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A communication efficiency model for etl projects in financial data warehousing

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A COMMUNICATION EFFICIENCY MODEL FOR ETL PROJECTS IN FINANCIAL DATA WAREHOUSING

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Abstract

The financial industry relies greatly on information technology (IT) because of its work with immaterial goods. Nowadays, most information collected by a financial institution is usually stored in a central data warehouse system. This central financial data warehouse (FDWH) is permanently under construction. Requirements from all over the bank have to be met by FDWH projects in an ongoing process. These requirements need to be communicated to the FDWH project team to do implementations properly throughout the system landscape. Especially the creation of extraction, transformation and loading (ETL) processes depends on the project team's communication ability and given communication barriers. Enhancing recent research in FDWH a theoretical efficiency model based on philosophy of language and project management fundamentals is built in this paper. The conceptualization of information systems development projects as language communities is an important presumption for this theoretical model. Suggestions derived from this model lead project managers of FDWH projects to more appropriate decisions keeping efficiency drivers in communication in mind.

Keywords: financial data warehousing, theoretical efficiency model, project management, communication efficiency.

1 INTRODUCTION

Financial data warehouses (FDWH) are an important and relevant issue for most financial services providers today. Especially large banking groups with foreign subsidiaries have to deal with new regulatory demands, e. g., Basel II, IFRS or Sarbanes-Oxley Act (Behrmann and Räkers 2008). Moreover, financial service providers try to employ DWH for controlling their risk management approaches. It is general consensus that DWH support the management perspective on business processes technically, but their implementation is extremely costly (Vassiliadis 2000). Therefore, a clean design and specification of the system is of great importance. Consequently, the involvement of the management users and management's support are deemed key factors for DWH quality and system success (Wixom and Watson 2001, p. 35 f.). Since DWH projects often fail or significantly exceed budgets, existing research has concentrated on quantitative or qualitative analyses of success factors as well as contemporary best practices for building DWH (Weir, Peng and Kerridge 2003, e. g., Herrmann and Melchert 2004, Hwang, Ku, Yen and Cheng 2004, Watson, Fuller and Ariyachandra 2004, Hwang and Xu 2007).

March's and Hevner's (2007) thorough literature research warns how links between data warehousing, strategic decision-making and evaluation are under-researched. For March et al. (2007), *integration* (i. e., the consolidation of data from disparate sources into one consistent body of data) lies at the heart of decision-making tools and is one of the biggest challenges for DWH designers (March et al. 2007, p. 1036). Effective integration can only be achieved by experts who have access to knowledge about internal and external business contexts (i. e., "what questions are momentarily important?") and access to knowledge pertaining operational systems that have to be integrated (i. e., "which operational systems provide data for answering those questions?") (March et al. 2007, p. 1041).

This theoretical argument is consistent with statements which suggest that FDWH projects show specific integration characteristics (Behrmann et al. 2008):

- *Financial data warehouse projects have to deal with several business domains and fields of knowledge*. This leads to different domain knowledge in different departments and subsidiaries and specific fields of knowledge arise. To build up a centralized and integrated system a common understanding between all involved department and subsidiaries has to be reached.
- *Financial data warehouse projects are characterized by a high semantic complexity*. Several business domains can occur within a single financial institution. Due to the different fields of knowledge a high number of context-dependent homonyms (e. g., limit, facility, book value, market price) and synonyms (e. g., debt security, bond, obligation) can be observed. Due to this variety, the definition of terms (e. g., dimensions and measures) is challenging.
- *Specification-based approaches are not sufficient in financial data warehouse projects*. Beside the specification additional methods are required, for instance, face-to-face communication.
- *Financial data warehouse projects require knowledge transfer methods and strong interaction*. For a successful implementation a common understanding between all involved project members has to be ensured. This cannot be reached by merely interchanging a written specification.

In this paper a theoretical model is developed to explain and predict interconnections in FDWH projects that lead to project management decisions which change general procedures within these projects over time. During *phases of terminology creation*, a foundation for more efficient communication (i. e., better aligned to the current project environment) is built by the project team. This changes the ability of the project team to solve problems either by using formal specifications or using face-to-face communication. We argue that the beginning of a phase of terminology creation is decided by the responsible project manager based on efficiency considerations and the perception of project status and future project progress.

