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Efficient communication in financial data warehousing projects - Insights from a multiple case study

Marc Rakers
zeb/information.technology, marc@raekers.com

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

EFFICIENT COMMUNICATION IN FINANCIAL DATA WAREHOUSING PROJECTS – INSIGHTS FROM A MULTIPLE CASE STUDY

Räkers, Marc, zeb/information.technology, Schlossstr. 22, 48455 Bad Bentheim, Germany, marc@raekers.com

Rosenkranz, Christoph, Goethe-University, Grüneburgplatz 1, 60326 Frankfurt am Main, Germany, rosenkranz@wiwi.uni-frankfurt.de

Abstract

Data warehouses play important roles in the IT landscape of the financial industry. Banks have to deal with complex communication issues in financial data warehouse projects. Especially the creation of extraction, transformation and loading (ETL) processes depends on the project team's communication ability and given communication barriers. We briefly present a theoretical efficiency model based on philosophy of language and the conceptualization of information systems development projects as language communities. We test the model against three case studies to derive evidence for and confirm three propositions leading to suggestions for project management of financial data warehouse projects.

Keywords: Financial Data Warehousing, Case Study, Project Management, Communication Efficiency.

1 INTRODUCTION

In order to cope with proliferating complexity (Courtney, Merali, Paradice and Wynn 2008), information systems (IS) are often developed in the form of structured approaches (Hirschheim, Klein and Lyytinen 1995, p. 33). IT projects are a structured set of activities concerned with delivering a defined IT capability to an organization based on agreed schedule and budget (Ribbers and Schoo 2002, p. 45). Complex IS development projects are large-scale IT projects with a significant and complex software component (Xia and Lee 2005). IS development projects are inherently complex because they must deal with both the technological issues and the organizational factors that, by and large, are outside of the project team's control (Xia et al. 2005, p. 46). Consequently, the complexity of IS development manifests itself in the high failure rate of IT projects (SGI 2001, BCS 2004). This is especially true for large financial data warehouse (FDWH) projects (Behrmann and Räkers 2008, pp. 7-9):

(1) FDWH projects have to deal with several business domains and fields of knowledge. To build up a centralized and integrated system a common understanding between all involved departments and subsidiaries has to be reached.
(2) FDWH projects are characterized by high semantic complexity. Due to the different fields of knowledge a high number of context-dependent homonyms (e. g., limit, facility, book value, and market price) and synonyms (e. g., debt security, bond, and obligation) can be observed.
(3) Specification-based approaches are not sufficient in FDWH projects. Beside the specification, additional methods are required, for instance, face-to-face communication.
(4) FDWH projects require knowledge transfer methods and strong interaction. For a successful implementation a common understanding between all involved project members has to be ensured.

Therefore, the imperative of this paper is to develop and test an understanding of how communication influences decisions of (FDWH) project managers. The following research questions are of special interest to us: *(1) How do managers deal with the efficiency and effectiveness of a (FDWH) project? (2) How do identified communication barriers influence management decisions?*

The structure of the paper is as follows. In the second section, we discuss related work and the theoretical basis for the later sections. Then, in section 3, we introduce three case studies we extended to find evidence for our propositions. Afterwards, we discuss and generalize our findings in section 4. Finally, section 5 summarizes this paper and draws conclusions for further research.

2 RELATED WORK AND THEORY

2.1 Communication in IT Projects

It has been known for complex IT projects that coordination between the various stakeholders involved becomes a necessity (e. g., Gallivan and Keil 2003, Ko, Kirsch and King 2005, Joshi, Sarker and Sarker 2007). Communication is considered to be a prerequisite for organizational coordination (e. g., Malone and Crowston 1994, Nahapiet and Ghoshal 1998, Pondy 2005, Quinn and Dutton 2005), and successful communication between involved stakeholders is deemed to be one of the main drivers for project success (e. g., Ribbers et al. 2002, Gallivan et al. 2003, Vlaar, Fenema and Tiwari 2008). Moreover, as organizations grow, they differentiate and specialize – a single company has several departments, a project has several specialized sub-projects. Each of the specialized units generate its own values, terms and coding schemes for information processing, which leads to a mismatch and a communication boundary hindering the information flow (Tushman 1977). From an information processing view, organizations information flows to function, and strive to create efficient information flows to be effective (Tushman and Nadler 1978, Jin and Levitt 1996). This perspective implies that project managers should first consider the tasks, composition and structure of subunits, and then

