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Experiences While Selecting, Adapting and Implementing ERP Systems in SMEs: A Case Study

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ABSTRACT

Enterprise Resource Planning (ERP) systems are important for all kinds of enterprises. The selection and implementation of such systems are very difficult and many projects do not meet their expectations. While large companies have financial and human resources to engage in such a project, the situation for smaller sized enterprises is different. They have only limited budget, human resources and experiences. Hence, this case study describes an EPR selection and implementation project at a small-sized enterprise by analyzing the selection and implementation procedure and its critical success factors.

Keywords

Case study, SME, ERP, BPR, SME, Enterprise, Process Management, Implementation

INTRODUCTION

The development and introduction of enterprise resource planning systems has been a major cause of change within enterprises over the last two decades. The emancipation from hard-coded individual systems with the help of standardized systems enables more flexible and adoptable business processes that can be changed to market demands (Davenport 2000; Shanks, Seddon and Willcocks 2003). However, the implementation of ERP software is very difficult and many projects do not meet their expectations or some even fail (for examples see Themistocleous, Irani and O'Keefe 2001; Willcocks, Petherbridge and Olson 2002; Robey, Ross and Boudreau 2002; PSCA 2006). Larger enterprises, being the natural early adopters of this kind of technology, have financial and human resources to start a project again. In contrary, for smaller enterprises with limited budgets failures or budget exceedances are an eminent problem. Furthermore, they only have limited experiences, resources and skills that help addressing and overcoming these matters (Adam and O'Doherty 2003).

This paper is a case study paper that describes the case of an ERP project within a small-sized ERP company. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context (Yin 2003). Writing up our experiences in a case study has three aims. First, it allows other researchers to get an impression of the holistic and meaningful characteristics of real-life events with organizational and managerial decisions and project issues in small-sized enterprise. Second, the paper wants to contribute to the ERP case studies for teaching and educational purposes by trying to illuminate why certain decisions were taken, how they were implemented and with what result. Third, the paper discusses the limitations within an ERP project in smaller enterprises and helps identifying possible solutions. A consideration of the critical success factors and lessons learned of such a project helps determining implementation and project management issues of smaller-sized ERP projects. The paper is a contribution to the AMCIS track "case studies on enterprise systems" that addresses "case studies on the planning and implementation of enterprise systems."

INITIAL SITUATION

Depiction of the enterprise

The project partner, we consider in this case study, is a small-sized German company of the manufacturing industry. The enterprise is developing metal products since 1970. Vertical integration is low, but product diversity is very high. About 125 employees are employed at one site. Products are built with the use of technologies like welding and assembly robots, CNC manufacturing equipment or CAD driven planning and design. Materials required for production are almost entirely bought. These are raw materials and supplies, in the main steal of varying dimensions.

At the company, order processing is done individually for each customer, due to the high diversity of product variants. Only a small amount of the overall contracting volume is covered by stocked standard products, which are normally shipped to customers with 24 to 48 hours. Members of the company's in-house sales team handle customer requests directly or forward orders to technical sales and distribution, if further order clarification is necessary. If an order does include non-standard products, production can only start after technical clarification.

IT-Infrastructure before the ERP implementation and goal of the ERP implementation project

Support of the as-is IT solution to the company's business processes was realized through a customized, COBOL based software system, which was implemented and maintained by an external service provider. It was an outdated hard-coded solution with limited functionality that did not match the company's requirements anymore. For example, the as-is system mainly focused on the creation of documents, required during order processing (e.g., enter orders and print order confirmations, write shipping orders or create bills- and working papers). Many processes were only possible with media breaks and manual steps instead of automated processes.

The age of the – from today's perspective outdated – system as well as its incomplete functional support of important operating areas, constituted the main reason for the replacement of the as-is IT infrastructure by an integrated ERP and PPC system. Furthermore, many isolated solutions existed. Using the as-is IT infrastructure neither supported the generation of orders from proposals, nor enabled computer-based procurement or even capacity-driven planning of production orders. Capacity planning was entirely done by an experienced production manager. Order taking was predominantly done without information on capacity utilization; proper time scheduling was not carried out.

Moreover, there has been plenty of data retyping in particular between administration and manufacturing, resulting from lacking integration of the IT infrastructure. Due to missing IT support, multiple tools like Microsoft Excel have been used, where users needed to compare and maintain data manually. In doing so, workers needed to manually note the completion of orders on their working papers, before administration employees had to re-enter this information into the software system. Hence, corresponding production order data was only available with a delay of one day, as production data acquisition (PDA) did not exist.

