Business Process Management in the Manufacturing Industry: ERP Replacement and ISO 9001 Recertification Supported by the icebricks Method

Jörg Becker, Nico Clever, Justus Holler, and Maria Neumann

Abstract

(a) **Situation faced**: A family-owned manufacturing company recently went through the transfer of management from the older to the younger family generation. A number of problems were uncovered during this process, such as prevalence of tacit knowledge, an inefficient decision-making process, outdated IT system support, and an urgent need for certification of production processes according to quality-assurance standards (ISO 9001). Each of these problems required thorough documentation of the as-is business processes in the organization to guide their improvement.

(b) **Action taken**: To ensure that the created process models serve as a valid communication medium, the company's process landscape was created during an initial workshop between the executives and external BPM consultants. Then the information on processes in the company's various departments was gleaned from semi-structured interviews with the department employees. At the same time, process weaknesses and potential improvements were derived and discussed with the functions' management. The succeeding depiction of the to-be process framework was achieved with the help of the icebricks modeling method and the corresponding software tool, which is a lightweight, standardized approach to ensure high quality of process models.

J. Becker • N. Clever (✉) • M. Neumann
University of Münster—European Research Center for Information Systems (ERCIS), Münster, Germany
e-mail: joerg.becker@ercis.uni-muenster.de; nico.clever@ercis.uni-muenster.de; maria.neumann@ercis.uni-muenster.de

J. Holler
Prof. Becker GmbH, Altenberge, Germany
e-mail: justus.holler@prof-becker.de

J. vom Brocke, J. Mendling (eds.), *Business Process Management Cases*, Management for Professionals, DOI 10.1007/978-3-319-58307-5_22

(c) **Results achieved**: During the modeling phase of the project, external BPM consultants documented the process landscape, thereby explicating the company's knowledge and good-practice processes. The process landscape served as basis for well-informed decisions regarding the implementation options of a new ERP system, which was introduced on time and on budget in the second phase of the project. The ISO 9001 recertification of production processes was achieved in the third project phase with the help of the process documentation that had been created.

(d) **Lessons learned**: Simply deploying process models on the company's intranet platform does not necessarily lead to their desired comprehension and use. All employees have to be trained that process models are a means of communication and are never finalized, a notion that also applies to continuous process improvement. Process owners must be defined so they take responsibility for adjustments to the process environment beyond the project's lifecycle, but such responsibility is not solely that of a project manager. Furthermore, the project demonstrated the appropriateness of the icebricks modeling method for the manufacturing domain, although it was originally designed for the retail industry.

1 Introduction

The founder of a medium-sized family-owned manufacturing company retired, and his children took over the company's management. The takeover process uncovered certain deficiencies in the company's organization that had to be addressed as quickly as possible in order to maintain the company's leading position in the market. The company's original specialization was in assembling trucks' rear doors with rubber seals, but the production portfolio grew to include a wide range of products and services in the area of computer numeric control (CNC) production, machining, assembly, and coating. Currently, the company has about 200 employees and a 20,000-m^2 site in northwest Germany. The company acts primarily on the B2B market; it has about 23,000 customers and more than 90,000 production orders per year.

The dynamic market environment and increasing competition required the company to optimize its production processes in terms of time and costs and to prove compliance with modern quality standards. The new management wanted to improve the company's production processes and safety record. Moreover, since the company was highly dependent on its existing customer base, which at the time of the ownership transfer consisted of several large automotive producers, management wanted to empower the development of new products and services in order to enter new markets and become more independent and diversified.

Overwhelmed with these far-reaching change initiatives, the new owners needed support in structuring and organizing the modernization activities. Identification and documentation of the organization's existing business processes was seen as the

most appropriate approach to managing the complexity of these activities. Invited consultants spent 6 months documenting the internal as-is processes, discussing them with the management and representatives of functional departments, deriving optimized to-be processes, and putting them to use by introducing a new ERP system, conducting ISO 9001 certification of the production processes, and laying the basis for the introduction of continuous management of process knowledge in the company. This paper focuses on the process-modelling phase of the project and highlights the rationales for the modeling technique that was applied.