consider appropriate mechanisms for linking those units together, using a range of communication tools (e. g., electronic mail, fax, phone, management IS, etc.) (Levitt, Thomson, Christiansen, Kuntz, Jin and Nass 1999). Therefore, an important task of project management is to design the communication within the project organization in an effective way (Boland and Tenkasi 1995). Consequently, the structured sharing and communication of relevant information is crucial for the overall success of any project.

2.2 A Theoretical Efficiency Model

Looking at the challenges of FDWH projects (Behrmann et al. 2008), effective and efficient team communication plays an important role for project success. In this part of the paper we briefly sum up a theoretical model for explaining and predicting project efficiency in FDWH projects that is described in detail in Räkers (2009). This paper aims to test this model. The following brief description is needed to explain our further proceedings. One of the major roles of project managers is to ensure that a project reaches its goals (effectiveness). Additionally, from an economic perspective, s/he should try to reach the predefined goal with as few resources as possible (efficiency). As s/he decides how work should be done (types of action), s/he is the leading part in an ongoing process of decision-making. As different types of actions consume different resources in different amounts, the project manager has to decide – based on her or his assessment of the current situation – what type of action is perceived as the most appropriate for reaching a desired goal.

As a FDWH project's success depends greatly on successful integration of source systems and consequently on the ETL processes (March and Hevner 2007), they especially have to deal with challenges regarding communication problems and common understanding of involved parties. While team members' time efforts are the driving cost component of a FDWH project, communication issues become crucial for project success. Therefore, we argue that the efficiency of communication inside the project team has to be managed well to be successful. A conceptualization of IS building on philosophy of language adds thoughts of communication costs in differently developed, domain-specific language communities (Holten 2007, Holten and Rosenkranz 2008). By investing differently in terminology progress, language communities reach different levels of shared understanding and communication efficiency. This principle is shown in Nikolopoulos and Holten (2007) and was used in Räkers (2009) to develop a theoretical efficiency model. From this perspective, each project team is a more or less developed language community that progresses in the project with a subjectively observable efficiency. Only if project team members use and understand the same domain-specific terminology as a know-how held in common, ambiguity and uncertainty are both lowered, and misunderstandings resulting from different interpretations should occur less frequently. Another problem the project manager has to care about is the estimation and measurement of the project's complexity (e. g., Xia et al. 2005). During the course of the project, as the project manager continuously engages into sense-making of the situation, complexity can be assessed more accurately.

To summarize the proposed model, using the cost function derived from the application of the conceptualization of IS as language communities, goals of higher complexity (increased variety) can only be reached by current members of the project team by *investing more resources* (i. e., person-days) into the development of domain-specific terminologies and creating a mutual understanding of a situation. The efficiency decreases while complexity that can be handled grows in the cost curve belonging to a project team, having its specific terminology T in place to attack problems of different complexity levels C (see Figure 1, left side).

In general, we argue that in a continuous process of decision-making, a project manager has to check the current project status and make forecasts for the project outcome (goal and complexity). The less unambiguous and uncertain a project environment is the better the forecast will be. Building on this, we propose that there are points D in time where project managers of FDWH projects take actions to shift the project team's cost curve to a different efficiency level by investing into additional terminology. Doing this initially might raise costs in the short-term, but lowers overall costs of

communication in the project in a long-term view. The project-specific *curve of efficiency* is the path determined by costs curves and decision-triggered terminology-building steps between them (see Figure 1, right side).

