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Twenty Years of Boundary Spanning and Brokering in ISD: Implications for the Data Warehouse Domain

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ABSTRACT

Data warehouse (DWH) systems are developed to support the process of decision making. Due to the number of involved communities and the complexity of their collaboration, DWH projects are costly. Nevertheless, despite a growing amount of research on DWH project management, success factors of DWH development projects and so forth, we still lack a thorough understanding of how processes on the borders between participating communities, namely boundary spanning and brokering, influence the DWH development process per se. To our knowledge very few studies and with no extensive research have examined this topic. We therefore conducted literature review of a more general research domain, namely information systems development (ISD). As a result, we found helpful implications for the development of DWHs.

Keywords

Information Systems, Data Warehouse, Boundary spanning, Brokering, Boundary objects

INTRODUCTION

DWHs technically support the management perspective on business processes, including the tools and applications that end-users apply to access and analyze the data (Vassiliadis et al. 2001). The development of a DWH requires huge capital spending, consumes a good deal of time, and has a very high possibility of failure (Hwang et al. 2004). Because of a multitude of different participants from different communities (e. g., DWH experts, operational source system specialists, business experts or managers), developing a DWH is a complex team activity where each participating community contributes specific knowledge that needs to be merged (March and Hevner 2007). DWH development can thus be understood as a process of exchanging knowledge between different interest communities.

Knowledge management theories (Nonaka 1994; Nonaka and Takeuchi 1995) have been so far applied to explain why it is difficult to move knowledge back and forth between different participants of the project in terms of tacit and explicit knowledge dimensions in IS development (ISD) (Kjærgaard et al. 2010). Additionally, studies of boundary spanning describe activities that occur at organizational boundaries between different project's participants or internal boundaries that separate organizational subunits. (Pawlowski and Robey 2004). The general topic of boundary spanning has a rich conceptual and empirical history within the organizational learning and social psychology domain. This domain includes the work of Ancona and Caldwell (1992; 1998), Aldrich and Herker (1977), Tushman (1977), and others, who explore the nature of organizational boundary spanning roles, facilitators and constraints on role behavior, and anticipated outcomes associated with such roles for both individuals and their organizations. Yet the literature on intra-organizational boundary spanning lacks the power to explain the knowledge exchange between participants from different communities, working together on ISD projects (Fleming and Waguespack 2007; Pawlowski and Robey 2004). Theories of situated learning in communities of practice (Brown and Duguid 1991; Wenger 1998), additionally provide key concepts useful for this investigation, namely brokers and boundary objects. Brokers are defined as individuals who participate in the work of multiple communities of practice and facilitate the transfer of knowledge across the boundaries using boundary objects (Brown and Duguid 1991). Boundary objects are any "artifacts, documents, terms, concepts, and other forms of reification around which communities of practice can organize their interconnections" (Wenger 1998, p.107). In different social contexts (i. e., communities of practice), these objects can have different meanings; however, their structure is common enough across contexts to make them recognizable by means of translation (Star and Griesemer 1989). Therefore, shared IS such as DWHs, can be seen as a kind of boundary object as well (Massa and Testa 2004; Pawlowski et al. 2000).

To sum up, research on boundary spanning and brokering has emerged as a major concern in the context of knowledge sharing. Nevertheless, despite a growing amount of research on DWH project management (e. g., Vassiliadis et al. 2001) or success factors of DWH development projects (Hwang and Xu 2008; Wixom and Watson 2001), we still lack a thorough understanding of how boundary spanning and brokering influence the DWH development process per se. The original objective of this paper was to conduct a literature review assessing the current state of the research in the field of boundary spanning and brokering in DWH development. However, our first results revealed very few research contributions (Massa

and Testa 2004; Pawlowski et al. 2000) for the DWH development domain in the leading IS journals and conferences over the past 20 years. We have therefore broadened the scope of our investigation to ISD in general.

The paper is structured as follows. Section 2 gives an overview of the intra-organizational boundary spanning literature and theories of situated learning in communities of practice. We further discuss our literature review approach in Section 3. Consequently, Section 4 presents the results of our analysis. Finally, we give a short overview of the suggestions for future research and summarize our findings in a set of implications for boundary spanning studies in the DWH field.

