# PROCUREMENT OF INTEGRATED IT SYSTEMS FOR THE DEREGULATED ELECTRIC UTILITY

**Jonas Andersson, Pontus Johnson**
**Dept. of Industrial Control Systems, KTH, Royal Institute of Technology**
**SE - 100 44 Stockholm, SWEDEN**
**Tel: +46 8 790 68 20 - Fax: +46 8 790 68 39 - E-mail: jonasa@ics.kth.se**

## SUMMARY

*Management of mission critical Information Technology (IT) systems constitutes a growing problem area. This paper deals with procurement of integrated IT systems for Electric Utilities from an organizational and a requirements engineering perspective. The presented analysis is based on an industrial case study of a procurement project. The procurement was carried out by one of the major Scandinavian electric utilities. The purpose of the paper is to describe two analytical frameworks and their application on industrial IT-procurement projects. The frameworks consider intra-organizational as well as inter-organizational aspects of such projects.*

## INTRODUCTION

### Background

Electric utilities have a long tradition of technology procurement. The recent deregulation of the Swedish electricity market has brought increased attention to Information Technology (IT) procurement issues, as the restructuring of the market has resulted in substantial investments in new IT systems. A more competitive environment has lead to a strive for shorter time-to-market, leaner organizations, and cost-cutting. In addition, utilities are influenced by the rapid evolution of IT. This evolution has not only opened up new opportunities, but has also increased complexity of IT projects.

IT procurement projects are normally carried out according to one of the following two modus operandi, *traditional procurement* or *partnership-oriented procurement*. The procurement project analyzed in this paper has attempted to combine the advantages and manage the disadvantages of both approaches. The research project has, from a buyer perspective, taken organizational and requirements engineering issues into consideration. The content of the paper is relevant for all utilities facing deregulation and/or major IT renewal efforts.

The studied procurement project is of special interest for several reasons. Firstly, the procurement strategy was well defined in the early phases of the project. Secondly, the contract contains only functional (i.e., technology independent) requirements. Thirdly, the project incorporates a strict definition of responsibilities between buyer and vendor. Fourth, both the buyer and the vendor considered the project successful.

### Purpose

The overall purpose with the research project has been to evaluate the applicability of the theoretical frameworks used, to find out how these frameworks can support planning, management, and experience feedback of IT procurement projects. The studied project has been analyzed from both an intra- and an inter-organizational perspective. The intra-organizational analysis, which focuses on how a structured pre-defined methodology can improve a state-of-the-practice IT procurement project, is mainly based on [1]. To analyze the inter-firm relationships in the studied project, an inter-organizational approach, based on [2], [3], [4], and [5], has been applied. The inter-organizational analysis has focused on the following characteristics of the transaction between the buyer and the vendor organizations: Degree of product standardization; Formal communication; Informal communication; Risk distribution, Hierarchical control features; and Degree of requirements specification detail.

### Methodology

The research project has been carried out as a descriptive case study in two phases. In the first phase, an exploratory study has been conducted in order to create an understanding for the project, its actors, and the procured system. The second phase has focused on analyzing the collected information from a procurement methodological, i.e. intra-organizational, and an inter-organizational, perspective.

The data collection has aimed at producing qualitative material. Throughout the research project, methodology according to [6] has been used for case study design. The sources of data include protocols, progress reports, specifications, and the contract, as well as in depth interviews with key-personnel from both the buyer and the vendor. Before the analysis, all collected data has been validated with involved parties. After the analysis, the results have been audited with the involved parties in order

to validate the results and identify usable experiences for future IT procurement projects.

**Outline of paper**

The content of the paper is divided into four sections. In the first section, three types of procurement projects are described, namely traditional procurement, partnership-oriented procurement, and functional procurement. The main characteristics of the studied procurement project, and the main features of the procured system, are presented in the second section of the paper. In Sections three and four the procurement is analyzed from an intra- as well as an inter-organizational perspective. The paper ends with concluding remarks. Note that the terms *acquisition* and *procurement* are used alternatively throughout this paper.

## TYPES OF PROCUREMENT PROJECTS

**Traditional procurement projects**

In *traditional procurement* projects, procurers single-handedly specify the desired system functionality in a Request-For-Proposal (RFP). Based on the RFP, the vendors present proposals including a technical specification, which constitutes the base for the system selection. Traditional procurement is characterized by formalism, competition during bidding, and detailed requirements specifications. Trust is typically low and the parties strive to divide risks, and make the respective responsibilities of the involved organizations explicit. The utility typically spends considerable resources on the evaluation of the technical system when selecting a vendor.

