerge between different CoPs in contemporary DWH development projects.

The remainder of the paper is structured as follows. Next section discusses challenges of a requirements phase reported for conventional IS and projects these issues to the DWH domain. We further discuss boundary spanning.

Section 3 presents selected methodology used throughout this research. Section 4 presents the results from our analysis. Consequently, we summarize our findings and limitations, arguing that the existence of brokers accelerates the process of requirements elicitation. We conclude by giving an outlook on further research.

Related Work & Theoretical Background

Several studies have revealed the importance of determining information requirements in DWH development (Wixom and Watson 2001, Watson et al. 2004). Rizzi et al. (2006) report the absence of effective techniques in DWH development (1) for collecting information needs and quality-of-service requirements and (2) for translating those requirements into conceptual models based on a common vocabulary between IT experts and decision-makers. A recent field study conducted by Hansen and Lyytinen (2010) reports on the key challenges design professionals experience in the elicitation, specification, and management of IS requirements and clusters them in two groups. According to their study, the first group, the so-called *limits of individual cognition*, are key foundation for the socially-based challenges that emerge when multiple stakeholder groups interact in the design process. These limits stem from inability of relevant stakeholders to articulate their needs concisely due to the differing perspectives between users and designers. Another relevant limit of individual cognition is the difficulty of envisioning a future that differs substantially from the present. As DWH systems should address these challenges supporting actual information needs as well as providing the means to meet future, presently unknown, information requirements (Winter and Strauch 2003). The second group contains challenges based on *interpersonal processes* through which requirements are identified, specified, and managed. Among these challenges, the problematic relationship between business and IT as separate communities stands out: *"It has repeatedly been observed that business and IT professionals 'speak different languages' and apply differential yardsticks for desired outcomes"* (Hansen and Lyytinen 2010, p. 4). We use the label "community" because it captures the sense of independent groups of individuals sharing the knowledge about a practice (e. g., IT practice). Incorporating IT, business, and several additional participating communities, it is obvious that DWH development has to address these challenges as well.

A DWH extracts data from the source systems and transforms it so that it is meaningful for decision support. Therefore we distinguish two crucial communities who confront each other in DWH development projects: (1) *operative system professionals* (OSPs) with the knowledge of source systems and (2) *business experts in decision-making fields* (BEDFs). OSPs are in charge of operational source systems; each unique source requires specialized expertise and coordination to access the data (Wixom and Watson 2001, p. 24). BEDFs, on the other hand, develop and implement strategies or make informed decisions. The DWH is used as a data source for support of such "business intelligence" functionalities such as reporting or mining (Watson and Wixom 2007, p. 97). OSPs usually have strong technical knowledge; however, they typically lack business domain knowledge. In contrast, BEDFs have strong business but not deep technical knowledge and usually do not engage directly or in detail with technical components or artifacts. The connection between these two practices is made by introducing a third, spanning practice: *DWH professionals* in charge of DWH development. All three communities are internally and informally bound by what they do on a daily basis and by what they have learned through their mutual engagement in these activities. As a result of this engagement, OSPs, BEDFs and DWH professionals differ from simple "communities of interest" because they imply a shared practice as well as a joint enterprise and a shared communication repertoire. Wenger (1998) defines communities with such characteristics as CoPs. CoPs are usually considered to be voluntary groups that emerge from common work practice (Storck and Hill 2000, p. 65), like the practices of OSPs and BEDFs. However, in supply chain controlling (Holten and Dreiling 2003) or cross-company business intelligence (Watson and Wixom 2007), which are large-scale DWH projects, multitude of different OSP and BEDF communities, as well DWH professionals coming from different companies could be found. We therefore observe each OSP and BEDF community as a separate CoP. As these large-scale projects usually last for a longer period of time, we consider it likely that the different DWH professional CoPs will coalesce into a single CoP over time.