THEORETICAL BACKGROUND

The borders of an organization separate the organization from its environment by protecting it from external influences and by regulating the material and information flow into and out of the organization (Leifer and Delbecq 1978). As boundaries are a defining characteristic of an organizations' separation from its environment, activities on the boundary enable the borders to open for environmental influences (Adams 1980; Aldrich and Herker 1977; Ancona and Caldwell 1990; Drach-Zahavy 2010; Katz and Kahn 1978; Leifer and Delbecq 1978; Yan and Louis 1999). In contrast to the boundary spanning activities at the organizational level, group boundary spanning studies (Ancona and Caldwell 1992; Yan and Louis 1999) provide insights that are relevant to the level of work units within an organization. Yan and Louis (1999) distinguish between three activity classes on the work unit level: (1) boundary buffering, (2) bringing up boundaries, and (3) boundary spanning activities. Through boundary spanning activities, members of a work unit acquire all the information, resources, and support from the environment necessary to carry out the task at hand. According to Aldrich and Herker (1977), some individuals act as boundary spanners when they engage in boundary activities. They manage the coordination and knowledge transfer, as well as the political maneuvering needed for the information sharing across the borders of an organization. Ancona and Caldwell (1998) categorized these boundary management activities into four types: scouting, ambassadorial, coordinating and spanning activities. However, boundary spanning, as a key activity (Yan and Louis 1999), can be accomplished by work unit members not only within their organizations, but also by social networking, i. e., through activities undertaken to build and maintain links among people for various purposes, e. g. ISD. Through boundary spanning efforts, ISD teams bridge otherwise diverse and disconnected work units and act as critical conduits for information transfer, knowledge creation, and innovation (e.g. Argote et al. 2003; Hargadon 1998).

A second domain of related research lies within the organizational literature, which has studied boundary spanning between communities of practice within/outside organizations, so-called theories of situated learning in communities of practice (Brown and Duguid 1991; Wenger 1998). According to Wenger (1998), these 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. Thus, communities participating on IS projects differ from simple "communities of interest" because they imply a shared practice as well as a joint enterprise and a shared communication repertoire. In line with Wenger's (1998) study, boundary spanning between two different communities of practice should hence include individuals familiar with both practices. He refers to these individuals as brokers. However, if negotiation of meaning on the border lacks real, physical arguments, participants will find it hard to coordinate their argumentation lines and solve the differences (Wenger 1998). These boundary objects represent a nexus of perspectives between communities and were originally defined by Star and Griesemer (1989) as being "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). Wenger (1998, p. 61-62), however, warns that these objects are only reifications of the community's internal history of learning, and if they are pulled out of the context and sent across the border, they are likely to be misinterpreted on the receiver's side. To overcome this situation, good brokers help to introduce the reified objects from their community of practice to the others when such translation is needed (Pawlowski et al. 2000). Therefore two forms of boundary connections exist—boundary objects and brokering (Brown and Duguid 2001; Wenger 1998)—and they form a duality (Wenger 1998).

To summarize, incorporating IT, business, and several additional participating communities of practice, DWH development has to address boundary spanning issues as well. To our knowledge very few studies (Massa and Testa 2004; Pawlowski et al. 2000) and with no extensive research have examined the potential impact of boundary spanning and brokering in DWH development. Hence, we have conducted a literature review of these topics in a more general research field, namely in ISD.

LITERATURE REVIEW

In order to select specific articles to be reviewed, we first conducted electronic searches for early work by representative authors in the fields of intra-organizational boundary spanning theory (e. g. Ancona and Caldwell, Tushman, Adams) as well as theories of situated learning in communities of practice (e. g. Wenger, Brown and Duguid). Next, using their research as a guide, we searched for the three keywords: boundary spanning, boundary object, and brokering using "full text, exact phrase" search in online databases (sources: Table 1) to identify subsequent contributions in the leading IS journals and conferences

over the past 20 years. We searched through the AIS-8 Basket of Journals, extending the list with journals from the VHB-Ranking2 (2008) list limited to IS field. It is important to notice that the conducted literature review focuses exclusively on the stream of boundary spanning and theories of situated learning literature in ISD (not IS adaptation, use, innovation, or maintenance). We listed all papers in Table 2, Table 3 (see Appendix).