**Partnership-oriented procurement projects**

An alternate approach is the *partnership-oriented procurement* project, where the procurer and the vendor jointly specify and develop the system in close co-operation. The utilities' selection process here focuses on the vendor and its perceived capability to fulfil its obligations in terms of technical competence, available resources, and financial strength. Partnership-oriented procurement is characterized by low formalism and adaptive, sequential decision making, where major issues are settled after the vendor has been selected. As the transaction scope definition tends to be vague, partnership-oriented procurement often allows for considerable vendor discretion. Trust is considered high and risks are often shared or unclearly divided .

**Strict functional procurement**

Functional procurement refers to procurement projects where the buyer's requirements specification solely specifies *system functionality*, i.e. *what* the system is to perform [7]. In functional procurement projects, it is the vendor's exclusive task to specify the *system design*, i.e. *how* the system is to meet the functional requirements. As functional procurement implies considerable vendor discretion, the vendor is also expected to assume the *functional risk*, guaranteeing not only that the system is constructed in accordance with the design specification, but also the actual functionality of the system.

## THE STUDIED CASE

**The procurement project**

Characteristic for the studied project has been the buyer's *strict* functional approach, which has lead to the vendor assuming the greater part of the total functional risk. In the project, the vendor has also taken the full responsibility for the interfaces towards existing surrounding IT systems within the buyer's organization, except for issues related to the buyer's internal local area network. A fix price agreement has added to the vendor's comparative risk. In return, the vendor has obtained considerable latitude in the choice of technical solutions, providing it with the prospect of making extensive use of its present portfolio of standard system components. Thus, development of new, customer unique functionality, which is considered a risk, can be minimized. However, the strict functional approach was a new experience for the vendor, and also meant a new way to deal with IT procurements for the buyer. The main purpose of adapting the concept of "strict functional procurement" on an IT procurement project was to distribute a considerable part of project risk on the vendor - not only in theory, but also in practice. Clarity in distribution of risk and responsibility was deemed important; formal inter-firm communication was therefore stressed.

**The system**

The procuring project represented three separate subsidiaries to the utility, with slightly differing requirements. The procurement therefore concerned three resembling systems. The system to be procured in the studied project is a client-server based system for the deregulated electricity market. The system, featuring a standard relational database, required integration with a number of surrounding systems, including metering systems, customer information systems, and various communication systems. The system integration undertaking, mainly relying on low level integration employing file transfer solutions, necessitated involvement of third-party assistance in addition to the tasks performed by the buyer and the vendor. Since the procurement comprised three integrated systems for three different organizations, the number of system interfaces was fairly high.

# INTRA-ORGANIZATIONAL ASPECTS

## Software Acquisition - Capability Maturity Model

This section discusses software procurement from a buyer perspective. Although, the buyer and the vendor agreed on that the studied project was successful, that the project objectives were well defined, and that the buyer had an adequate procurement strategy, the applied methodology was entirely based on previous experiences of individuals in the procurer's organization. I.e., the buyer's project team used no structured and well-documented model for quality assurance of software related procurement projects.

In order to analyze the procurement from an intra-organizational perspective, the authors selected parts of Level two of the *Software Acquisition – Capability Maturity Model* (SA-CMM) [1] as a framework. SA-CMM is a model for process quality improvement of software procurements. The framework has been developed by the Software Engineering Institute, Carnegie Mellon University. The model is adapted to a wide range of software procurements, from procurement of commercial-of-the-shelf products to procurement of source-code development. The model includes five levels, namely *Initial*, *Repeatable*, *Defined*, *Quantitative*, and *Optimizing*. For each level, the model contains a number of *key-process-areas*, which the authors of the model have identified as significant for carrying through successful procurements of software systems. Each key-process-area comprises a number of goals and five "common features": *Commitment to perform*; *Ability to perform*; *Activities performed*; *Measurement and analysis*; and *Verifying implementation*.