The case is structured as follows. Section 2 provides details about the situation the company faced before the process modeling began. Section 3 discusses the chosen approach for the process-modeling project and the actions taken to address the company's problems. Section 4 presents the results of all three of the project's phases. We conclude with a discussion of the lessons learned from the case study.

2 Situation Faced

Lack of Process Documentation

Since its foundation in 1981, the company has been a family-owned organization with an autocratic management style. It was an effective organizational form at the early days of the firm, but with the growth of the organization, the effectiveness and efficiency of this management style decreased. The founder's management style and the concentration of decision-making power at top made the growth and further development of the organization problematic. According to the company's new CEO, "What was functioning well 30 years ago no longer satisfies the needs of an organization with 200 employees." The single decision point—the founder—slowed the management process, and in some cases, the founder changed decisions that had been made proactively at lower management levels. This situation demotivated the employees and produced a negative image of the company among them.

The autocratic management style also hindered the creation of a knowledge-sharing culture in the organization. Since the tacit knowledge of single process managers was seldom exchanged, there was no comprehensive overview of the existing processes in the organization. Even the CEO lost the "big picture" once the organization increased in size. Tacit knowledge was also prevalent at the lower organizational levels. Therefore, it was apparent that the missing process documentation was a major shortcoming and a barrier to effective knowledge management. When the new generation took control, they understood that everyone in a management position had to know the core company functions and to have at least a general understanding of the processes in the organization's various departments. This idea led to the decision to start a process-modeling project for the documentation of as-is processes. The main requirements for the documented processes were comprehensibility and completeness. Since the managers were not specialists in conceptual modeling, the modeling notation used for the project had to be as simple as possible,

but it also had to allow for the depiction of a variety of elements in the organization. The company wanted each documented process to capture the process owners, to offer textual process descriptions, and to be accompanied by known weaknesses and potential for improvement. Besides representing the chronological order of activities, the process descriptions had to incorporate the IT systems' and organizational support's perspectives (Berente et al. 2009).

Outdated Information System Support

Outdated information system support added to the necessity for internal business process documentation (Berente et al. 2009). The existing ERP software had been introduced in the company in the year 2000 and suffered from a wide range of functional and usability problems. The company admitted that the ERP system lacked certain functionalities, such as efficient material requirements planning and reporting modules, which led to inefficient and ineffective decision-making and management. Because of the absence of an integrated reporting module, the company had to purchase ad-hoc reports from an external data analytics company, which was costly and time-consuming. For example, a single query cost about 500 € and 2–4 weeks of processing time. Moreover, since the most communication with the company's large customers was performed through the ERP system interface, the system had to function flawlessly, which was not the case with the existing ERP software. The company's employees often complained about the incorrect price listings or erroneous calculations performed by the CRM module.

The new owners wanted to replace the outdated software, but before starting the process of selecting and implementing a new ERP system, they had to know which processes had to be automated and to what extent. Moreover, it was sensible to perform at least some process improvement before the introduction of new ERP software, since automation of inefficient or superficial processes brings no benefits to the organization (Becker 1997).

Outdated Quality Assurance

Finally, the market and, in particular, the company's most important customer had demanded that the organization continuously demonstrate its compliance with the latest standards of production processes in terms of quality and safety at the workplace. Most of the company's competitors have undergone this certification, and while the company had once done so as well, the certificate was outdated and had be renewed as soon as possible. One of the most important certification standards was the ISO 9001, which demands well-documented production and quality-assurance processes.

Table 1 summarizes the problems faced by the company and their respective project goals.

Table 1 Problems faced and resulting project goals

Problem faced	Resulting project goal
Lack of process documentation with regard to knowledge management	Comprehensive documentation of as-is and to-be company processes
Ineffective decision-making and management because of outdated information systems support	Replacement of outdated ERP system
Outdated quality assurance because of missing recertification	ISO 9001 recertification through production and quality-assurance process documentation

3 Action Taken

The BPM project described in this case was carried out according to the procedures proposed in the frameworks of Becker et al. (2011) and Dumas et al. (2013). According to Becker et al. (2011), the first step in any BPM project should be the preparation of the modeling endeavor, which includes defining the overall modeling goal and selecting a modeling method with specific rules for syntax and semantics, along with a modeling software tool that supports the selected modeling method.