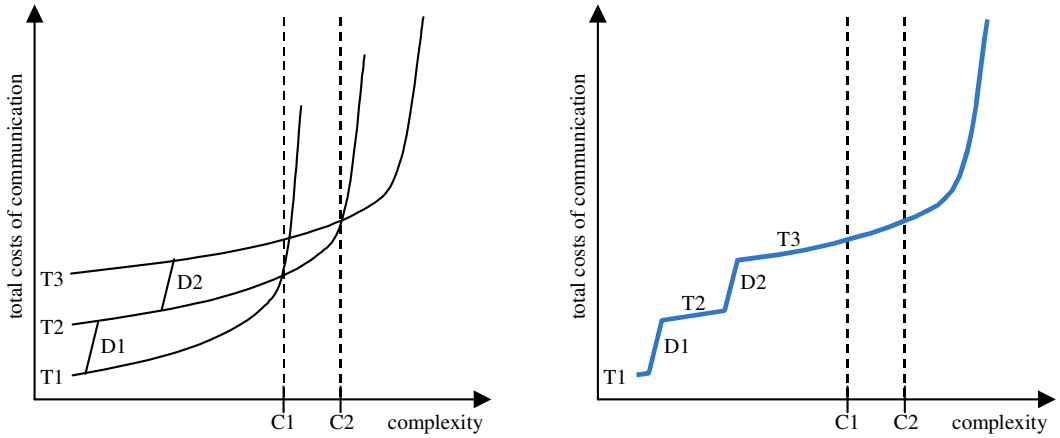

Figure 1. Proposed Efficiency Model for ETL projects in FDWH

This directly leads to the central propositions to be addressed in this paper:

P1: *The curve of efficiency really exists in real project situations and can be observed.*

P2: *Projects go through phases with different levels of efficiency by creating additional terminology (terminology-building steps which shift the curve).*

P3: *Projects which explicitly address communication problems are more successful than others that do not.*

We believe that project managers inherently observe projects and their team communication to detect points of efficiency change and that FDW projects should become more successful if project managers explicitly keep this possible shift in mind and react accordingly.

3 MULTIPLE CASE STUDY

3.1 Method & Case Selection

We decided to conduct a multiple, embedded case study in order to examine the central proposition made in section 2. Case studies are ideally suited when the investigator has limited control over events and boundaries of a phenomenon and when the phenomenon and the context in which it is investigated are unclear or closely related (Yin 2003). Challenges of communication and requirements specification in FDW projects certainly satisfy these criteria (Miles and Huberman 1994, p. 15). Since we wanted to test the propositions previously made, we followed a deductive pathway (Lee 1989). Two case selection criteria were applied. First, the research decided to focus on FDWH projects in the European financial services industry. The selected cases are typical for recent projects in this sector. Second, one of the authors worked for more than six years at a major German consultancy which focuses on IT in the financial services industry. He therefore had broad experience with working in FDWH projects, first as a consultant and later as a project manager, enabling him to establish contacts and to get in touch with the key informants. Moreover, he participated for some time in two of the projects (source of potential bias). The trigger for all the projects was the supervisory requirements known as Basel II. These regulations have an impact on the whole structure of a financial service provider and especially affect ETL due to the needed integration of various source systems.

Three FDWH projects of various banks in Europe were selected, which offered access to members of all stakeholders involved, that is, internal project members from IT and business units, external IT and business consultants, and project managers. Table 1 gives an overview of the selected cases.

	Bank A	**Bank B**	**Bank C**
Natural languages used in project	German, English	German, English	German
Scope	Europe	Europe	Germany
Project duration	> 5 years	> 2.5 years	> 2 years
No. of countries involved	> 13	> 5	1
No. of subsidiaries involved	18	6	-
Balance value	100 bn. EUR	70 bn. EUR	7 bn. EUR
Project size (person-days)	about 100,000	about 40,000	about 5,000
Core system change	No	Yes	Yes

Table 1 Cases Overview & Comparison.