SA-CMM's Level two, *Repeatable*, focuses on an organization's ability to repeat previous successes and to some extent, learn from gained experiences. The key-process-areas of Level two are: *Software Acquisition Planning*; *Solicitation*; *Requirements development and Management*; *Project management; Contract Tracking and Oversight*, *Evaluation*; and *Transition to Support*. Hence, the process capability of a SA-CMM Level two acquisition organization can be summarized as being stable for planning and tracking of the software procurement, since documented procedures provide a project environment for repeating earlier successes. It is stressed that this paper does not present the result of an assessment according to SA-CMM. SA-CMM is a quantitative model whereas the study mainly has been qualitative. The key-process-areas of SA-CMM's Level two have been used as an example of a general-purpose framework for structuring software procurement projects. The model is intended for procurement of software only. However, one outcome of the study is that the key-process-areas of Level two are applicable also when procuring systems containing hardware. The authors of this paper strongly advise against procurement of hardware and software separately, since hardware and software are intrinsically coupled, which for instance become evident when performance aspects of a system are dealt with.

## Planning of procurement

In the studied procurement, no written guidelines formed the basis for planning of the different phases of the procurement. Instead, the planning of the project was based on the buyer representatives' unanimous view of software procurement management. Requirements specifications and other documents where developed in a number of steps. A number of internal feasibility studies were followed by a pre-study, which led to a *Project directive* document, in which the studied project was one of several proposed projects. The documents were then gradually refined during the pre-project, and the contractual negotiation.

Changes of project objectives and basic system requirements are common causes for over-run budgets and failure to reach contractual requirements [8]. The project's functionally formulated requirement specification was "frozen" when the contract was signed and thereafter constituted the core document of the project whenever there was a contractual disagreement between the vendor and the buyer. Since this document mainly was technology independent, topics related to the technical implementation of the system, including system integration, were left to the vendor's discretion. Both the buyer and the vendor state that the chosen approach was a contributing factor to the fulfillment of the project's functional intentions.

The Project plan was not compiled into a written document prior to contract execution. All topics in the plan were regularly tracked during the remaining part of the project. A number of topics stated in the SA-CMM were not included in the project plan, nor were they tracked and managed later in the project, e.g. early life-cycle-cost (LCC) analysis and planning of system lift-cycle support. Negligence to estimate the LCC and to outline a migration path for an integrated IT system, during the early phases of a procurement, can easily lead to high costs and limited freedom of action during later phases of the system's life-cycle [8] [9].

## Project management

At the repeatable level, the project team is aware and supportive of policies, regulations, and standards that relate to the project and attempts to comply with them. Planning and tracking of a project is based on experience with similar projects. The project manager tracks costs, schedules, requirements, and project performance. Also, the project team tracks the performance of the contractor for adherence with the project plan and for compliance with contractual agreements.

According to SA-CMM, the purpose of project management is to handle the activities of the project to ensure timely, efficient, and effective software procurement. Project management involves planning, organizing, staffing, directing, and controlling activities and tasks. No project plan was written prior to the planning and evaluation phases of the studied project. Instead, documents such as the steering-committee's Project directive, meeting protocols, and later the RFP provided structure and guidelines until the contract was signed. In spite of the absence of a project plan, no lack of structure related to project management became evident during the study. The detailed progress of the procurement project was tracked in monthly reports, which were prepared before each steering- committee meeting. The reports included a detailed description of the project progress relative the previous meeting. Also, project meetings, the vendor's status reports, quality assurance, milestones, requirement management, resources, and project economy were tracked in the reports. The reports were concluded with the project leader's personal view of the project's status.

### Requirements engineering

**Requirements formulation.** During the formulation of the RFP, the buyer's project team spent substantial effort in order to formulate technology independent and vendor neutral requirements. Further, no structured guidelines or methods on requirement formulation were used during the design of the RFP. As a result, the contractual requirements did not fully met SA-CMM demands on being unambiguous, traceable, and verifiable. For example, some requirements related to performance under operation were not possible to test, since neither the test environment nor the initial operational conditions, provided sufficient conditions for adequate requirements verification.

**Evaluation of proposals.** In contrast to SA-CMM requirements, no separate written plan formed the basis for the actions carried out during the evaluation phase of the procurement. Instead, the RFP contained information on the criteria for evaluation of proposals sent by the potential contractors. The Swedish and the European legal framework for procurements heavily influenced the procedures for selecting a contractor.

**Verification of contractual requirements**. The purpose of verification is to determine that the procured system satisfies the contractual requirements prior to the formal approval and the hand-over of the system to the end-user organization. The contract stated that there would be no formal approval of design or technical solutions prior to system acceptance. However, during the design phases and the vendor's integration tests, the buyer commented on the result to avoid misunderstandings. Therefore, the only test where the buyer formally accepted the system was the

Site-Acceptance-Test (SAT). In accordance with the requirements of SA-CMM, the general guidelines for testing procedures and explicit performance requirements were specified in the contract. The test procedures were developed from the contract specification, translated into use-cases [10], and checked back against the contractual requirements after the SAT. Personnel from the vendor mainly carried out this work. However, the buyer should reviewed and approved the SAT document. The contract also reserved the buyer's right to introduce new tests during SAT.