Knowledge is contextual and, when learned, often remains entangled in its original situation and meaning (Nonaka 1994). Consequently, during DWH development, DWH professionals need to learn about the knowledge resources within the other two CoPs, capturing and storing that knowledge to use in current or future projects (Levitt and March 1988). To acquire the necessary knowledge from OPSs and BEDFs, we argue that DWH professionals should create a mutual understanding between all participants in early phases of DWH development, i. e., in requirements elicitation and analysis phase. In support of this argument, recent studies (Ko et al. 2005, Chakraborty et al. 2010) on requirements engineering argue that one decision appears to be highly relevant with respect to overcoming the aforementioned challenges: which members of the different participating communities to assign to a project. User domain experts, for example, who not only have an intricate knowledge of the business processes, but also have previous experience with technical aspects of development, appear to be important (Ko et al. 2005). The same holds for developers who have business knowledge and familiarity with the thinking of business people. This is also in line with Ancona and Caldwell's (1998, p. 27) view of "team composition". Likewise, building on Iivari et al.'s (2004, pp. 318-319) five components of domain knowledge of requirements engineering participants, Chakraborty et al. (2010) found that requirements engineering participants possessed specific individual knowledge components as well as certain shared ones. Applied to the context of knowledge sharing across CoPs involved in DWH development, their findings imply that there should be individuals with experience in bordering CoPs among the DWH professionals who can respond to the diversity of the practices of external CoPs, namely OSPs and BEDFs. All of this leads to the assumption that having a DWH professional (1) who is familiar with both the BEDFs' business domain and (2) the technical and business background of the source data (OSP domain), may provide the DWH professionals CoP with quicker and more understandable insights into the requirements. To sum up, we expect DWH professionals to be a spanning community and to engage in *brokering* (Pawlowski et al. 2000, p. 335), i. e., to manage coordination, knowledge transfer and political maneuvering needed for information sharing across the borders of their CoP.

Boundary connections between CoPs, however, are not only formed by brokering, but also by *boundary objects* (Wenger 1998, 2009). Star and Griesemer (1989) define boundary objects (BOs) as "both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (p. 393). Common examples in the context of DWH development are report printouts, Excel spreadsheets, conceptual specification documents, data models, and so forth. Although BOs can generally be moved across boundaries (Wenger 1998, p. 105), they can only be understood by participants of the community where they were created. Brokering provides the missing coordinating connection between CoPs. This involves introducing those reified objects from one CoP to the others, when such translation is needed, thereby facilitating transactions and the flow of knowledge between CoPs (Pawlowski et al. 2000, p. 335). Hence, DWH professionals actively facilitate a negotiation of meaning between all involved CoPs with help of BOs.

For DWH professional, eliciting BEDF requirements in DWH development projects means, on the one hand, to meet and discuss with BEDFs. In these meetings, for instance, definitions of sample reports can be used as examples for required information. These BOs represent some of the more tactical decision-making requirements (Kimball and Ross 1996, p. 15), but they are purely reifications of them. Only through interaction of DWH professionals with BDEFs who participated in the process of the BOs' reification can a full understanding of the requirements be reached. This suggests that, in these meetings, members of the BEDF CoP have a spanning role as well. On the other hand, in interaction with OSPs, DWH professionals concentrate on the technical design of extraction, transformation, and loading (ETL) processes (Kimball and Caserta 2004). Extraction of operational data implies the knowledge of (1) what operational data needs to be extracted to meet the BEDFs demands, and (2) from which source systems this data needs to be extracted. In this context, we suggest that communication between OSPs and DWH professionals is a profound prerequisite for aligning different perspectives of exchanged BOs in those two CoPs. Only in close cooperation with knowledgeable representatives from OSPs, DWH professionals can extract and interpret operational data so that it matches the requirements of the BEDFs. In order to support negotiation and alignment, BOs need to represent, transform, mobilize, and legitimize heterogeneous design knowledge between all participatints. Bergman et al. (2007) define BOs embodying these features as *design boundary objects* (DBOs).

All of this suggests that interaction of and knowledge transfer between CoPs involved in DWH design is important for DWH development success. We therefore suggest that the spanning role is not delegated only to DWH professionals during different brokering situations, but that knowledge representatives from BEDF and OSP communities take spanning roles as well. As a result, we define a *brokering situation* as a knowledge exchange situation with at least two boundary spanners from different CoPs that have the role of a *broker* and use BOs and DBOs to mediate knowledge exchange. The social structure concentrated around each brokering situation represents a *brokering community,* connecting participants from all communities with the one goal: the knowledge transfer. In many important aspects, our perception of a brokering community does not differ from a traditional perception of a project team, as detailed in the following, project teams always coincide with a brokering community. However, brokering communities might also exist without a team, for example, when representatives from different CoPs meet in order to exchange knowledge. Also, unlike project teams per se, we suggest that successful brokering communities could with time develop into CoPs.