The underlying research approach is in line with Lee's (1991). approach of integrating positivist and interpretive approaches in organizational research . After having created a subjective understanding of everyday meanings and common sense within observed organizations, which provides the basis for the interpretive understanding, the researcher creates a positivist understanding in order to explain the empirical reality – the explanation being a scientific theory which can be tested against the subjective meaning as recorded in the interpretive understanding (Lee 1991, pp. 351-354). Therefore, as a first step, the subjective understanding of involved persons in FDWH projects was analyzed by creating an interpretive understanding of the specifics of FDWH projects (Behrmann et al. 2008). In order to create a positivist view on FDWH projects, this paper introduces an efficiency model which explains theoretically why observed behavior and procedures in FDWH projects operate as they do. Further research will test this model in additional FDWH project situations and try to apply the model in a broader scope than financial data warehousing.

The remainder of this paper is structured as follows. In section 2, related work concerning research approach, software project management and language theory is presented. Section 3 contains the communication efficiency model for FDWH projects. Finally, section 4 summarizes the findings and gives an outlook to further research.

2 RELATED WORK

ETL projects take about 70 percent of the efforts of a data warehouse project (Kimball and Caserta 2004, p. 391) and therefore need professional project management. Accordingly, Kimball et al. (2004) suggest specific project structures and organizational rules to manage the inherent complexity of ETL projects. To complete a project successfully, the objectives (goals) have to be reached within time, cost and performance as the most critical project dimensions (Jurison 1999). Projects are usually conducted in four generic phases (e. g., Jin and Levitt 1996, Kunz, Christiansen, Cohen, Jin and Levitt 1998):

(1) *Conceptual phase*: the project scope is determined by the project sponsor and the project manager. Software designers work together with the project manager on possible arrangements of the future software.
(2) *Planning phase*: the project manager builds a project plan containing project tasks. Each task has allocated resources, duration and a defined result. This information is generated by conducting estimations with different techniques as summarized by Boehm (1981, p. 203).
(3) *Execution phase*: in the execution phase the software development and testing of the built software product takes place.
(4) *Termination phase*: During the termination phase the project is documented, closed and delivered to the operations department of the company. The project sponsor approves the results to the project manager.

Furthermore, complexity is identified as one of the major problem-driving factors in information system development (ISD) projects (Jurison 1999, Xia and Lee 2005). With the advent of the fourth generation of ISD methodologies in the 1980ies it became clear that intensive user involvement is needed for coping with proliferating complexity, and ISD has an important social component as well (Hirschheim, Klein and Lyytinen 1995, p. 36). The social system resulting from an ISD project is closely interconnected to the project team itself. Therefore, purely mechanistic and formalized system development methodologies need to be treated more critically (Fitzgerald 1996). For example, to be able to handle complex ISD projects successfully, different kinds of communication between project members need to be combined efficiently. Effective communication has already been researched concerning requirements (Coughlan and Macredie 2002). Although requirements play an important role for FDWH projects and especially ETL processes, this paper focuses on explaining operational project management and not on building an additional methodology for requirements specification.

Adding to this, 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 *communication efficiency*. This principle is shown in

Nikolopoulos and Holten (2007). This and other findings form organizational research (e. g., Boisot and Li 2006) suggest that the building of a shared terminology and language community is beneficial for coordination and communication.

3 A THEORY EXPLAINING MANAGEMENT IMPACT OF COMMUNICATION EFFICIENCY IN FDWH PROJECTS

3.1 Basic Components of an Efficiency Model for FDWH Projects

Further development of the efficiency model proposed by Nikolopoulos and Holten (2007) is based on project management basics, for example, as summarized by Jurison (1999). The relevant management dimensions can be derived directly from Jurison (1999) and have been observed to be of relevance in empirical studies of FDWH projects (Behrmann et al. 2008, Räkers and Rosenkranz 2008):

- *Time*: the time needed to reach a project's goal. Time is a constraint in projects as there usually is a specified deadline in a project plan. Furthermore, time is an effort-driving component of a project. As overall tasks like project management need resources every day during the running time of the project, a longer project needs more resources for these tasks.
- *Cost*: the amount of efforts needed to reach a project's goal. The main driver for costs is the assigned project team members. Personnel expenses are the relevant cost driver in FDWH projects, because the hardware and technological components are usually needed anyway, are becoming more and more a reliable and well-tried commodity nowadays (Avison and Fitzgerald 1995, p. 6), and do not influence the organizational view on project management this paper tries to address. The working hours of a team member can be split into travel time, meetings, telecommunication etc.
- *Performance*: the created results of a project. The performance of a project is tracked by project managers throughout the whole project. Performance corresponds directly to the benefit a project has for its sponsor. For the project sponsor, the benefit is the primary goal of the project. From an economic point of view, the (rationalized) goal of a project can be summarized as creating a benefit with least possible costs under the constraint of time.