Thereto, no IT support for the preparation of controlling relevant information (e.g., post calculation of customized orders) or the possibility of connecting the as-is software system to the internet (e.g., for data exchange with importing business partners) has been available.

The company did not start a deep make or buy discussion (Harrell, Higgins, Ludwig 2001) when deciding on a new ERP system. Due to the small size of the enterprise, individual software was hardly discussed. Instead, the company decided to buy a standard software system. Due to the broad functionality of standard ERP systems and their implemented international business knowledge it is hardly reasonable to develop individual ERP systems (Knackstedt, Winkelmann, Becker 2006). Furthermore, most production and retail sectors have various standard systems that support most typical processes within the sector.

The software system should offer ERP functionality with a focus on covering PPC-functionalities. The system must support customer-dependent production and capacity planning. In a first implementation step it should only substitute the old system and improve the automation of existing processes. Since there has not been an in-house IT department until the implementation of the integrated ERP and PPC software solution, we – being consultants at the project's site – should furthermore verify the possibility to run the system without designated in-house IT employees. In doing so, the company demanded a periodic maintenance by the vendor or the implementation partner only. Software as a Service (Turner, Budgen, Brereton 2003) was not considered because the company wanted to keep the data in-house. Consequently, the system should be able to run mostly autonomously, highly stable at a low level of failures. Because of the smaller-sized business characteristics, our project partner requested a set of implementation references from potential vendors.

REPLACEMENT OF THE AS-IS IT INFRASTRUCTURE BY INTEGRATED STANDARD SOFTWARE

Process modeling of the as-is-situation

Initially, we documented and analyzed material and information flows by the use of Petri-Nets, to gain an overview of the status quo and the potential of a new system implementation. We evaluated business processes and information flows based on a strengths and weaknesses SWOT analysis. The overall process view and additionally identified characteristics of our project partner, subsequently constituted the basis of our system selection. Figure 1 exemplarily depicts the process of proposal generation, displayed in Petri-Net-Notation (DPN = Documentary Petri Nets).
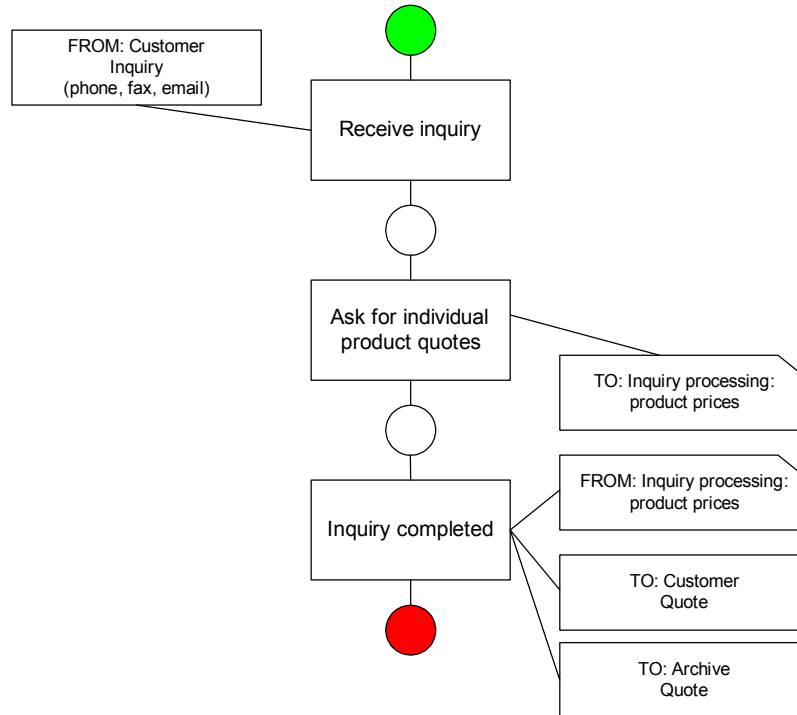
Figure 1. Exemplary modeling of proposal generation process in Petri-Net documentation

Next to the (coarse-grained) documentation of business processes, we installed data acquisition terminals for introducing operating and machine data logging as project preparation action. We used a simple, MS Access based software for this purposes. Our goal, on the one hand, was to collect machine data (e.g., setup and process time for distinct types of products), which we wanted to use in the configuration of the integrated ERP and PPC system at a later point. On the other hand, we aimed at providing the possibility of getting to know the future data acquisition process to the employees of our project partner at this early stage.