Journal	Source	Boundary Spanning	Boundary Object	Brokering	ISD
ISJ	onlinelibrary.wiley.com	17	0	8	2
ISR	isr.journal.informs.org	32	45	9	3
EJIS	www.palgrave-journals.com	21	22	22	2
JMIS	web.ebscohost.com	16	1	8	0
JAIS	aisel.aisnet.org	18	31	2	4
MISQ	web.ebscohost.com	42	11	13	5
JSIS	www.scirus.com	11	2	3	1
JIT	www.palgrave-journals.com/jit	16	4	40	2
MS	mansci.journal.informs.org	29	4	13	1
OS	Orgsci.journal.informs.org	69	11	24	0
AMJ	web.ebscohost.com	96	1	30	0
AMR	web.ebscohost.com	44	1	25	0
DSS	www.sciencedirect.com	5	4	35	0
I&M	www.sciencedirect.com	21	2	2	3
IJIM	www.sciencedirect.com	16	8	8	2
I&O	www.sciencedirect.com	9	7	15	1
DKE	www.sciencedirect.com	1	2	19	0
WI	www.wirtschaftsinformatik.de	0	0	0	0
IS	www.sciencedirect.com	1	0	5	0
SJIS	aisel.aisnet.org	4	19	1	1
Conf.	**Source**	**Boundary Spanning**	**Boundary Object**	**Brokering**	**ISD**
ECIS	2000-2007:aisel.aisnet.org	20	29	13	4
	1993-1999/2006/2008/2009/(manual search; no key word search):is2.lse.ac.uk/asp/aspecis: Total 11				
ICIS	1994-2010:aisel.aisnet.org 1989/1991:www.informatik.uni-trier.de/~ley/db/conf/icis/index.html Years missing:1980-1988/1990/1992/1993	53	80	31	10
AMCIS	1997-2010: aisel.aisnet.org Years missing:1995	89	101	47	6
	1996 manual search:amcis1996.aisnet.org: Total 5				
MKWI	2002-2008 (manual search):www.informatik.uni trier.de/~ley/db/conf/mkwi/index.html Years missing:1994-2000/2010				0
WI	2009:www.pubzone.org; 2005:141.13.6.53:8080/wi2005/de/home Years missing:1993-2003/2007/2009				0

Table 1. Results of the literature search (January 2011): journals and conference papers

DISCUSSION AND RESULTS

While our literature review revealed a great deal of empirical and theoretical work in the area of boundary spanning and brokering over the past two decades, only 47 papers (Table 1) report on the ISD in this field. Our results show that boundary spanning is well recognized in both in-house ISD projects (e. g. Gasson 2006; Guinan et al. 1998; Pawlowski and Robey 2004), as well as in management of outsourcing and offshoring (e. g. Gopal and Gosain 2009; Levina 2005; Levina and Vaast 2005; Vlaar et al. 2008). As DWH development can be carried out by a company's in-house team or by involvement of external consultants, both literature backgrounds (in-house and outsourcing/offshoring) can help us to define guidelines for boundary spanning research in the DWH field.

Boundary spanning/brokering

Developing an IS requires broad knowledge of the intended domain, exact knowledge of data structures and processing logic and disciplined knowledge of how best to develop software (Iivari et al. 2004). This is typically carried out via teams of two or more software developers who build a certain product to be delivered within a certain time frame (Sawyer et al. 2010). Based on the work of Ancona and Caldewell (1990), Sawyer et al.'s (2010) clustered analysis of boundary ISD teams reports that all such teams exhibit some levels of boundary spanning activities during requirements determination and development. Pawlowski and Robey (2004) also argue that the unique role of IS in organizations gives exceptional boundary spanning opportunities to people who develop IS and provide technical support to a variety of users. Adapting the term "knowledge brokers" from Brown and Duguid (1998), Pawlowski and Robey focus on the role of IT professionals as intermediaries and not only simple spanners of the boundaries. They argue that IT professionals as brokers typically operate as third parties, rather than as members of source or recipient communities of practice, transferring knowledge between, e. g., IT department and users or among users in different business units. These intermediaries can even evolve into a new breed of entities (e. g. offshore intermediary companies, Mahnke et al. 2008) that broker between the local client and vendors in offshore locations.

In DWH projects, IT professionals developing DWHs (DWH professionals) need to span the boundaries of their community in order to receive necessary information from other participating communities: business experts in decision-making fields (BEDF), who define business requirements, and operative system professionals (OSP) in charge of data required for fulfilling those requirements. Faraj and Sproull (2000) argue that coordination of diverse expertise in ISD projects is a more important predictor of project effectiveness than traditional factors, such as administrative coordination, individual expertise or development methodologies. Therefore we argue that:

(1) DWH professionals need to have a coordinative role as brokers in DWH projects in order to extract and interpret operational data from OSP spanners, so that it matches the requirements of the boundary spanners from the BEDF community.