In ISD projects, complexity has been often identified as one of the main reasons for problems. Complexity is often underestimated when starting a project. As complexity is one of the problem-driving factors mentioned by Jurison (1999, p. 4), it becomes an important part of the efficiency model as well. However, complexity is difficult to pin down. Generally, the term has a multiplicity of meanings (Flood and Carson 1993) and is a fundamentally subjective concept (Backlund 2002). In this paper, we build on Ribbers and Schoo (2002) and argue that the complexity of a (FDWH) project evolves from the variety of a project environment. Complexity arises from the inherent *variety of elements and interconnections* of an ISD project (Rosenkranz and Holten 2007). The project organization (i. e., the project team and its organizational setup) needs to be able to handle this variety. According to the law of requisite variety only "variety destroys variety" (Ashby 1956), the project team essentially needs to build up this variety itself. To be able to handle a certain degree of complexity, the variety of this situation needs to be addressed by a project team with at least the same variety at hand (Bar-Yam 2004).

In the beginning of a project, the project manager usually estimates the complexity of the project environment and builds up a project plan to address time, costs and the expected result (benefit for the project sponsor). After the project has started, the project manager has to track the status of the project. This is done by measuring time, cost and results while at the same time estimating whether the rest of the plan fits to the actual situation. As ambiguity and uncertainty in new situations usually are comparably higher at the beginning of the project, the more the project progresses, the less ambiguous and uncertain it becomes – maybe by risk elimination techniques (Boehm 2003, p. 9). The estimations become more realistic and more precise. While the desired project goal does not change, the variety

(i. e., complexity) of both the environment and the required tasks to cope with this variety become clearer with every step that is done towards the project goal.

A project plan consists of project tasks that are linked to each other as a network of activities. The most popular illustration of a project plan is a Gantt chart to visualize interdependencies of project tasks. All of these project tasks also have a desired benefit, a timeframe and costs. The project manager arranges different types of actions to reach his or her major project goal. Each type of action has its own profile regarding benefit, time and costs. During the project, the project manager comes to decisions about changing the project plan by reassembling the actions and changing types of actions to come to a different structure of benefits, time and costs. A constraint coming from the project sponsor is to deliver the expected project results, which means to be *effective* in the project. The project manager is usually trying to achieve this by also having economic *efficiency* in mind. Efficiency is defined here as the benefit reached per cost. Efficiency is important to the project manager for two reasons. Being efficient during the first part of the project increases freedom in later parts of the project. Furthermore, higher efficiency might be rewarded by the project sponsor. However efficiency becomes most important for the project manager when s/he realizes that the project goal cannot be reached with the current project plan, because the variety (i. e., complexity) of the project was underestimated earlier. As the expected benefit is fixed by the project sponsor, the efficiency can be increased by decreasing the project costs. It was mentioned above that the costs of a FDWH project are driven by personnel expenses for ETL process creation. Furthermore communication drives personnel expenses, what makes communication costs a very important influence factor for FDWH projects.

3.2 Matching FDWH Project Management with Communication Costs

One way of bringing theories about communication costs and project management together is having a look at the project costs. Assuming that the costs of communication have a major impact on project costs and assuming that communication has a major impact on project efficiency as well, the total costs of communication are chosen as an important measure for the suggested efficiency model. As benefit and time are constraints given by the project sponsor, the remaining influence factor is complexity. A visualization of this context is shown in Figure 1.