3.2 Data Collection & Data Analysis

The risk that participants displayed retrospective bias was minimized because at the time of the interviews, all selected projects or directly related successor projects were still ongoing. Data was collected from various data sources and with the help of different data collection methods, enabling triangulation (Eisenhardt 1989, p. 539). The interviews were undertaken in 2008, two years after the involved researcher had dropped out of the projects in order to counter his potential bias. Unstructured and semi-structured interviews, project documentation, and self-estimation surveys of project member activities were used to generate the data for a case study diary (Yin 2003, p. 105). The interviews were guided by an interview outline which was not shared with the interviewees and was only used by the researchers as a checklist and guideline. The interviewees were encouraged to provide a narrative of their experiences as freely as possible. The interviews were all recorded and fully transcribed. Follow-up e-mails and draft reports were sent to request clarifications and to offer informants the possibility to provide feedback and comments. Natural controls and treatments that were already in place were utilized in testing (Lee 1989, p. 39). For instance, the control was already in place by virtue of focusing on persons which were participants in more than one of the three projects, interviewing the same person for different projects.

3.3 Case Descriptions

Bank A is an international banking group having 18 major subsidiaries. The project at Bank A has been started in 2001 and was planned to end in December 2007. To fulfil the requirements of Basel II and to enable a group-wide calculation one of the main tasks of the project was to implement a central data warehouse. Primarily, data of transactions, collaterals, customers and rating information of both head office and subsidiaries had to be delivered into the central data warehouse. To achieve this, each subsidiary had to deliver specification-conform flat files to be imported into the central data warehouse. At the beginning, the core project team at headquarters, which consisted of consultants and Bank A experts from business and IT had designed a detailed data model for Basel II, and specifications for data loading interfaces in XML Schema Definition (XSD) format, which were send out to the project members in the subsidiaries (i. e., network banks). At the beginning of the project, an initial training workshop was conducted to explain the XSD format to the subsidiaries.

Bank B is a large European banking group with foreign subsidiaries. In order to deal with Basel II demands, Bank B put up a FDWH project in order to fulfil the requirements of Basel II. The project started in 2005 and officially ended in 2007. In addition, Bank B was in a post-merger situation and was the target of an acquisition during the project, so the ongoing consolidation process in the banking industry is considered as well. In addition, beside the Basel II-related data warehouse project, another large project was established in Bank B at the same time. A new core banking system was developed and switched productive during the second half of 2006. So nearly every department was involved in

two large and important projects at the same time while doing the normal daily work as well. From core banking systems over the group-wide data warehouse to the reporting and supervisory systems, nearly every application and business process was affected. All in all, Bank B was undergoing enormous organizational changes, and the changing environment heavily influenced the project.

Bank C is mid-sized European bank with mainly national activities. While implementing a new core banking system the bank's management decided to take the opportunity to renew the technical landscape regarding regulatory systems and the underlying data warehouse as well. The project started in 2005 and was finished by the end of 2007. One of the major goals was the implementation of the Basel II requirements, which makes this case comparable to the cases of Bank A and B. Like in the other cases, this project was supported a consultancy and all departments of the bank were involved in the project. Looking at Bank C, this case gives us a different view on a smaller and mostly national bank to compare and analyze whether size and geographical diversity have impact on the projects and the theorized curve of efficiency.

3.4 Case Findings

3.4.1 Bank A

The complexity at Bank A was perceived as high (1) due to new regulatory demands and (2) the existence of various important subsidiaries with different environmental situations. However, since the specification was assumed to be unambiguous by the project managers due to the use of XSD, it was sent to each subsidiary via e-mail without further descriptions. Furthermore, the project managers believed that employees in the subsidiaries would share the same knowledge about the banking domain as employees at head office, that is, that the meaning of each of the used terms and descriptions would be understood without any problems. Since after the distribution of the specification all support requests of the subsidiaries could be satisfied by a contact person at headquarters, the head office team assumed that each subsidiary had understood the specification in the intended way. But first completeness checks of the flat files that were delivered by the subsidiaries showed several problems resulting from a different understanding of the meaning of the terms. It seemed as if employees from head office and subsidiaries spoke different languages, since the interpretations of the published specification varied to a considerable degree, although the required data and data structures were perceived to be unambiguous due to the use of XSD and additional extensive textual descriptions.