According to Storck and Hill (2000) both project teams and CoPs are characterized partly by the nature of their members' relationships. For project teams, individuals are assigned to a team or they become team members by virtue of their organizational function, whereas in a CoP, relationships are defined by people's interaction on a "playing field of practice" (Storck and Hill 2000, p. 67). We suggest that assigned team members from different CoPs interact with each other during different brokering situations and that a common work practice emerges through this mutual engagement if the DWH development team is successful. This forms the kernel of the aforementioned brokering community. As a second characteristic feature of CoPs, Wenger (1998, p. 77) names the negotiation of a joint enterprise, a source of community coherence. Joint enterprise is the result of a collective process of negotiation that reflects the full complexity of mutual engagement and it is defined by the participants. Storck and Hill (2000) argue that most of the teams in an organization cease to exist after accomplishing their goal, while a CoP, by its nature, will last as long there is an interest in maintaining a group to support building and exchange of knowledge (Wenger and Snyder 2000, p. 142). In contrast, we suggest that some connections between members of the brokering community will become of permanent nature in the course of the DWH development project and outlive the project itself. Finally, members of a CoP share a repertoire of communal resources (routines, sensibilities, artifacts, vocabulary, styles, and so forth) that they developed over time (Wenger 1998, p. 83). In comparison, teams must satisfy well-defined communication patterns and work processes (Storck and Hill 2000, p. 69). We understand the communication patterns within the brokering community to be more of an ad-hoc nature and to be vaguer than those clearly specified and intended by project management.

We argue that brokering communities, which incorporate brokers, can better compensate for limits of individual cognition and challenges based on interpersonal processes, thereby alleviating some of the communication barriers in DWH development projects. As detailed above, it is insufficient to focus on project teams in the traditional sense because only the analysis of the brokering communities allows the evaluation of effects lasting longer than the DWH project itself. Furthermore, we suggest that BOs and DBOs form the nexus of analysis for brokering situations, allowing the following *analysis steps*: (1) discovery of participating CoPs and the knowledge representatives (brokers), (2) learning about the brokers within those CoPs, and (3) bringing different representatives' perspectives together, forming the brokering community in order to link to the current design solution.

Research Methodology

To understand the brokering situations and their role in DWH development projects, we conducted interviews with experienced DWH developers in two interconnected phases in order to gather a selection of projects from different industries. Table 1 gives an overview of the interviewees from phase I and II and lists the industries in which the reported projects took place. The interviewees averaged 8 years of experience in IS and 7 in DWH development. All interviewees have a master's degree in computer science. The number of participants on reported projects was from 4 to 70, with an average of 15. The durations of these projects were from 6 months to 6 years, with an average of 1.5 years. Four of the subjects reported on in-house development projects.

Phase I: Open Interviews with Data Warehouse Developers

During phase I, subjects were asked: (1) to identify and discuss spanning activity elements within early phases of DWH projects; (2) for their impressions of the goals of business experts, of operational system specialists, and of their own goal for the project; (3) to describe the activities of DWH developers. Each of these questions was followed by extemporaneous, probing ones. The interviews lasted about an hour on average and were afterwards transcribed and coded using MAXqda (MAXQDA 1995). The interview protocol was used as the preliminary coding structure. To start, two types of BOs were coded: BOs according to Carlile's (2002) categorization and DBOs as defined by Bergman et al. (2007). Detected BOs were: meetings protocols, examples of the old reports, new report specifications, definitions of calculations and so forth; observed DBOs were primarily project documentation files (e. g., functional and technical documentation). As specific sub-codes began to surface in the coding process, additional interviews were conducted with the same subjects via chat and e-mail in order to clarify open issues. The code structure was iteratively revised with two-person coding using the same set of codes on the transcripts, until it was determined that all relevant themes or issues were reflected (Eisenhardt 1989). Differences were resolved by detailed discussions. The same approach was used for coding brokers.

Phase II: Semi-structured Interviews with Data Warehouse Developers

The findings from phase I were used to form the topic guideline for a series of semi-structured interviews in phase II. These interviews focused in more detail on exploring brokering situations. Two of the interviewees from phase I reported only minimal or no spanning activities within their projects. Both had reported on in-house projects. Therefore we excluded them from phase II. Three interviewees did not respond to our invitation for phase II. Therefore we decided to include 11 new interviewees in order to increase the diversity of projects (cf. Table 1). We asked interviewees to be as inclusive as possible in their descriptions of: (1) the team's DWH skills and the team's familiarity with the customer's business domain; (2) individuals from the BEDF community, including the team's familiarity with the business domain as well as the business background of the data delivered by relevant operational systems; (3) individuals from the OSP community, including the team's familiarity with the IT domain as well as the IT background of the data delivered by relevant operational systems; (4) all exchanged BOs and DBOs.