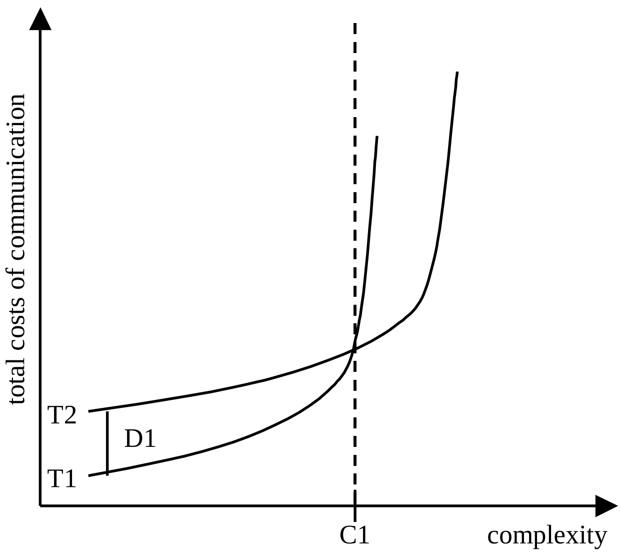

Figure 1. Cost Curves: Total Costs of Communication given Degrees of Complexity (adapted from Nikolopoulos & Holten (2007))

With increasing degree of *complexity* (C), the total cost of communication to handle this complexity rises for a given *terminology* (T) of a language community. If the complexity of a situation is too high for a language community to deal with it, the variety of the problem becomes greater than the variety of the language community (i. e., project team). To cope with this increasing variety, the terminology of the language community has to be increased as well. In a project environment, for example, this can be done by *decisions about activities* (D) of the project management, that is, explicit decisions to engage into language community creation and sense-making. On the one hand, these decisions increase the total costs of communication. On the other hand, they subsequently create a more effective terminology for the language community and shift the project to a different cost curve.

In Figure 1, the upper cost curve is less efficient for project degrees of complexity below C1, but is more efficient for degrees of complexity above C1. We propose that if a project manager adapts the estimations for the degree of complexity in his or her project from a level below C1 to a level above C1, and his or her project team uses terminology T1 right now, s/he will decide (D1) to engage into terminology creation and to switch to terminology T2 by investing in this terminology training (special type of action).

3.3 Enhancing the Cost Curves to an Efficiency Model

To enhance and detail this model findings from FDWH project research (Behrmann et al. 2008) are applied. Proceeding from a terminology T1 to another terminology T2 in FDWH projects means to change the *style of communication* from a specification-based way to a more personal face-to-face communication. By doing this, a higher degree of complexity can be handled by the project team. This is consistent with usual theories about media richness and information processing (e. g., Daft, Lengel and Trevino 1987) Therefore, the shift (D1) from the cost curve of terminology T1 does not proceed in a straight line, but is more diagonal as shown in Figure 2.

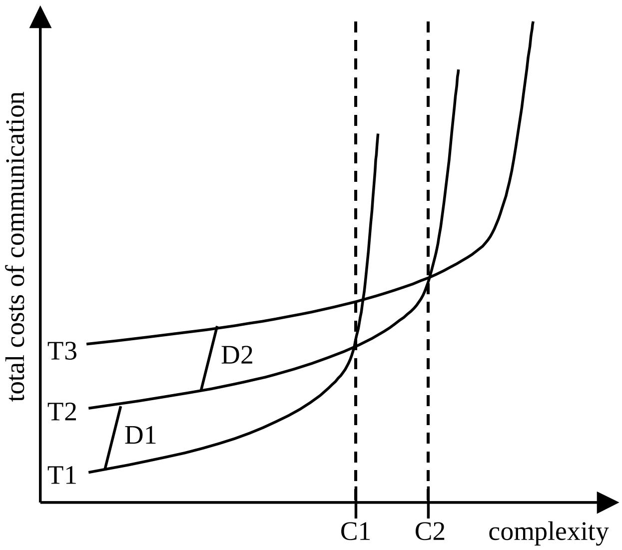

Figure 2. Efficiency Model for ETL Projects in FDWH

During large and long-running projects, multiple of these decisions are observable. This leads to a step-wise increase of total communication costs concerning the degree of complexity of a project. While the project team deals with more and more complexity over time, this step-wise increase should be observable in real projects. Consequently, as multiple cost curves are relevant for a project manager's decision (i. e., a set or continuum of cost curves), there are a lot possibilities to be taken into account. Depending on his or her estimation of how a single cost curve appears, s/he (intuitively or deliberately) identifies thresholds (such as C1 or C2 in Figure 2).