## INTER-ORGANIZATIONAL ASPECTS

### Market and bilateral governance

According to transaction cost economics [2], the relations between a buyer and a vendor organization may be placed on a scale between *market governance* and *bilateral governance*. *Market governance* is characterized by short transaction time, formalism, competition, an efficient legal system, and contingent claims contracting. Furthermore, the market governance form is argued to require low transactional risk and to promote a low degree of communication [2].

*Bilateral governance* is based on the concept of mutual dependence. The relation between the trading parties is long-term, communication is informal, and unbalanced dependencies are accepted. Decisions are made in an adaptive, sequential manner as the project unfolds and the communication between the parties is extensive. The bilateral governance form is commonly referred to as suitable for high risk transactions, trust is normally considered high and responsibilities are often shared or vague [3] [4]. It is often claimed that bilateral governance entails loss of market mechanism incentives [2].

### Traditional and partnership-oriented procurement

Procurements of IT systems are not clearly classifiable into any of the extremities of the market-bilateral governance scale. The scale presented here consists of the middle segment of the market-bilateral governance scale. Traditional procurement is located on the market governance side, while partnership-oriented procurement is located on the bilateral governance side. The traditional procurement form is characterized by formalism, competition during bidding, and a detailed requirements specification, which often includes technically oriented requirements. Communication is high in the early phases of the procurement as the scope of the transaction is set, but tends to diminish during project execution. Trust is typically low and the parties strive to make the responsibilities of the organizations explicit.

Partnership-oriented procurement is characterized by low formalism and adaptive, sequential decision making.

Communication is typically extensive throughout the project, while the definition of the transaction scope tends to be vague. The partnership-oriented procurement form allows for considerable vendor discretion, thereby encouraging employment of standardized products. Trust is considered high and responsibilities are often shared or unclear.

The study has focused on the following characteristics of a transaction: Degree of standardization of the product; Formal communication; Informal communication; Distribution of risk; Hierarchical control features; and Requirements specification detail.

### The studied procurement

The studied procurement project is characterized by a high degree of standardization, significant formalism, insignificant communication, distinct distribution of responsibility and risk, hierarchical control, and a low degree of requirements specification detail.

**High degree of product standardization.** Since time was considered important by the procuring organization, a key concept was to make as extensive use of standardized components as possible. Also, standard product employment may lower costs, and reduce the risks inherent in development of customer-specific functionality [7]. To encourage the vendor to use standard products, the procurer formulated functional requirements with a low degree of detail.

**Functionally formulated requirements.** The argument for functional specification combined with low-detail specification is that it gives the vendor freedom of choice concerning design considerations, while retaining a clear division of risks, as the vendor accepts the *functional responsibility* [7]. The scope of the transaction is thereby viewed as determined, since testing of functional requirements is considered viable in spite of the low degree of specification detail. Note that it is important for the buyer to succeed in the specification of truly verifiable requirements.

**Distribution of risk.** The vendor assumed an extensive portion of the risk in the transaction. As previously discussed, functional responsibility refers to vouching for *functions* rather than *design*. To take responsibility for system integration involves assuming risks for third-party products and services, since system integration rarely is carried out by the vendor alone. It is here important to point out that there are limits to the vendor's ability to assume risk. In the studied procurement, the vendor was a relatively small and new actor. Consequently, the vendor's abilities to handle economic or other losses were confined. When the vendor is assigned extensive risks in the contract, it may incur substantial financial loss in case of third-party non-performance. If the vendor does not possess an adequate financial body, it will not be able to fulfill its contractual obligations.

**Formal communication.** The procurer considered formal communication important in the inter-firm relations. Agreements were textual rather than oral, meetings were documented, and significant opinions and views where communicated in a written form. The argument for formal interaction was to maintain a clear distinction as to the distribution of risk.

**Informal communication.** The communication between the buyer and the vendor was considered unsatisfactory by several interviewees. One consequence of the reduced communication in combination with the low degree of detail in the requirements specification was misinterpretations. The vendor perceived the requirements on the system as vague, which occasionally resulted in design and implementations of system components based on speculations on the desired system functionality. In a traditional procurement project, where communication tends to be of a formal nature, the requirements are more specific. On the other hand, in a partnership-oriented procurement, the degree of informal communication is higher. In the studied functional procurement, the requirements were at several occasions too diffuse, and the communication was too limited to avoid misinterpretations.