Preparation for Process Modeling

The BPM project described in the current case had three major goals: (a) creation of clean and resilient business process documentation that the company's management and employees could understand and use, (b) implementation of the new SAP Business One ERP system with follow-up end-user training, and (c) recertification of the company's production processes according to the ISO 9001 quality standard. The first goal is covered by the process identification and discovery steps of Dumas et al. (2013) framework. The latter two goals are highly dependent on the business process documentation created and can be seen as parts of the process analysis, redesign, and implementation steps of the same framework.

In preparing for process modeling, the choice of a suitable process-modeling method depends on factors like the BPM project's goal, the structure of the modeling team, and the model users' level of BPM knowledge. The current case required a process-modeling language that was easy to use and understand, but the company did not want to use textual descriptions in Microsoft Word or generic drawing tools like Microsoft Visio since these tools do not have the features that are necessary for BPM projects, such as management of the collection of process models, model analysis, or model creation by a distributed modeling team.

In the end, the icebricks modeling method and tool were chosen for the simple syntax and structure of its modeling language, predefined layers of abstraction, a semantic standardization approach using domain-specific glossary, and the use of attributes for storing related process information, particularly attributes of a hierarchical nature (Fig. 1). icebricks' corresponding web-based modeling tool has a central process repository, provides the user with a convenient way to create a