The next step in our construction is to fit the project manager's estimation of project complexity into this model. In case the estimated project complexity is below C1, the project stays with terminology

T1. Having an estimated project complexity between C1 and C2, the project manager should decide to invest into terminology T2. If the estimated project complexity is above C2, the project manager should think about additional terminology building or enhancements, and at last decide to switch to terminology T3. The example in Figure 2 shows a project where the project manager decided (D1) to switch from terminology T1 to T2 in a first step. After more complexity was encountered within the project, new estimations showed additional need for communication and terminology investments which led to decision D2 and terminology T3.

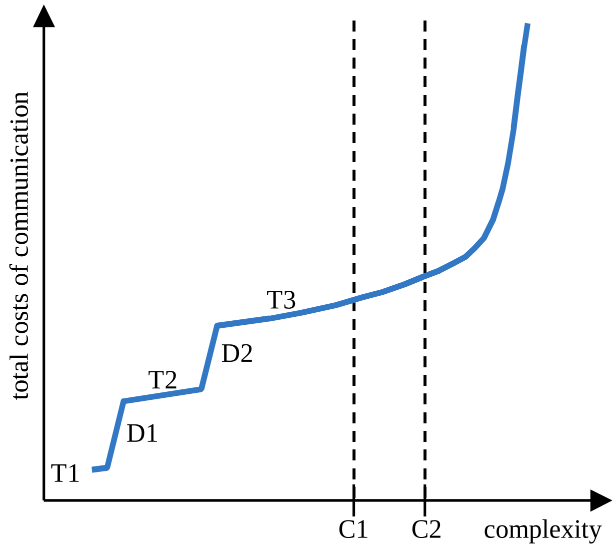

Figure 3. *Curve of Efficiency for a Specific Project*

Figure 3 shows the resulting curve of efficiency based on decisions of the project manager for this theoretical and exemplary project. As the project passes a complexity threshold, the project manager gets evidence whether his or her decision was right or wrong. Anyway, s/he does not know for sure at all, because s/he had no chance to observe the real cost curve s/he used before s/he made his or her decision (based on estimation). Obviously, taking into account the previous remarks, there is a lot of subjective appreciation and perception of the project manager in the model. However, this is precisely the reason why this model should be able to explain and predict project observations in real situations (which, in contrast to laboratory situations, are characterized by high variety, ambiguity, and uncertainty) very well. It should become clear why project managers act and decide as they do with regard to communication efficiency.

3.4 Explicit Consideration of Constraints

Adding to this basic efficiency model the constraints for the project manager are addressed in this section to completely incorporate all influences identified in section 2. The basic constraints for this model are the fixed benefit and the time limit to finish the project successfully.

The *fixed benefit* as a background factor for the project's complexity might change over time while the scope of the project is adjusted. This is normally done by bringing change requests into a project. Changes of scope (e. g., due to external perturbations) can have a direct impact on the resulting curve of efficiency by changing the available or (subjectively perceived from the project manager's point of view) possible cost curves. The *fixed time limit* (deadline) is a more important constraint for a FDWH project. As financial companies today rely on IT to a very high degree (Guo, Tang, Tong and Yang 2006) and the data warehouse is a central system with a lot of interdependencies to core banking systems and distributive systems, a precise timing is needed for the release cycle of a FDWH. Postponing of FDWH releases has high impact on the whole IT infrastructure of a bank since release cycles are highly interrelated.

Figure 4 adds this time constraint to the efficiency model. As there is no time dimension included in the model yet, the time has to be aligned to each possible way a project manager can chose to go. A fixed duration for a time period is defined and every time a period ends a dot is put on a curve of efficiency. By changing from one curve to another ways are split and each way has its own remaining distance until the end of the next time period is reached. As projects have to deal with a general time constraint, only a predefined number of spots should be passed by the project to be successful. The following paragraph contains a short example of how the time constraint can have impact on management decisions.

Given a time limit of three time periods, every end of a time period is represented by a black dot. After taking decision D1, the project manager has to decide whether s/he stays on the cost curve associated with terminology T2 or makes a decision D2 to change to the cost curve of terminology T3. Given an (subjectively) estimated degree of complexity for the project of a little more than C2, the project would reach the fixed time limit in period three before the estimated degree of complexity for the project is reached. That is, the project would be overdue. Although switching to T3 would be more efficient regarding total cost of communication, the time constraint limits possible decisions for staying with the cost curve of terminology T2. To state it more simply, the shift from one cost curve to another does not only come with the price of investing resources such as project workers, but also consumes time in itself.