March and Hevner (2007) warn that during development of management information systems (MIS), effective integration of user's requirements can only be reached by experts having intimate acquaintance with knowledge domains pertaining to the user's business internally (March and Hevner 2007). Therefore, a pre-sequence that prefigures an integration process should be the DWH professionals' affiliation with BEDFs and OSPs. For that, brokers need to become members of neighboring communities of practice (Pawlowski et al. 2000; Volkoff et al. 2002), e. g. by actively participating in them (Pawlowski and Robey 2004). Slaughter (2009) argues that IT workers who gain experience by applying IT solutions in a business domain learn the business and then become the means through which IT and business domains can be connected.

In support to this argument, recent studies (Chakraborty et al. 2010; Ko et al. 2005) argue that one decision appears to be highly relevant with respect to overcoming the aforementioned challenges in ISD: which members of the different communities to assign to a project. IT professionals, for example, who have business knowledge and familiarity with the thinking of business people, appear to be important (Chakraborty et al. 2010). The same holds for user domain experts, who not only have an intricate knowledge of the business processes, but also have previous experience with technical aspects of development (Chakraborty et al. 2010). This is also in line with Ancona and Caldwell's (1998) view of project team composition. Likewise, in IS offshore outsourcing, offshore engineers who have had an onshore placement are more able to turn knowledge of the client received at an offshore location into action (Williams 2010). Applied to the context of knowledge sharing across communities involved in DWH development, their findings imply that:

(2) In DWH development projects, there should be individuals with experience in bordering communities among the DWH developers, OSPs and BEDFs, who can respond to the diversity of the practices of external communities.

Boundary objects

In the context of ISD projects, the artifacts exchanged between communities of practice can potentially become boundary objects if they should belong to (at least) two different practices (Brown and Duguid 2001). These artifacts then form a nexus

of different perspectives, which need to be coordinated. Boundary objects include physical product prototypes (Carlile 2002), development/design artifacts (Bertelsen 2000; Guinan et al. 1998), standardized reporting forms (Star and Griesemer 1989) and even the definitions of group memberships (Gasson 2006), through which the interests of achieving ownership, or the alignment of others' interests with your own, may be achieved. Several studies (e. g. Massa and Testa 2004; Pawlowski and Robey 2004) focus on the potential role of IS as boundary objects in supporting knowledge formation and communication. The suggested results state that these IS should support the forum-like discussion between project participants for articulation of task narratives, accompanied by the exchange of representation (e. g. project documentation) (Bertelsen 2000).

Thus, both theoretical arguments (Carlile 2002, 2004) and past empirical evidence (Vlaar et al. 2008) suggest that in addition to developing artifacts for the integration of knowledge across the borders, it is important to establish a shared language between artifact-sharing communities for the consistent and meaningful interpretation of artifacts across the development communities. When used in a process of knowledge transfer, a boundary object must create "a shared syntax or language for individuals to represent their knowledge" (Carlile 2002). Carlile (2004) scaled the relative complexity of the circumstances at the boundary using Shannon and Weaver's (1949) three levels of communication complexity: syntactic, semantic, and pragmatic. He argues that, depending on the type of complexity the boundary faces, BOs with different capacities are required. In case of mismatch between the boundary faced and the BO used, effectively sharing and assessing each other's domain-specific knowledge is likely to be handicapped. Extreme examples are found in the offshoring literature (Leonardi and Bailey 2008; Vlaar et al. 2008), where objects produced at the home sites need to be interpreted on the vendor sites. Without the common means of representing and applying one's knowledge in an across-domain setting, some participants might withdraw from or even hamper the knowledge integration process (Carlile and Rebentisch 2003).

Therefore, it is misleading to assume that OSP and DWH professionals, or BEDF and DWH professionals, have an aligned common understanding of all relevant concepts and terms right from the start of the project (a prerequisite for using syntactical BOs). Based on the previous discussion, we summarize:

(3) In DWH development projects, DWH professionals and boundary spanners from OSP and BEDF communities should use boundary objects with sufficient capacity.

CONCLUSION & OUTLOOK

Due to the fact that very few studies have examined the potential impacts of boundary spanning and brokering in DWH development, we conducted a literature review on these topics in the ISD field. The knowledge-transfer processes in ISD are mediated by human (boundary spanners and brokers) and non-human (boundary objects) intermediaries. We identified three important implications for boundary spanning and brokering research in DWH development: (1) DWH developers adopt a brokering role, while OSP and BEDF members adopt boundary spanning roles; (2) individuals with experience in bordering communities should be among the DWH developers, OSPs and BEDF; (3) participants of the DWH project should use boundary objects with sufficient capacity.