"*A classical example is that the central business data base table was named 'counterparty' due to a translation error […]. This caused a lot of confusion because therefore this term appears relatively often in the data warehouse. […] In fact, there are really 13 data warehouses that have to be loaded identically, but which weren't loaded identically […]. This was the case in the first implementation phase, that one just gave the documents to everybody and everybody did interpret them. And the result was 13 interpretations. […]* " (Mr. JS, project worker)

"*At the moment of the rollout, specific concepts were not clear for the people on site, what turned out only afterwards, and specific types of business naturally only existed locally or, again, used other terms, so that it was not clear to them how to convert that adequately into the warehouse.*" (Mr. WB, project manager)

After this problem surfaced (following the first release of the data warehouse that had already been implemented), a *change in the course of action* was observable at Bank A. Additional *workshops* were conducted once the project management team realized that the sent XSD specifications were not enough for coping with proliferating complexity of the situation. During the workshops, changes to the data model in subsequent releases were introduced and *the meaning of terms and concepts was discussed* in detail with all involved stakeholders of business units and subsidiaries. After the workshops, once it was realized that the delivered data quality was still not satisfactory, the project

managers decided to engage into *local visits of head office project members* at problematic subsidiaries. Patterns of terminological discourse are traceable once the existence of separate sub-terminologies and jargons had been understood and accepted, and those sub-terminologies began to be consolidated into a terminology by the project team (generation of language community). The project managers explicitly decided to switch from written specifications to direct face-to-face communication. The joint discussion, clarification and learning of terms (i. e., the creation of a language community) were time-consuming, but perceived as necessary for reducing ambiguity and to be able to deal with the complexity at hand.

"*At one point in the project […] it was recognized that the specification must be improved and refined […] then one realized that this XSDs are not enough, and then one created the data delivery concept, and drove out to the subsidiaries to explain this. This were points where one noticed that they needed a little more support, but the real turning point, where this issue had full management attention, came actually in April 2007, where one said the data delivery does not work at all […] and then did decide that we need so-called task forces, […] very different persons now became involved, who really were on-site [at the subsidiaries] and went through the data with them weekly, looked at the data fields and discussed every single thing. This actually was one of the greatest turning points for me. There, the upper management realized 'Now we have to do something, and we have to spend money […].*'" (Mr. BK, project worker)

The on-site visits and the discussions with all project members and subsidiary employees finally succeeded in establishing a shared, mutual understanding of terms. Ambiguity was mostly lowered by the subsequent face-to-face discussions between all project members. Afterwards more complex topics were discussable.

"*Absolutly, it became apparent that the number of questions which one brought back from the countries and the on-site visits, that by looking at these one saw, that many open questions existed and once we had those, we could clarify those. […] There are still questions, but these questions are much more difficult to answer because most of these require much more detailed knowledge. Also it didn't run like it's on rails afterwards directly, but I think, the amount of questions which had been clarified in this did certainly justify this [the on-site visits].*" (Mr. JS, project worker)

Thus, the project went through phases of *different communication policies* due to project management decisions. Each of these decisions changed the style of communication. For example, based on assessments of the self-estimation survey, these changes doubled the time spent on communication and also doubled efforts for on-site meetings. By conducting expensive on-site meetings, a shared terminology and a common understanding regarding project issues was built. After those changes in policy, project members state a perceived increase of efficiency in the project in later phases compared to earlier phases.