Table 1. Overview of Interview Subjects from Phase I and Phase II

	Years in IS	*Years in DWH*	*Reported projects*	*Industries*	*Phase I*	*Phase II*
A	6	2.5	2	Banking, Telecom.	X	X
B	8	8	2	Banking, Energetics	X	X
C	8	8	2	Telecom., Pub. Health Insur.	X	
D	12	2	1	Higher education	X	
E	8	8	1	Higher education	X	
F	9	7	3	Banking, Insurance, Trading	X	X
G	10	7	1	Telecom.	X	
H	10	10	2	Banking, Energetics	X	
I	5	5	1	Trading		X
J	15	10	1	Telecom.		X
K	11	8	2	Trading, Metal Industry		X
L	4	3	2	Banking		X
M	6	4	2	Banking		X
N	6	6	1	Banking		X
O	3	3	1	Telecom.		X
P	8	8	3	Energetics		X
R	5	4	1	Telecom.		X
S	12	10	2	Banking, Tobacco Industry		X
T	11	11	2 (same as **S**)	Banking, Tobacco Industry		X

Discussion of Preliminary Findings

Since this paper is only research-in-progress, its main goal is to present and discuss preliminary results. Therefore we only summarize most of our findings and do not give a detailed discussion of how we arrived at our conclusions. As a first result, we discuss the three dimensions of "practice", as a property of the CoP, providing examples from the project ENERCOM01 as reported by interviewee P (see Figure 1). Based on this short excerpt, we explain how successful brokering communities could in time develop into CoPs. The interview refers to two parts of the project. In the part I, members from DWH CoP, joined several members from IT and BEDF (manufacturing, finances and accounting) department in order to develop a basic set of reports, mainly to support reporting in the manufacturing department. Through the mutual engagement of the participants from all three CoPs, the first part ended successfully together with the first set of reports. However, the transactional system changed which triggered the second part of the project. Based on the data from the interview, we discover that "old teams" have already developed shared routines (shared repertoire) by the beginning of part II, skipping the demand-response working protocol. They started communicating on the daily basis more intensively with all parties more closely involved. "They wanted their reports to be finished" (Figure 1). Their new main motivation (joint enterprise) was not the primary one, i. e., development of the DWH, but "the automation of their personal reporting process". The interviewee also added:

This person, for example, needed 10 days to create these reports manually. Now these reports were produced instantly. He saw the benefit immediately… In manufacturing there were 70 reports and they joined us [from manufacturing] and created reports with us side-by-side [representatives from BEDF learned to produce reports].

Based on the data from Figure 1 and the additional cited remarks, we presented the genesis of a CoP from a brokering community. As a second result, we give a more detailed presentation of one brokering situation to demonstrate our data analysis process: from the search for BOs or DBOs, over discovery of participating CoPs and brokers within these CoPs, to the forming of the brokering community. Firstly, we shortly discuss the role of BOs and DBOs in brokering situations.

Mutual enagagement

In a CoP individuals become members of the CoP voluntary (Storck and Hill 2000, p. 65, Wenger and Snyder 2000, p. 142), while in project teams they are assigned to a team (Wenger and Snyder 2000, p. 142).

We suggest that during different brokering situations, assigned team members from different CoPs interact with each other and through this mutual engagement a common work practice emerges if the DWH development team is successful.

Joint enterprise

In a CoP, members identify with the group's expertise and mutual accountability develops with time (Wenger and Snyder 2000, p. 142) while project teams are oriented towards achieving a specific goal and most of teams are dissolved after achieving their goal (Storck and Hill 2000, p. 67, Wenger and Snyder 2000, p. 142).

We suggest that after the end of a DWH development project, as some connections between members of the brokering community are of a permanent nature they outlive the DWH development project itself.

Shared repertoire

In a CoP, members share a repertoire of communal resources that they develop over time (Wenger 1998, p. 83), while project teams have well-defined communication patterns and work processes (Storck and Hill 2000, p. 69).

We propose that communication patterns within the brokering community are more ad-hoc and diffuse than firstly specified and intended by project management

Goal in phase I: Development of DWH for business areas (manufacturing and part of finances & accounting)

There were two teams, one team with knowledge of DWH and BI development methodology [external DWH consultants from a single company] and on the other side a team who was familiar with the business processes and existing operating systems [BDEF and in-house OSP CoP]; and these two teams somehow got combined by "synergy". Knowledge from one team was transferred to the other team and got mixed. [**mutual engagement**. Result: successful DWH development in phase I]

…

Q: And now we are in phase II, where the transactional system got changed. What happened then?

It happened that…the data sources had to be visible/understandable. We figured that the BI team needs to cooperate more with the OSP team. I became the project manager. Formal project manager became my boss [she gets employed by the company] and thereby I joined the IT team.

Now, the cooperation between the whole IT department becomes more aware, two-way. That means, BI team helps IT department to define the data sources with the methodologies they use and with the help of the knowledge they probably brought from other projects…so that they define sources. On the other hand, IT department helps BI team to define data sources, i.e. what, how, where to do with data..There is more synergy between these two teams. Before, users demanded something, and then I would look for data in the sources to respond to this demand. Now it was actual two-way, daily communication **[shared repertoire]**.

We've started rebuilding reports all over again. Some reports had to be created from scratch, involving them much more into to the process.