Software selection process

We identified around 60 relevant vendors of potentially suiting ERP systems in trade journals, branch summaries and at trade fairs, while generating a first overview. In the next step, we eliminated vendors without PPC-functionality, while conducting phone interviews or web research. The remainder of about 15 vendors was categorized, according to their support of variant management, lot size calculation, overlapping production as well as time scheduling, into the categories "good criteria fit", "criteria fit" and "no criteria fit". In particular, the high amount of product variants restrained the amount of prospect integrated ERP and PPC systems. Figure 2 emphasizes the vast amount of differing characteristics that are to be considered in a customer-dependent production environment.
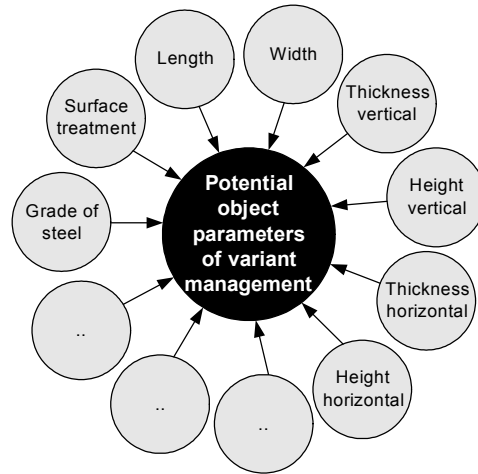
Figure 2. Potential object parameters of variant management

Finally, we requested first proposals from three vendors that overcome the probe and sent out invitations for a site visit to these software vendors, when a given scenario should demonstrate all solutions (cf. figure 3). The goal was to deploy a standard application to keep costs low, on the one hand, but also to assure release capabilities, on the other hand. Hence, implementing a strongly customized solution did not offer an adequate option (e.g. Brehm, Heinzl & Markus 2000).

Figure 3. Scenario guidelines for ERP vendors (excerpt)

ERP vendor selection

Following to the presentations of the final three vendors, we selected a well-established system, due to the good functional coverage, acceptable costs, a good position in the German market and manageable implementation efforts. The software company ranks among the leading German vendors of ERP solutions based on the IBM eServer iSeries. It is a subsidiary of a software developer, which employs more than 200 employees in Germany and Austria. It focuses on particular small and medium-sized industry und wholesaling enterprises.

The selected ERP system has a three-tier-architecture and constitutes an integrated system. It offers typical ERP functionality from production to marketing and accounting (Klaus, Rosemann, Gable 2000). One IBM iSeries system is thereby required to

act as a server. Users work with a java-based, graphical and multi-window capable user interface, running on both Windows and Linux operating systems, and are able to configure necessary input masks, according to their working needs. The system can distinguish between info-users with read-only access and active users with full access rights. This is important in production because not every worker should be allowed to change data but most workers need some of the information for their work at various machines.

The ERP system offers the possibility to store so-called model parts as templates. In addition, AutoCAD modules are available to enable support of the custom manufacturing department. Hence, there exists the possibility to directly integrate parts lists of complex reengineered parts, e.g. for proposal generation. Interfaces to Microsoft Office and the possibility to integrate operating and machine data logging over existing interfaces, contributed to the selection of the ERP system.

Contracting negotiations and form of contract

The process and potential analysis that we conducted while evaluating ERP vendors, constituted a profound basis for the contracting negotiations and the form of contract between our project partner and the ERP vendor (Verville, Halingten 2003). To suite the requirements deducted therefrom, we initially selected the modules material planning, warehousing, sales, statistics and production control for productive use. It was agreed to make a decision on the use of further modules and their contractual conditions, after the selected modules have proven success. Based on the requirements provided, the software vendor suggested to use an IBM eServer i5 (model 520) as hardware platform.

Our project partner and the software vendor furthermore agreed to forgo a budget for a preliminary, detailed, and thus extensive appliance test. Based on the information available at the point of negotiations, this was mainly done due to the expectations that the ERP solution could be applied in the standard version without any modifications. Additional implementation effort was only negotiated for connecting the previously acquired production and machine data acquisition terminals. Therefore, a detailed implementation plan was not existent at sign of contract. An implementation plan should be written at the beginning of the project, collaboratively by the vendor and the company.

The originally negotiated budget did only foresee a relatively short period for implementation. It was tied to deploying the system in standard, having only minor implementation efforts.