3.4.2 Bank B

In general, the complexity of the project was perceived to be very high, since (1) Bank B was faced with new regulatory demands, (2) Bank B was target of an acquisition, and (3) a new core banking system was implemented in parallel to the Basel II project. Ambiguity and uncertainty were perceived as being high due to the existence of several jargons and terminologies in the project and its surrounding environment. As in Bank A, particularly the creation of a shared understanding between head office and subsidiaries proved to be difficult. On the one hand, the interfaces to the subsidiaries and the core banking system were very complex. On the other hand, the types of businesses in foreign countries were fundamentally different from businesses at head office, leading to an even greater complexity and much more ambiguity for the project, which was not perceived as a problem at the beginning. Similar to Bank A, the project managers at first did not address that different understandings and meanings for the same words existed in Bank B.

"*[…] There was this nice module, which was called [offer processing application] […]. Under this term, one can imagine quite a lot, and there we had a lot of discrepancies between both projects, even concerning the question where this is positioned with regard to IT, technically. And then we had different coordination meetings where one said 'OK, what really is the content of this system?' so that later you really could clarify the business activities and could limit responsibilities and interfaces relatively well.*" (Mr. TA, project manager)

But as different understandings proved to be the case, the procedure for dealing with those problems explicitly changed as the project progressed (*change in the course of action*). According to our findings, the project at Bank B was characterized by two distinct procedure models, where the shift from procedure 1 to procedure 2 was consciously made by the project management team. The first phase was specification-driven whereas the second phase was communication-driven. For example, the project manager's self-estimation efforts for on-site meetings were three times higher during the use of procedure 2 than before using procedure 1. For some of the subsidiaries which showed immense problems, so-called task forces were established. The technical face-to-face coaching on-site was very important to make members at the subsidiaries understand the requirements. Therefore the creation of a language community by intensive face-to-face communication was one of the central factors for project success and the handling of the high complexity.

"*This then changed from the initial procedure of 'We send you a concept, look what you got and send us back the results' to a much more workshop-oriented procedure. So one did say 'We have to support you much more, we come over to you and look everything through in workshops together with you' and in a second step one conscripted the colleagues respectively and said 'We let our project member sit with you and he will support you for the next days and weeks'.*" (Mr. TA, project manager,)

Due to the fact that one key informant was a team member of both projects in Bank A and Bank B, we could directly address the difference between both projects. The initial external complexity and uncertainty due to Basel II are comparable. Bank A has more subsidiaries than Bank B, but Bank B was the target of an acquisition during the project and also implemented a new core banking system.

"*Uncertainty in both projects was rather almost equal. At Bank A, it simply lasted five years […] and had a multiple of effort [of Bank B]. […] they certainly started in 2003 in earnest, and practically, they now have reported for the first time […]. They had a much longer project runtime. Fair enough, it is a slightly larger bank with much more subsidiaries, so they have 18 subsidiaries in different countries […], this is really much bigger in dimension. But they also had to make some real turnarounds and extra loops within the project, concerning the subject of classification: what is market risk, what is credit risk? Where do I represent the credit risk, in which data warehouse, where do I represent the market risk, and so on. They certainly got closer to the target more serpentine […]*" (Mrs. SK, project worker).

So while external complexity, ambiguity and uncertainty that both projects faced due to new regulatory requirements and other external circumstances were comparable, Bank B reached the same goal faster (two years compared to six years), and the quality of the processes and product were also perceived as being clearly superior. Basically, Bank B changed its course of action (investing in language community creation and shifting the curve of efficiency) earlier and faster.

"*[Bank B's project] also had a much shorter duration, thus we have now in 2008 reported with the standardized approach, and the project has started in 2006, that is, we have implemented the basic functionality for Basel II in two years […] the duration compared to the number of resources that have been burnt, is certainly much lower than at Bank A […]."* (Mrs. SK, project worker)