Q: Who exactly?

Team from finances & accounting. Being on the same boat, IT department also got more involved. We all rawed together. Reports had to be made. In the previous phase, all reports were not yet defined. Therefore, this phase was more intensive and all wanted their reports to be completed **[joint enterprise]**. We usually met all together at the same meeting. There was no big coordination between departments **[shared repertoire]**.

Figure 1. CoP's development - observation through three CoP's dimensions (project ENERCOM01)

Interviewees in both phases I and II mentioned a wide range of BOs within the process of requirements elicitation. Our analysis confirms Carlile's suggestions that BOs with different capacities are to be used when facing syntactical, semantic or pragmatic borders (2004, p. 560). For example, our analysis reveals few cases of misunderstandings or misinterpretations (in eight out of thirty projects) occurring on the DWH-OSP border. One interviewee even added: "*We understand each other very well with the IT department, because we speak 'the same language"*. We suggest that this results from the fact that DWH professionals as well as average members of the OSP community are usually both computer scientists by profession. Therefore we presume the communication border between OSPs and DWHs is positioned on the syntactical level, where, according to Carlile (2004), a *common lexicon* suffices to specify the differences and dependencies of consequences at the boundary. We found examples of such syntactical BOs (e. g., database documentation). However, it is misleading to assume that OSP and DWH professional have an aligned understanding of all relevant concepts and terms right from the start of the DWH project. This became apparent in several reported cases, where business concepts were unsuccessfully mapped to the data fields in source systems. OSP and DWH professionals ascribed different meanings of business concepts to the same terms. Basically, the problem was not a syntactical one, but one of *pragmatically* creating a mutual understanding and of *semantically* describing the terms. In this context, "mismatches" occur due to the misalignment between the faced type of boundary (pragmatical) and BO's capacity (e. g., syntactical BO: database documentation) used for the knowledge process (Carlile 2004, p. 560). OSP and DWH professionals will try to use their "old" semantics to transfer knowledge, but they actually need to transform and align the meanings semantically first.

BOs that have adequate capacity can help in this process. The BOs are those matching the object group classified for the pragmatic boundary (Carlile 2002, p. 444). Although these object can be found on OSP-DWH border, we detected majority of such BOs on the DWH-BEDF border. Figure 2 gives a short insight into the analysis results from one of the reported projects MONINST02. For example, interviewees mentioned the use of prototypes (e. g., old and new examples of reports) for supporting information scanning. In Figure 2 we present an example of such a BO (Figure 2: Table with the calculations) which helped DWH professionals to gather information about the mathematical calculations, later on used in the design of user reports. For the support of coordination activities, we discovered examples of DBOs, such as project documentation (e. g., functional and technical specification). In Figure 2, we present an example of such a DBO (Figure 2: Document of logical design). Both groups of artifacts, when viewed through the lens of boundary spanning, were highly instrumental in enabling the fine-tuning of behavioral control because they enable higher-order knowledge to be shared between BEDFs and DWHs, particularly in cases where significant gaps might have existed in understanding between the DWH professionals' view of the desired system and the one of the BEDFs (Figure 2: Handling the gap).

BO: Table with the calculations	Information scanning They [members of BEDF community] gave us a table [excel file] **with all necessary calculations, defining how the data should be prepared.** Q: You discussed with them the content of that file during the analysis? Yes
BO: prototype of the new report	Handling the gap Q: ..and after the analysis, did you understand the whole content of the file ? Did you make any mistakes during the development, based on how well you understood the content? Did you make any mistakes? …**well, there was a pretty big mistake, as a result of our misunderstanding [gap]** of the data from that table, let say, ..because we understood some things differently. We implemented calculations literally as they were defined in the table. Only when they saw **an example applying a calculation from that table [a report]**, they've complained: "well, we don't want this in that way. We want it the other way around". That was the first problem. Second problem was the fact that during our development, they've changed table definitions 4-5 times.
DBO: documetn of logical design	Support of coordination After the analasys phase, we created the document of logical design, which included all necessary dimensions and measures. When they [members of BEDF community] saw the document, they knew exactly what it meant for them. **If the document didn't contain some dimensions or an attribute, they wouldn't be able to use those in their reports.** Q: Did they complain, if they noticed that something was missing? **Of course they did,..some things ware missing. On the other hand, for some, they said: "you should remove this from the document, it won't be necessary…" or for example "..we calculate this in very specific way, so you won't be able to get to this in such an easy way."**

Figure 2. BOs and DBOs for supporting information scanning and coordination (project MONINST02)

In other words, these objects formed a nexus of analysis for brokering situations and facilitate the transfer of knowledge across boundary. Figure 3 presents an episodic example of such a brokering situation, from an interview about the in-house project NUTCOM02. We followed the aforementioned three step analysis for brokering situations, using clients' old reports as the nexus of our analysis.