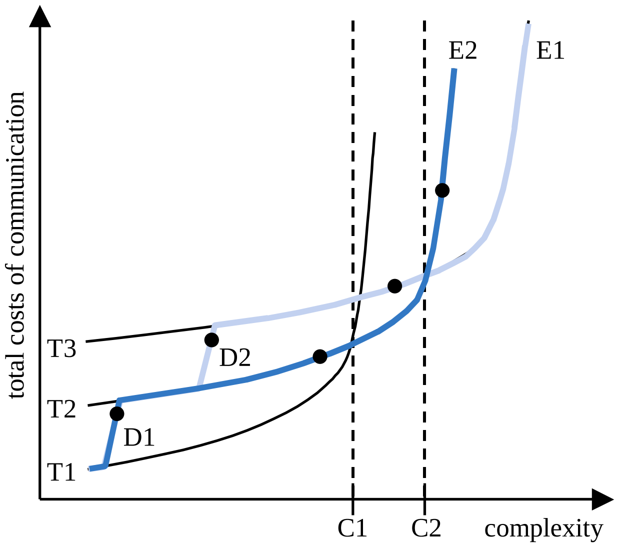

Figure 4. Curves of Efficiency and Time Constraint

In addition to the constraints discussed above, projects can have a *cost constraint* as well. The project sponsor usually might announce a cost limit or the project is done for a fixed price, so the project manager has to meet a cost limit. This cost constraint is added in Figure 5. Enhancing the previous example of Figure 4, the project manager now has to decide whether s/he wants to violate the time or the cost constraint. S/he can keep the cost constraint by switching to the cost curve of terminology T3 and choosing curve of efficiency E1.

3.5 Explaining Special Cases

There might be situations where the predefined complexity cannot be reached by the current cost curve. Looking at the example of Figure 4 in Figure 6, this would be the case if the estimated project degree of complexity becomes too high to be handled by the cost curve of terminology T2. There would be no other way than switching to the cost curve of terminology T3 to be able to reach the project goal defined by the project sponsor. In that case, the time constraint would need to be violated. The curve of efficiency E1 would be the result of the project manager’s decisions.