3.4.3 Bank C

The FDWH project at Bank C had to integrate the topics "regulatory reporting" (Basel II, loss database) and "controlling" (operational and business control). The to-be-developed data warehouse was intended to be an integrated database for both project topics. Consequently, changes in one area

had significant impact on the other area, which had to be taken into account. During the project, three different consultant teams were active at Bank C and had to work closely together to implement the new core banking system, the regulatory reporting system and the central data warehouse. Since the data warehouse team had to build interfaces and integrate data from both other systems, this was deemed one of the most important tasks for project success. External and internal complexity were both perceived to be very high by the project management team (1) due to environmental factors (e. g., new regulatory requirements) and (2) the organizational situation (e. g., implementation of a new core banking system). However, in contrast to the previous projects, no subsidiaries did exist. At the beginning, the presence of three teams was hindering the project due to the existence of several different terminologies in the teams. The teams had quite separate IT-related jargons and also different understandings of banking-related technical terms that were important for the project. Between those sub-language communities, misunderstandings occurred quite frequently during the project. This was caused by the perceived ambiguity concerning the different meanings of terms in the different teams.

"*The example 'validierter Saldo' [German: validated balance] strikes me on this level. […] this wasn't a problem at the beginning of the project, […] but something that happened at some time during the project […] for us it was clear, this is an established term and means the actual capital disbursed […] but in the core banking system team, they understood it differently, or in the core banking system the data field with this description yields something different respectively, namely the original capital disbursed […] this led to many bad coordination loops and to costs on our side because we had to adapt the data history.*" (Mr. VC, project worker)

As in the previous projects, the general procedure was consciously changed by the project managers in order to create a shared language understanding and to reach the project goal on time. For example, the efforts for communication became three times as high as before.

"*[…] In the first phase, one had the attitude, we really don't want to understand the core banking system, instead, we want to have interfaces filled, delivered data requests catalogues respectively and one hoped that this will match somehow. Then the second phase […] 'OK, that isn't really working out, now we sit together and try to understand their basic problem.' And in the last phase, I had the feeling that one had a look at the core banking system oneself a little bit, did discuss this with some bank employees and the interface developer […].*" (Mr. JD, project worker)

This consolidation and the intensive discussions of all involved stakeholders reduced ambiguity and finally led to better data quality. The project was perceived as running more smoothly once ambiguity had been reduced or when it was noticed that a different understanding of a term was existing.

"*When you […] talked this through together, then you had no discrepancies. In certain circumstance, it wasn't clear for single data field, because our software has its requirements and if you don't name them explicitly, they are hard to infer from the field names or field descriptions. […] you have to address such things explicitly if this was somehow lost in the torrent of data requests. […] Such things are very important, meaning the precise description of data requests or technical contents. In my judgment, this accounts for more than half of project success in such an IT or data warehouse project.*" (Mr. VC, project worker)

4 DISCUSSION

To link our findings to our propositions we sum up our findings from the cases.

- In each case the project management team got to a point where a change of the general procedure and original project plan (type of action) was undertaken in order to increase efficiency or at least being effective. The types of action became more communicative and sense-making-related and succeeded in creating a more shared and joint terminology. So within all cases, the existence of a curve of efficiency as theorized before can be observed (*proposition P1*).

- Project members of all projects state that fundamental problems in communication and understanding existed which led to a change in the project procedure. We recognize these approaches as an increase of terminology creation and as a shift to a different level of efficiency (*proposition P2*).
- By changing the efficiency, all three projects assured project success. Projects which addressed those communication issues earlier (i e., Bank B compared to Bank A) were perceived to be more successful than others (*proposition P3*).

Two important consequences for research and practice arise from our findings. First, the extension of the cost curve to a cost curve with multiple efficiency levels (curve of efficiency) allows the explanation of communication behavior and possible types of action for project managers in complex project situations. Therefore we are very confident that the derived efficiency model, which was applied to FDWH projects in this paper, is stable for other types of complex IT projects as well. This leads us to suggest that replicating our study in other settings and using a diversity of different research methods (e. g., case studies, surveys, experiments, action research) will lead to similar results. Second, project managers in practice should explicitly address communication efficiency in their project management approaches and project plans for integration and ETL processes in complex (FDWH) projects. Variety and ambiguity are major problems in complex IT projects. It has been over 60 years since Ashby (1956) proposed that only variety destroys variety, and over 25 years since Daft and Macintosh (1981) argued that ambiguity and uncertainty are important organizational design factors. But still IT project managers make the mistake of misjudging the impact of those factors and try to implement IT before the variety of a problem situation has been matched and ambiguity has been reduced by creating a language community. Usually, issues and problems of communication, understanding and sense-making are not a part of the "accepted" or "rationalized" costs. But as our findings suggest, those costs should be explicitly addressed and incorporated in the management process of complex IT projects.