SOFTWARE IMPLEMENTATION

Project organization

Since there has neither been an IT department available at our project partner, nor could an employee from another department overtake project management duties, due to high daily working load, the management charged us with the in-house project management. The ERP vendor alike named one project manager and one programmer to perform the modifications, to connect the existing data acquisition terminals.

The project started, having one core project team that was constituted by two employees of the software vendor and two consultants (us). In particular, the assistant to the project partner's management and, on a demand-driven basis, employees of the partner's affected business departments supported the core project team. These have mainly been (in-house) sales, job preparation and production. The resulting form of organization can, therefore, be considered as a staff and line organization (cf. figure 4).
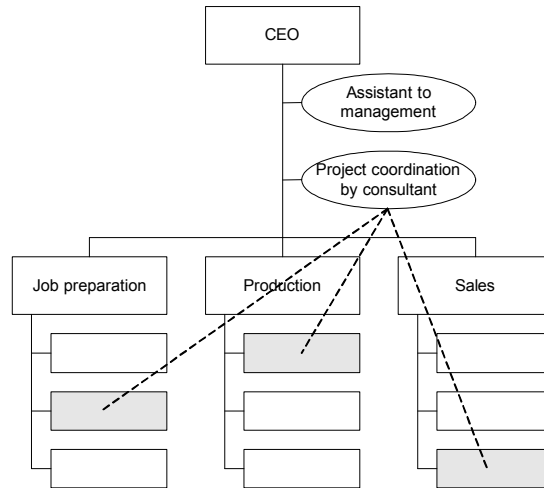
Figure 4. In-house project coordination

Project progression

All phases processed during the ERP implementation project are depicted in figure 5. Creating the infrastructural framework, mainly labeled the phase of *project initialization (phase 1).* Thereby, installing and launching an OS/400 respectively an i5/OS-based server, necessary for operating the ERP system, as well as installing the basis ERP application and the selected modules, was to be done. Next to the ERP server a Windows-capable server, operating as file and mail server, and a set of Windows-capable desktop PCs were to be installed during this phase. Later on desktop PCs were intended to replace the terminals of the current IT solution, providing client-sided access to the future ERP system. Further tasks, during the project initialization, comprised training of the core project team and the collaborative design of the project plan.

Starting point of the *as-is analysis (phase 2)* has been the process and SWOT analysis, conducted in the context of the earlier software evaluation. During the as-is analysis, existent process documentation was extended by further summaries (e.g., lists of work places or types of products with corresponding bill of materials). Moreover, examining the functional range of the as-is IT solution and business documents used within the enterprise was to be done (e.g., invoices, order confirmations, shipping orders or bar code labels). Finally, the analysis of already used operating and machine data logging gained first approximations of expected setup and processing times in dependence of types of products to manufacture.

Project phase	Tasks
Project initialization (Phase 1)	- Installation und launch of ERP server - Installation test system (basis software, modules) - Design of project plan - Training of core team - Installation und launch of Windows-Server und desktop PCs (Clients)
As-is analysis (Phase 2)	- Business document analysis - Analysis of as-is IT solutions (functionality and interfaces - Analysis of as-is master and transaction data for data migration - Analysis (coarse) of organizational and process structure
To-be design (Phase 3)	- Master data concept (in particular parts data) - Concept of variant configurator - Definition of interfaces - Develop concept of forms and input masks
Realization / Prototyping (Phase 4)	- Customizing - Implementation of user input masks - Creation of business documents forms - Execution of functional and integration tests - Start user training - Coding of modifications
Rollout / operate (Phase 5)	- Install production system - (Master) data migration from test system - Technical tuning / system behavior optimization - Adjustments to user requirements

Figure 5. Phases of the ERP implementation

Business document overviews and other summaries, generated while performing the as-is analysis, are composing the foundation of *the to-be design (phase 3)*, when printing forms and user input masks were defined. They moreover constitute the basis for the development of parts list master data, putting particular focus on the requirements of variant intense and customer-dependent production. Additionally, a role and user authorization concepts was defined upon available staff lists. Defining the interfaces to other software systems was hardly required, since the new ERP solution was designed to entirely replace the old IT infrastructure. This only excluded financial accounting, as this module was not intended to run productive in the first step.

Consequently, the implementation strategy can be considered as big bang approach (Brown, Vassey 2001). However, we want to remark that the initial goal was to replace as-is functionality with a new ERP software system only. That is why sales, material planning and production were focused. Successively addressing additional functionality should only be done after a first consolidation and familiarization period, which was scheduled to follow the launch of the new ERP (e.g., procuring, material planning, and capacity management). In doing so, existing manual efforts should be reduced in the near future.