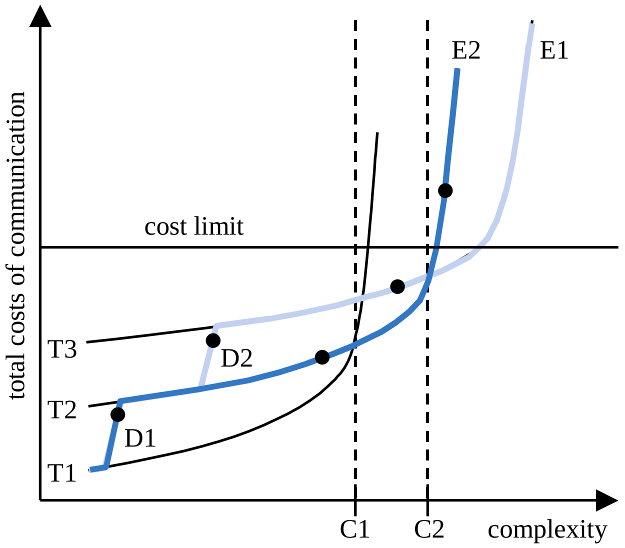

Figure 5. Curves of Efficiency and Cost Constraint

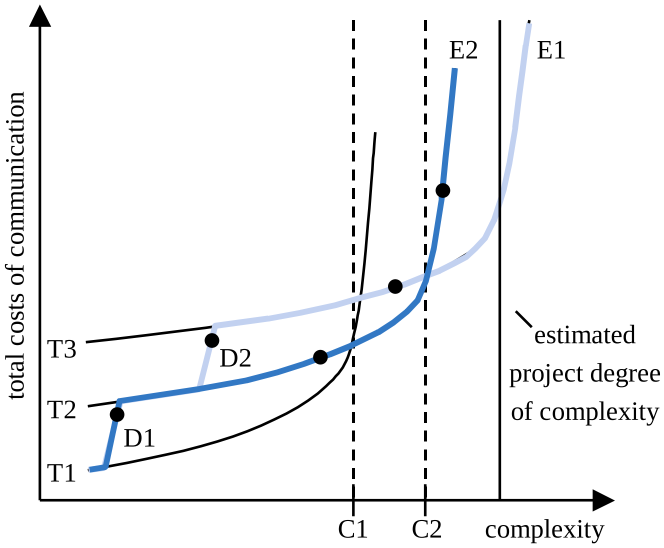

Figure 6. Curves of Efficiency with Time Limit Violation

Another phenomenon having impact on curves of efficiency is reusability. If the investment in terminology building phases does not only help the current project but also other activities of a company, this reusability effect can influence the curve of efficiency. Therefore the project manager has to estimate to which extend the costs can be split up between costs that can be directly allocated to his or her project and costs that can be allocated to other projects or general company cost centers. This might decrease the total cost of communication for the terminology building phases (i. e., directly after decision D1 and D2). The cost curves of terminology T2 and T3 would have to be shifted down in that case.

3.6 Limitations

The efficiency model with its different cost curves is only meaningful and applicable if one of the following situations occurs:

- The actual estimated project degree of complexity is higher than the project degree of complexity estimated before.

- The scope of the project was changed and new estimations for the curve of efficiency are needed to adapt the project plan.
- The curve of efficiency has to be adapted due to possible time constraint violations becoming clear by actual estimations.
- The curve of efficiency has to be adapted due to possible cost constraint violations becoming clear by actual estimations.

Therefore the efficiency model is only suitable for complex projects like FDWH projects. Simpler projects without change of scope or with limited complexity will not need to be reviewed and adapted as often. So the efficiency model is only suitable to explain and predict management decisions in complex projects depending on communication efficiency. Another limitation is that the whole approach is based on subjective understandings of the involved project members and project managers. As project managers rely on information coming from the project team, the project team evaluates itself. Furthermore the approach is based on the precondition that project managers work in line with the goals of the project sponsor and no other interfering goals exist.

Although the model shows only a few possible cost curves in the examples, there is an infinite number of cost curves due to the huge set of possible terminologies. Each term added to a terminology produces a new terminology. So possible terminologies and their corresponding cost curves for a specific project lead to a floating intersection of cost curves for this project. However, the project manager cannot have all of these possibilities in mind. It depends on his or her subjective awareness of different terminologies or approaches to gain them. Most times the project manager will not be able to define concretely how a new terminology should look like, but makes some kind of best guess what terminology and corresponding cost curve might be reachable. That brings project managers to just define how much costs are invested and to hope that a suitable cost curve is reached. This once again makes clear that project management has to do with experience and a feeling for efficiency. As far as the model is developed, it is only applied to the financial data warehouse context. Further research should focus on generalizing the model to other complex ISD projects and implications for less complex projects.

4 CONCLUSION & OUTLOOK

A theoretical model for communication efficiency in FDWH projects was derived based on a theory of communication costs and project management fundamentals. The model is based on exploratory research of the last years and should be able to explain and predict identified specifics of FDWH projects.

The model suits the conditions for theoretical models given by Lee (1989) based on Popper (1965):

- *Falsifiability*: the theoretical model is presented in a way that allows testing against the theoretical approach by conducting empirical studies focusing on it.
- *Logical consistency*: the inherent mechanisms of the model are explained in a step-by-step way to assure logical consistency. Additionally, special cases and common project situations were stressed.
- *Relative explanatory power*: the theoretical model explains FDWH project observations in a more sophisticated and detailed way than the introduced general communication cost model or the introduced general software project management classification.
- *Survival*: since the first idea for a cost-based approach to FDWH in the beginning of 2007, no better applicable model could be found by our research group.

As all criteria are met for the moment, further research steps can be taken to corroborate the theoretical model for FDWH projects in real settings. Currently, additional research focuses on testing the theory in different FDWH project situations in multiple case studies (Räkers and Rosenkranz 2009) and future research will try to apply the theoretical approach to ISD projects beside financial data warehousing as well.

To sum up the findings and formulate theoretical suggestions coming from the efficiency model for FDWH projects, there are already practical implications for the behavior of project managers. They should keep in mind that communication costs are one of the most relevant drivers for project efficiency, and that the complexity of the project has to be judged and estimated throughout the project to stay on the most efficient curve. Due to the characteristics of communication cost functions, investments in terminology should be done as soon as a need for a higher estimated degree of complexity for a project is identified. Practically, this means to engage team members more into face-to-face communication when new variety enters the project environment or becomes visible.

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