The process of requirements specifications in DWH projects involves the integration of DWH professionals' own knowledge of the BEDFs' business domain with the knowledge of members from the BEDF community. The presented episode shows that a DWH professional with previous knowledge of BEDFs' business domain renders the gathering of requirements less difficult and complex (Figure 3: Using boundary objects discover brokers within DWH community). We call such individuals *DWH brokers*. Subsequent probing in phase II also revealed specific members of the BEDF community who have already conducted data analysis and were familiar with the meaning of the source data required for further DWH development. We refer to these individuals as *BEDF brokers*. The presented episode shows that, due to the nature of their job, departments A, B had more BEDF brokers (Figure 3: Difference between departments A, B and C, D, E, F). As a result, departments A, B were able to articulate future system requirements better and thereby help DWH professionals to elicit requirements (Figure 3: Departments A, B). The analysis also reveals that in absence of BEDF brokers (Figure 3: Departments C, D, E, F), DWH brokers who were familiar with the BEDF communities' business were able to compensate for unclear exceptions in customers' requirement definitions (Figure 3: Brokering communities - DWH Professionals and users from departments C, D, E, F). However, the brokering community in the case that brokers existed only on one side needed more iteration cycles of DWH specification validation than the community towards departments A, B (Figure 3: Brokering community - DWH Professionals and users from departments A, B). Therefore, existence of brokers in at least one of the involved CoPs helped in creating common understanding and successful knowledge transfer between participants. All of this suggests that brokering communities which incorporate brokers from DWH as well as boundary communities, OSP and BEDF, resolve the brokering situations in DWH development projects successfully. We further propose that these successful brokering communities, which already share a common repertoire, have potential to develop joint enterprises and become CoPs by the end of the project.