Our literature research also suggests several paths for future research: While a large body of literature recommends that project managers should strategize about boundary spanners and objects "in practice" (Levina 2005; Levina and Vaast 2005) and their institutionalization in ongoing projects, Gopal and Gosain (2009) warn that the appropriate *choice of objects and spanners* in those projects is a question which was not often considered in previous literature and clearly reflects an avenue for further research. Next, although the types and the use of boundary objects have been examined in multiple settings, Levina (2005) suggests that further insights could be gained if the research focus shifts from an object to the practices surrounding the use of an object. In addition, Kimble et al. (2010) propose that researchers should concentrate on examining the interplay (e. g. political interplay) between boundary objects and brokers, rather observing them separately. However, Gasson (2006) warns that IS design does not take place in vacuum and argues that only when a border is politically unobstructed, participant of IS development projects can tackle the problem of knowledge transfer.

As the research on DWH development moves forward, it could potentially benefit from contributions by a wider range of theoretical perspectives. Indeed, we argue that research in the boundary spanning and brokering in DWH projects can help to explain how co-work of project's participants from different communities influences DWH development process per se. We further argue that the proposed set of implications can help researchers identify the structures of complex knowledge transfer problems that typically underlie DWH development.

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APPENDIX

Publication	Year	Author
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JAIS,11(4),212-249	2010	Chakraborty S.;Sarker S.;Sarker S.
MISQ,28(4),645-672	2004	Pawlowski S.D.;Robey D.
MISQ,29(2),335-363	2005	Levina N.;Vaast E.
MISQ,32(2),205-225	2008	King W.R.Torkzadeh G.
MISQ,32(2),411-436	2008	Leonardi P.M.;Bailey D.E.;
MISQ,32(2),227-255	2008	Vlaar P. W.L.;van Fenema P.C.;Tiwari V.
JSIS,13(4),279–304	2004	Volkoff O.;Elmes M. B.;Strong D.M.
JIT,23(1),18-30	2008	Mahnke V.;Wareham J.;Bjorn-Andersen N.
JIT,12 October 2010	2010	Valorinta M.
MS,46(12),1554-1568	2000	Faraj S.;Sproull L.
I&M,35(2),63-75	1997	Volkoff O.;Chan Y. E.;Newson E.F.P.;
I&M,42(5),709–718	2005	Massa S.;Testa S.
I&M,44(2),216–230	2007	Mirani R.
IJIM,17(5),359-375,	1997	Court A.W.;Culley S.J.;Mcmahon C.A.
IJIM,30,437–444	2010	Kimble C.;Grenier C.;Goglio-Primard K.
I&O,20(1),44–63	2010	Hansen S.;Rennecker J.
SJIS,12(1),15-27	2000	Bertelsen O.W.

Table 2. Journal papers

Publication	Year	Author
ICIS,329-338	2000	Pawlowski S.;Raven A.
ICIS,267-277	2002	Levina N.
ICIS,527-542	2006	Levina N.
ICIS,Paper 148	2007	Gasson S.
ICIS,Paper 75	2008	Martin S.F.;Wagner H.T.;Biemborn D.
ICIS,Paper 98	2008	Vieru D.;Rivard S.
ICIS,Paper 131	2009	Slaughter K.T.
ICIS,Paper 222	2010	Du W.;Pan S.L.
ICIS,Paper 262	2010	Rai S.;Chakraborty S.;Sarker S.
ICIS,Paper 76	2010	Vranesic H.;Rosenkranz C.
ECIS,1214-1226	2001	Huang J.C.
ECIS,505-516	2008	Rönkkö M.;Mäkelä M.M.
ECIS,380-391	2009	Vranesic H.;Rosenkranz C
ECIS,Paper 155	2010	Vranesic H.;Rosenkranz C.;Räkers M.
AMCIS,Paper 208	2001	Huang J;Newell S.;Galliers R.;Pan S.
AMCIS,958-862	2002	Volkoff O.;Strong D.;Elmes M.
AMCIS,1402-1410	2005	Gasson S.
AMCIS,Paper 197	2008	Krishnan P.;Ranganathan C.
AMCIS,Paper 4	2009	Vilvovsky S.
AMCIS,Paper 178	2010	Vranesic H.

Table 3. Conference papers