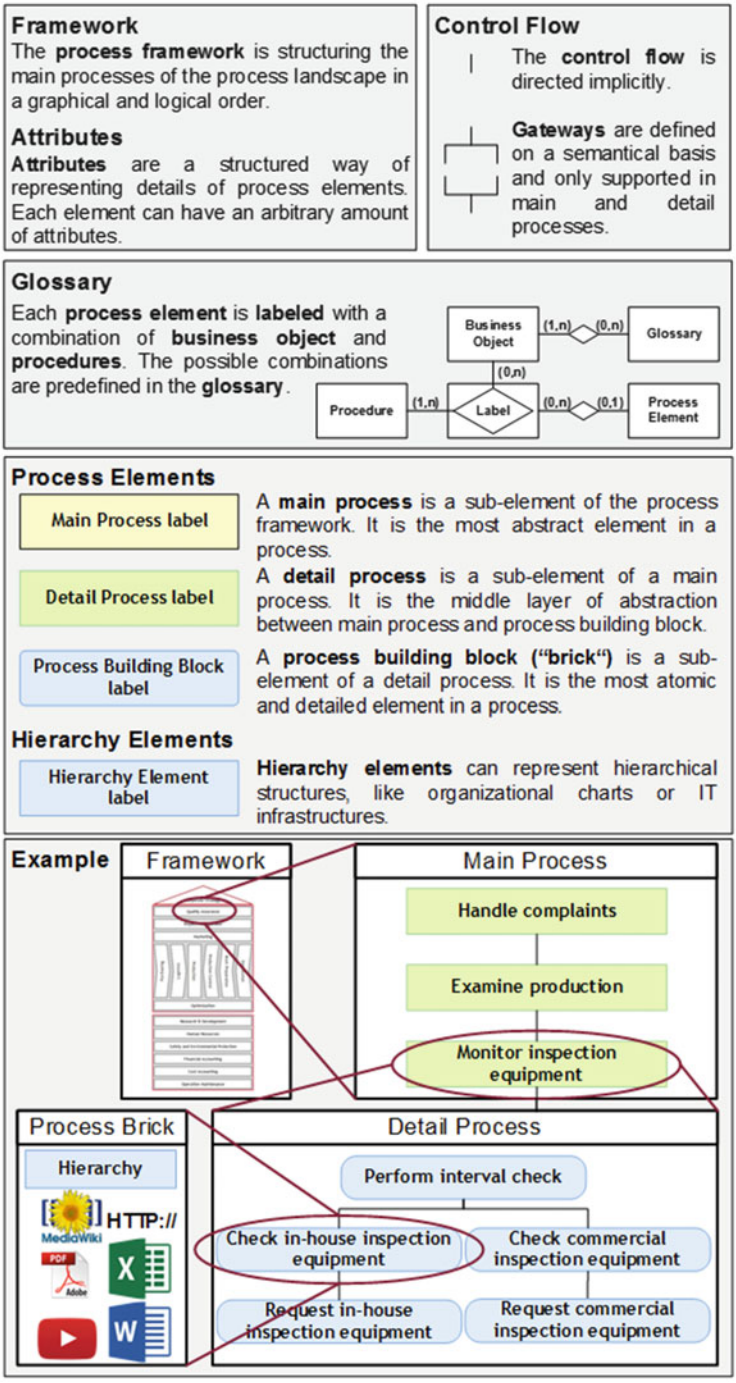

Fig. 1 Characteristics of the icebricks modeling method

standardized domain glossary, and allows model creation at different levels of abstraction by a distributed team of process modelers (Becker et al. 2013b).

Framework Construction

The new management required a comprehensive overview of all the processes in their company, but before starting the process identification cycle with detailed process analysis and redesign, it was necessary to reach agreement regarding the company's main processes and present them in the form of a process framework.

For this purpose, external consultants who had been invited to conduct the modeling and analysis part of the project organized and moderated two half-day workshops with the new owners and the relevant management representatives of the company departments. The revealed processes were organized graphically in a logical order, forming a company-specific process framework. The definition and acceptance of the process framework has significant influence on the overall modeling project's chances of success, as it provides structure and orientation for the modeling team and helps the model users to navigate efficiently through the process landscape (Meise 2001; Becker et al. 2011). In order to ease the process of defining the final form of the framework, the external consultants moderated the workshops, highlighted the important aspects of the framework, and provided examples of best-practice frameworks for the company's domain, such as the Y-CIM model (Scheer 1997). The company's strategic direction must also be taken into account when defining the process framework, so all of the high-level processes that had been identified were classified into management, support, and core processes (Porter and Millar 1985).

The icebricks modeling tool was easily applied to the creation of the framework. Its modeling language is based on the principle of abstraction, which is an inherent characteristic of every model-creation process (Stachowiak 1973). icebricks uses four layers of abstraction, which guide the modeler in creating a model. The first layer, the *process framework*, provides a high-level overview of the organization as a whole in the form of a process landscape. Under the process framework is the second layer, which consists of *main processes*, and here the various functional areas to be covered in a modeling effort are specified. The third layer consists of *detailed processes*, which specify the main processes on a more detailed level. In the fourth layer, the detailed processes are broken into *process bricks*, the most atomic process elements. These four layers, the result of long consultancy experience in the area of BPM and process-modeling projects, are depicted in Fig. 1.

After the external consultants reconciled the workshops results, the management agreed on the framework with 17 main processes, as depicted in Fig. 2.

As-Is Modeling

The next step of the BPM project, in compliance with Becker et al. (2011) and Dumas et al. (2013), was to record the detailed as-is process information regarding each of the 17 main processes. To accomplish this phase within 4 weeks, the consultants conducted semi-structured interviews with knowledgeable