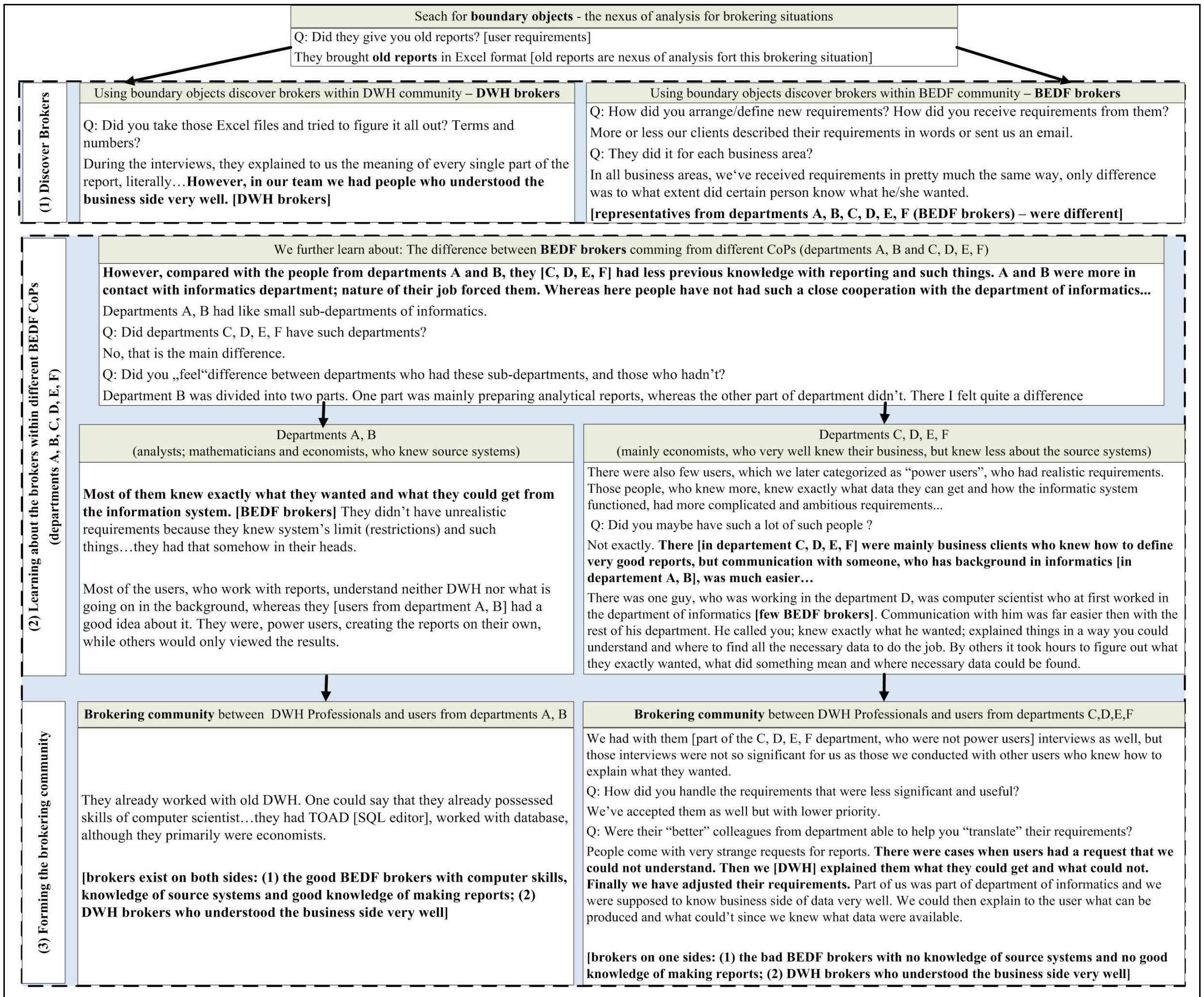

Figure 3. Analysis of the brokering situation, following 3 analysis steps (In-house project NUTCOM02)

Conclusion & Outlook

In this paper, we reported on preliminary results from our study that investigates the role of brokering situations in contemporary DWH development projects. We conducted interviews with experienced DWH developers in two interconnected phases and used the identified BOs and DBOs as the nexus of our analysis. The first analysis of our results indicates that spanning roles within brokering situations are not only delegated to DWH professionals; knowledge representatives from BEDF and OSP communities can take on spanning roles as well. However, due to the fact that the reported members of both DWH and OSP communities in principle had some background in computer science, very little boundary spanning was found on the OSP-DWH border. We further argue that the selection of those community representatives with experience in such boundary communities can improve brokering situations. Our analysis also reveals that, if spanning is required, the brokering community incorporating brokers from all involved sides facilitates better knowledge transfer between boundaries. These successful communities have potential to develop further joint enterprises and become CoPs that outlive the actual project team.

It is obvious that our study has limitations with regard to the data. For example, we conducted only eight exploratory interviews in phase I. However, as this was followed by 14 semi-structured interviews in phase II, we hope that reported DWH projects succeeded to introduce enough diversity for the generalization of our study. Moreover, the study itself, although illustrative, does not in any way test the findings being discovered. In order to alleviate these issues, we plan to conduct more intensive case studies. Once we have established a good theoretical grounding in the data, we can formulate more rigorous propositions and test these, for example, using experiments or surveys.

References

Aldrich, H. and Herker, D. (1977). Boundary spanning roles and organization structure. Academy of Management Review, 2 (2), pp. 217-230.

Ancona, D. G. and Caldwell, D. F. (1998). Rethinking team composition from the outside in. Research on managing groups' and teams' composition, 1 21-37.

Bergman, M., Lyytinen, K. and Mark, G. (2007). Boundary Objects in Design: An Ecological View of Design Artifacts. Journal of the Association for Information Systems, 8 (11), pp. 546-568.

Brown, J. S. and Duguid, P. (1998). Organizing knowledge. California Management Review, 40 (3), pp. 90-111.

Carlile, P. R. (2002). A pragmatic view of knowledge and boundaries: boundary objects in new product development. Organization Science, 13 (4), pp. 442-455.

Carlile, P. R. (2004). Transferring, translating, and transforming: An integrative framework for managing knowledge across boundaries. Organization Science, 15 (5), pp. 555-568.

Chakraborty, S., Sarker, S. and Sarker, S. (2010). An Exploration into the Process of Requirements Elicitation: A Grounded Approach. Journal of the Association for Information Systems, 11 (4), pp. 212-249.

Chen, L., Soliman, K. S., Mao, E. and Frolick, M. N. (2000). Measuring user satisfaction with data warehouses: An exploratory study. Information & Management, 37 (3), pp. 103-110.

Drach-Zahavy, A. (2010). Interorganizational teams as boundary spanners: The role of team diversity, boundedness, and extrateam links. European Journal of Work and Organizational Psychology, 19 (1), pp.

Eisenhardt, K. M. (1989). Building Theories from Case Study Research. Academy of Management Review, 14 (4), pp. 532-550.

Gopal, A. and Gosain, S. (2009). The Role of Organizational Controls and Boundary Spanning in Software Development Outsourcing: Implications for Project Performance. Information Systems Research, 1-23.

Hansen, S. and Lyytinen, K. (2010). Challenges in Contemporary Requirements Practice. In Proceedings of the [43th] Annual Hawaii International Conference on System Sciences January 5-8, pp. 1-11.