**Hierarchical control features.** The procurer introduced several hierarchical control features in the contract, such as significant fines in case of vendor non-performance, functional responsibility assumed by the vendor (including responsibility for certain third-party performance), and quality inspection options at the procurer's disposal. The power asymmetry inherent in the differences in financial bodies and commercial experiences of the procurer and the vendor added to the hierarchical structure. Control may be desirable when facing transactional uncertainty. Although the procuring organization had experience of strict functional procurement in other areas, they had not employed it when acquiring IT systems. The uncertainty was increased by a low-detail requirements specification introducing the risk of misinterpretation, and an initial uncertainty as to vendor commitment and commercial competence.

To sum up the findings of the inter-organizational analysis, the authors advocate the following. Functional procurement with a fairly low-detail requirements specification facilitates a high degree of standardization. However, functional procurement requires the vendor to assume the functional risk. To make the distribution of risk between the buyer and the vendor distinct, formal communication may be employed. But, since the requirements specification detail is low and the content of the formal communication is limited, it is recommended that functional procurement is complemented with a focus

on informal inter-firm communication. Further, hierarchical control features may be desirable when facing transactional uncertainty, such as new transactional forms, vague transaction scope, misinterpretation risks, or uncertainty regarding vendor performance or commitment.

## CONCLUDING REMARKS

The intention of this paper is to compare state-of-the-practice procurement methodology of a integrated IT system with two theoretical frameworks in order to explore how theory and practice can be mutually improved. The authors would like to stress the importance of an early structured analysis of procurement strategy and methodology. The analytical frameworks applied to the studied procurement highlight some potential intra- and inter-organizational pitfalls.

Well-defined objectives and an adequate procurement strategy are vital factors when procuring integrated software systems. Changes of project objectives and basic system requirements are common causes for over-run budgets and failure to reach contractual requirements. Combining a strict functional procurement approach with a low-detail requirements specification, offers the vendor the possibility to maximize its use of standardized software components, thereby lowering costs, saving time and reducing risk. However, it is emphasized that strict functional procurement be complemented with a focus on informal inter-firm communication. Furthermore, the authors stress that functional procurement projects pay special attention to the formulation of unambiguous and verifiable requirements.

A structured framework for IT system procurement can help in managing risk factors early in the project, which may have a significant impact on the system in its later life-cycle phases. Also, feedback of experiences must be prioritized so expensively learned lessons can be implemented in succeeding IT procurements.

## REFERENCES

[1] J. Ferguson, et. al., *Software Acquisition Capability Maturity Model (SA-CMM) Version 1.01*, Technical Report CMU/SEI-96-TR-020, Software Engineering Institute, Carnegie Mellon University, Pittsburgh (1996).

[2] O. Williamson, *The Economic Institutions of Capitalism: firms, markets, relational contracting*, Free Press, New York, USA (1985).

[3] M. Sako, *Price, Quality and Trust: Inter-firm Relations In Britain and Japan*, Cambridge University Press, Cambridge, (1992).

[4] P. Ring, A. Van de Ven, *Structuring Cooperative relationships between organisations*, Strategic Management Journal, vol. 13, pp. 483-498 (1992).

[5] A. Stinchcombe, *Contracts as Hierarchical Documents*. Article in Stinchcombe, Arthur L. Heimer, Carol A. *Organization Theory and Project Management,* Norwegian University Press, Oslo, Norway (1985).

[6] R. Yin, *Case Study Research: Design and Methods*, Second Edition, SAGE Publications, Thousand Oaks, California, USA (1994).

[7] T. Cegrell, Systems Specification and Requirements Engineering, Publiched in the technical report: The ISES Project. Enersearch, Malmö, Sweden (1998).

[8] J. Andersson, *On IT System Integration – Prospects and Consequences of Energy Market Deregulation*, Litentiate Thesis, Ex.R 97-07, Royal Institute of Technology, Stockholm (1996).

[9] M. L. Brodie, M. Stonebraker, *Migrating Legacy Systems - Gateways, Interfaces & The Incremental Approach*, Morgan Kaufmann Publishers Inc., San Francisco, USA (1995).

[10] I. Jacobson, et.al., *Object-Oriented Software Engineering: A Use Case Driven Approach*, Addison-Wesley Publishing Company, USA (1992).