We omitted the detailed specification of additional master data, while performing the to-be design. We rather focused on ascertaining additional required master data in collaboration with employees of affected business departments, and directly recorded the data in the system using additional mandatory or optional input fields.

Implementing the requirements was done during the *customization phase* (phase 4), using a prototyping approach. When system functionality was implemented and discussed with relevant employees of affected functional departments, based upon a typical mandate. Complying with budgeting and release capability issues, the implementation was done by utilizing the system's built-in standard functionality, as far as possible. That is why, business process modification were favored over system customizations. We furthermore designed concurrent feedback-loops to successively optimize the ERP solution. Corresponding workshops acted as initial training for end users, whereat the level of details was adapted according to users' needs.

Formulas and decision tables, integrated to the variant configurator, were used to ease the implementation of the requirements, originating from the strongly customer-dependent production. In doing so, we again contributed to the prevention of customization efforts. However, as the project progressed, it became apparent that certain business processes must not be changed and automation possibilities where missing, for so-far manually performed functions (e.g., because of high individuality or decision intensity of tasks). These absences of functionality resulted in a set of customization requirements to the standard of the ERP software system.

During the final phase of *rolling-out and operation (phase 5),* we had to reorganize and add master data and customize and configure the ERP standard. After extensively testing the system's functionality and integration, we transferred the ERP solution to the production environment. At the beginning of productively using the new ERP solution, new particularities arose, which did not appear during any of the formerly conducted interviews within the core team. Those additional requirements sometimes could be fixed very easily and quickly, but as the case may be required additional customizations to the new ERP solution. Finally, scheduled adaptations, concerning the succeeding modifications to connect the existing production and machine data acquisition terminals, and subsequent implementations of additional functionalities, consciously omitted during the initial implementation to reduce complexity (e.g., automated material planning or generation of additional reports), were applied.

LESSONS LEARNED

The selection of ERP software systems and implementation projects at small and medium-sized enterprises, possess a series of particularities. A dedicated IT department, addressing the selection and implementation of an ERP system, does hardly exist in enterprises, having a size of about 100 employees, while one normally exists at large enterprises or even corporate groups. Medium-sized companies must cope with ERP implementations, while simultaneously running their day-to-day business, due to their sizing. Furthermore, the opportunity or possibly the willingness to release a dedicated employee from day-to-day business to support ERP implementation projects on a full-time basis does oftentimes not exist. Since many tasks are performed by one or maybe two employees, it is hardly possible to release employees from daily business to software projects, as the working load is too high. This hampers the opportunities of employees, affected by the software implementation, to get intensely involved into the implementation project, hence to actively bring up requirements of the own field of work, beforehand.

According to changes in business requirements, IT-structures have historically grown in many companies. At the same time, most employees do not hold the necessary level of IT knowledge. That is why, in particular in the beginning of such projects, it is essential to accompany the establishment of a framework for future directions, with intense preparatory work and reflection. This will contribute to not needlessly prolonging subsequent project phases. As outlined in this paper, process modeling has proven value as basis for subsequent ERP-system selections and their implementation.

However, it must not be underestimated that systems, which are to be replaced, often hold a detailed implementation of company-specific know-how and therefore fit the company's requirements precisely. This must mostly be attributed to continuous and long-run adaptations, driving the historical growth of existing (as-is) systems. Even if the functionality of elderly systems is low, we can conclude that a comparable degree of individuality is not achievable without modifications or significant adaptations to the standard of modern ERP systems, even for small or medium-sized businesses. In regard to this background, more detailed considerations of existing coarse-granular business processes might have revealed further need for adaptation, in the context of this case study at an early stage. In doing so, we would have identified some of the additional end-user requirements, discovered after productively using the implemented ERP system, in advance and would not have overcompensated supposed savings, when forgoing a preliminary and extensive appliance test.

During our project, initial barriers arose from the implementation of the new ERP system, involving higher complexity and less flexibility in comparison to the former system. The therein missing integration of separate business departments, allowed employees to react highly flexible to individual change request made by customers. The new ERP system and its use of automated lock flags, made such behavior unmanageable. In addition, the former software system has proven more performance, while executing batch jobs or manually completing inputs (due to predominantly textual input masks). We were

able to reduce the expenditure of time, while completing data inputs, to an acceptable amount, by designing more efficient input masks in collaboration with the software vendor.