Holten, R. and Dreiling, A. (2003). Provision of Customer Knowledge to Supply Chains. In New Paradigms in Organizations, Markets and Society. Proceedings of the 11th European Conference on Information Systems (ECIS 2003) (Eds, Ciborra, C., Mercurio, R., De Marco, M., Martinez, M. and Carignani, A.) Neapel, Italien.

Hwang, H.-G., Ku, C.-Y., Yen, D. C. and Cheng, C.-C. (2004). Critical factors influencing the adoption of data warehouse technology: a study of the banking industry in Taiwan. Decision Support Systems, 37 (1), pp. 1-21.

Hwang, M. I. and Xu, H. (2008). A Structural Model Of Data Warehousing Success. Journal of Computer Information Systems, 49 (1), pp. 48 - 56.

Iivari, J., Hirschheim, R. and Klein, H. K. (2004). Towards a distinctive body of knowledge for Information Systems experts: coding ISD process knowledge in two IS journals. Information Systems Journal, 14 (4), pp. 313-342.

Kimball, R. and Caserta, J. (2004). The Data Warehouse ETL Toolkit, Practical Techniques for Extracting, Cleaning, Conforming, and Delivering Data. Wiley & Sons.

Kimball, R. and Ross, M. (1996). The Data Warehouse Toolkit. Practical Techniques for Building Dimensional Data Warehouses. John Wiley & Sons, New York, NY, USA et al.

Ko, D.-G., Kirsch, L. J. and King, W. R. (2005). Antecedents of Knowledge Transfer from Consultants to Clients in Enterprise System Implementations. MIS Quarterly, 29 (1), pp. 59-85.

Levitt, B. and March, J. G. (1988). Organizational learning. Annual Review of Sociology, 14 (1), pp. 319-340.

March, S. T. and Hevner, A. R. (2007). Integrated decision support systems: A data warehousing perspective. Decision Support Systems, 43 (3), pp. 1031-1043.

MAXQDA (1995). MAXQDA.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. Organization Science, 5 (1), pp. 14-37.

Pawlowski, S. D., Robey, D. and Raven, A. (2000). Supporting shared information systems: boundary objects, communities, and brokering, Association for Information Systems Atlanta, GA, USA, pp. 329-338.

Rizzi, S., Abell, A., Lechtenbörger, J. and Trujillo, J. (2006). Research in data warehouse modeling and design: dead or alive?, Proceedings of the 9th ACM international workshop on Data warehousing and OLAPACM, Arlington, Virginia, USA.

Shin, B. (2003). An exploratory investigation of system success factors in data warehousing. Journal of the Association for Information Systems, 4 (1), pp. 141-170.

Star, S. L. and Griesemer, J. (1989). Institutional Ecology,"Translation," and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907–1939'. Social Studies of Science*,* 19 (3), pp. 387–420.

Storck, J. and Hill, P. A. (2000). Knowledge diffusion through "strategic communities". Sloan Management Review*,* 41 (2), pp. 63–74.

Tushman, M. L. (1977). Special Boundary Roles in the Innovation Process. Administrative Science Quarterly*,* 22 (4), pp. 587-605.

Vassiliadis, P., Quix, C., Vassiliou, Y. and Jarke, M. (2001). Data warehouse process management, 12th International Conference on Advanced Information Systems Engineering (CAiSE 00). Vol. 26, pp. 205-236.

Watson, H. J., Fuller, C. and Ariyachandra, T. (2004). Data warehouse governance: best practices at Blue Cross and Blue Shield of North Carolina. Decision Support Systems*,* 38 (3), pp. 435-450.

Watson, H. J. and Haley, B. J. (1997). Data warehousing: a framework and survey of current practices. Journal of Data Warehousing*,* 2 (1), pp. 10-17.

Watson, H. J. and Wixom, B. H. (2007). The Current State of Business Intelligence. Computer*,* 40 (9), pp. 96-99.

Wenger, E. (1998). Communities of Practice: Learning, Meaning, and Identity. Cambridge University Press.

Wenger, E. C. and Snyder, W. M. (2000). Communities of practice: The organizational frontier. Harvard business review*,* 78 (1), pp. 139-146.

Winter, R. and Strauch, B. (2003). A Method for Demand-Driven Information Requirements Analysis in Data Warehousing Projects. In Proceedings of the 36th Hawaii International Conference on System Sciences.

Wixom, B. H. and Watson, H. J. (2001). An Empirical Investigation of the Factors Affecting Data Warehousing Success. MIS Quarterly*,* 25 (1), pp. 17-41.

Xia, W. and Lee, G. (2005). Complexity of Information Systems Development Projects: Conceptualization and Measurement Development. Journal of Management Information Systems*,* 22 (1), pp. 45-83.