Case studies can confirm, challenge, or extend a theory because they can be used to reject propositions (Lee 1989). The theoretical efficiency model itself has been previously derived from literature and exploratory field studies, and has been challenged by us with case study data. Qualitative methods were employed to generate an interpretive understanding of the problem situations and to test the propositions (e. g. interview-based evaluation techniques). Nevertheless, further studies are needed to confirm the efficiency model for complex IT projects beside current FDWH projects and to generalize our findings. The chosen cases deal with comparable project topics, but the findings are not derived from a ceteris paribus ("all other things equal") configuration; instead, we rely on "natural" situations, where influences of other factors cannot be excluded. Furthermore, we greatly rely on subjective impressions from case study participants and our own interpretation. In order to counter those problems, rigorous case studies that want to test theories must address four requirements (Lee 1989, p. 42), which we explicitly tried to address. As a check for *falsifiability*, we verbally formulated propositions based on the model of the curve of efficiency, which have subsequently been tested against the data. As a check for *logical consistency,* the propositions follow from the logic of this model. The cases have been selected in order to provide generalizability and to allow checking for consistency. As a check for *empirical validity*, the theorized curve of efficiency has been confirmed and corroborated. Since this study was interested in providing first empirical evidence for the curve of efficiency and not in refuting any rival theory, a check for *relative predictive power* has not been addressed yet.

Since we wanted to provide first evidence for our propositions, this research is mostly dealing with construct validity. According to Yin (2003), construct validity is critical in qualitative research and can be improved by three tactics. The first is the use of multiple sources of evidence, which provides multiple measures for the same phenomenon. We explicitly addressed this issue and examined three projects with a multitude of informants in a multiple, embedded case study. The second tactic is that key informants review the case study, which we have addressed as well: the research project was introduced and discussed with the key informants; draft reports were sent to the key informants for

review. Finally, Yin (2003) recommends maintaining a chain of evidence, which we did by formulating propositions based on the efficiency model, collecting case study data, discussing it with our informants, and creating a case study diary that allows us to trace back from findings to initial propositions. However, further tests are necessary to corroborate our findings, e. g., in laboratory experiments.

5 CONCLUSION & OUTLOOK

The variety of complex IT projects is often underestimated and therefore has to be managed. We used a theoretical model based on efficiency considerations to explain the general behaviour of integration and ETL processes in FDWH and derived three major propositions. Three projects were evaluated in a multiple, embedded case study. Our findings provide evidence for corroborating our propositions. Project managers dealing with integration and ETL processes in FDWH can benefit from explicitly addressing communication issues in their project plans and general project procedures. By finding ways to remove existing communication barriers and misunderstandings, the efficiency of a project team can be improved. The project manager has to decide how much efforts need to be invested into this improvement to be most efficient for reaching the desired project goal.

From a theoretical perspective, the efficiency model is a building block for knowledge on communication in FDWH projects. We contributed to project management by providing concepts for this efficiency model. If "sound" FDWH project management is among the desired goals, researchers and practitioners may benefit from our insights on how to measure the relationship between communication, complexity and ambiguity, and FDWH project success. Of course, several instances are needed to support a theory. At present, the projects are the only setting for which our findings are valid. Our study needs a replication of the findings in additional cases. To strengthen our findings, we will conduct additional case studies to deal with more special topics of other projects and action research settings for explicitly addressing communication barriers in early phases of projects.

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