In the course of our project, we continuously improved the realizable economic benefit. At first, the new ERP systems mainly addressed functionalities, being already available in the former system. It added only little additional reporting functionality at the beginning of its productive use. Later on, significant benefit was achieved by the use of the new ERP system, after additional end-user trainings, continued system adaptations and implementing supplementary modules (like e.g., controlling and financial accounting). A quantitative evaluation of the project outcome is hardly possible and was not part of our research in the company. It is to be assumed that the realizable economic benefit will further increase in the future. In total, it turned out that various critical success factors contribute to the success or failure of such a project. To summarize our findings we used the Critical Success Factors as discussed by Somers & Nelson, 2001 (cf. table 1).

Critical Success Factor derived from Somers & Nelson, 2001	Case Study Results
Top Management Support	The CEO of the company supported the project whenever necessary. However, the understanding of requirements was very limited due to a lack of IT expertise.
Project Team Competence	Due to a shortcoming of employees none of the in-house employees was able to overtake the task of a project manager. Hence, we had to take this role. On the one hand, our IT expertise turned out to be very helpful for the company. On the other hand, our lack of internal knowledge was counter-productive sometimes.
Interdepartment Co-Operation	Due to the high daily working load, co-operation between departments or the overtaking of project duties among departments was very difficult. We believe, that a more intense incorporation into the project would have been very beneficial for the project but we also see the problems of daily duties in small and medium sized enterprises.
Clear Goals and Objectives	The main goal of the project was to abolish the proprietary old solution with a new system. Furthermore, the company wanted to abolish the incomplete functional support of operating areas. During the project, it turned out that there were additional demands and arising greedinesses, which led to an increase in budget, time and effort of implementation.
Project Management	See "Project Team Competence".
Interdepartmental Communication	Low hierarchical structures and an openness within the company turned out to be very helpful for the ERP project. Nevertheless, the lack of time due to daily work loads made interdepartmental communication very difficult sometimes.
Management of Expectations	Interest in the outcomes of the project was very high. Nevertheless, in the first place no excessive expectations arose.
Project Champion	n/a
Vendor Support	Vendor support was good and mostly reliable. Unfortunately, the vendor's project manager changed during the project which led to some irritations and time exceedances.
Careful Package Selection	With more than 60 potential vendors we had to conduct a careful pre-selection of relevant systems. We conducted phone interviews as well as additional web research in order to reduce the number to 15. A description of the relevant processes led to a reduction to only 3 remaining software vendors, who had to present their systems within the company.
Data Analysis and Conversion	There was a strong emphasize on master data management. With the old system, employees conducted many processes manually. For the automation of processes with the new system, reorganization and quality improvement of master data were necessary.
Dedicated Resources	It turned out that small companies such as our case study company do not have additional resources for new tasks. Hence, the company had to buy additional resources (us) and/or rely on the software vendor.
Steering Committee	Due to the relatively small size of the company the steering committee only consisted of the CEO, its assistant, us and the project manager from the ERP vendor.
User Training	In general, the IT knowledge within the company was very outdated. Hence, it was necessary to educate users a) on the general advantage of an integrated system and b) on the usage of the new system.

Education on New Business Processes	As a lot of automation came along with the project, some processes had to be changed in order to fit to the software. A strong emphasize on master data management was necessary due to the reorganization and quality improvement efforts in this area of the project.
BPR	See "Education on New Business Processes".
Minimal Customization	The goal was to deploy a standard application to keep costs low, on the one hand, but also to assure release capabilities, on the other hand. Hence, implementing a strongly customized solution did not offer an adequate option. At the beginning, we thought about implementing the standard only but it turned out that we had to adopt the standard in order to make it work for the company.
Architecture Choices	The company is a one site company with few architectural demands. It was not important to have a 3-tier-software or a web-based GUI. However, the company was looking for a solution that needed low maintenance efforts. SaaS was not a solution because the company wanted to keep the data in-house.
Change Management	An intensive testing and a comprehensive change management was part of the project.
Vendor Partnership	The vendor was responsible for the actual implementation of the system. He was involved in all decisions and project meetings.
Vendor Tools	We could rely on vendor tools with regard to project management and master data reorganization.
Use of Consultants	We did the consultancy part of the project and also some of the implementation part. No other consultants were involved. At the end, the decision to hire external consultants (us) for the project turned out to be very valuable.

Table 1. Critical Success Factors for ERP projects with regard to our results

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