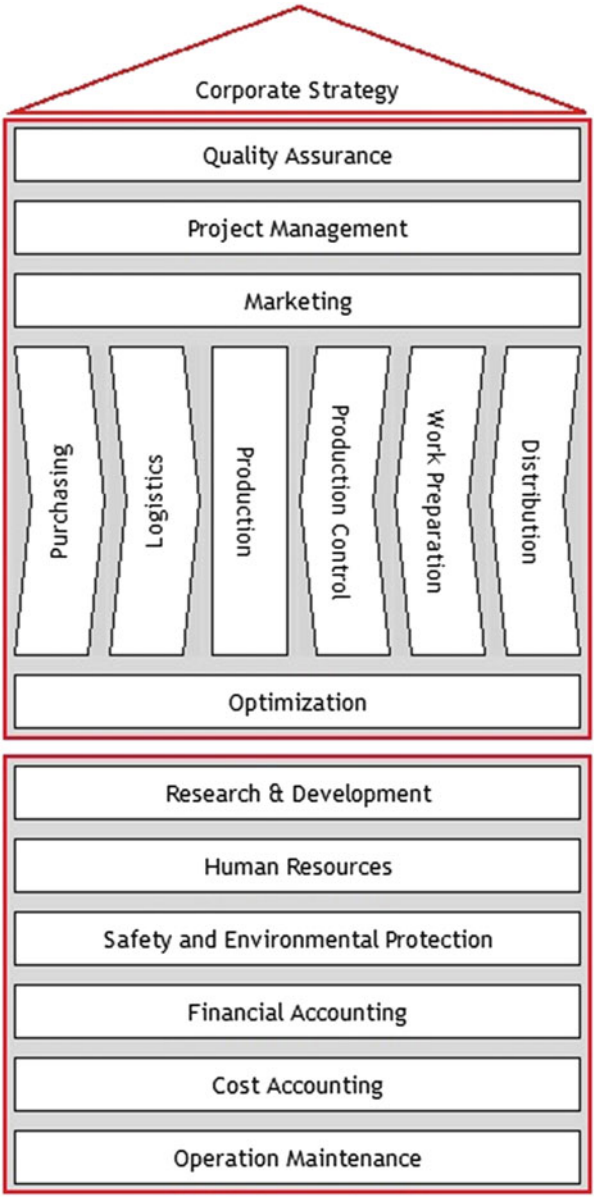

Fig. 2 Process framework (anonymized and trimmed screenshot)

representatives of each department. The as-is processes had to be optimized with respect to efficiency and strategic fit before they could be used as templates for the ERP implementation. Therefore, possible improvements were identified by investigating the recorded process information and including the domain knowledge and practical experience of the employees, who were encouraged to discuss

weaknesses in and possible improvements for the processes during the interviews. Finally, the interview information was transferred from the consultants' notes into a form that was easily accessible by the modeling team in order to allow for continuous process improvement during the project and by the company afterward.

The modeling team consisted of eight invited BPM consultants, each of whom was responsible for the creation of a particular functional department's process models. Comparability of each modeler's modeling results was ensure so single models could be merged into a uniform process landscape at the end of the distributed modeling phase (Mendling et al. 2010b; Schütte and Rotthowe 1998).

In order to achieve such comparability, the element labels were standardized to a certain extent (Mendling et al. 2010a). The icebricks semantic standardization approach builds on the guidelines for labeling process elements from Rosemann (1996), Kugeler (2000), and Delfmann et al. (2009). Simple verb-object phrase structures are the most comprehensible (Mendling et al. 2010a), so every process element in icebricks is labeled in the form "<verb, imperative>" (<noun, singular> OR <noun, plural>)—for example, "pay invoice." Semantic comparability of icebricks process models is ensured through the use of a *domain glossary*, which consists of *business objects* (nouns) and *procedures* (verbs) that can be carried out on these business objects (Becker and Kahn 2011).

In the current project, the domain-specific glossary had to be created before the modeling activities began. The Retail-H reference model was used as a basis for the glossary (Becker et al. 2013b; Becker 1997), but the glossary was constantly expanded and adapted to the manufacturing sector during the creation of the as-is process models, so in the end it consisted of 305 business objects, 218 procedures, and 659 <business object, procedure> combinations. The modelers were restricted to using only these combinations of business objects and procedures in labeling the process elements. The use of these phrase structure conventions and the domain glossary allowed the creation of unambiguous and semantically standardized as-is process models that were comparable and could be directly used for (semi-) automatic analysis.

One of the most important requirements to the as-is process models was their simplicity so they could be understood easily. An excessively large set of modeling elements in a modeling language often leads to their erroneous use and to process models that their intended audiences cannot comprehend (Chen and Scheer 1994; Dehnert and Rittgen 2001; Kindler 2006; Langner et al. 1998; Leymann and Altenhuber 1994; Nüttgens and Rump 2002; van der Aalst 1999; van der Aalst and ter Hofstede 2005; Wynn et al. 2005). Unlike general-purpose modeling languages like the Business Process Model and Notation (BPMN) and the Event-driven Process Chain (EPC), the icebricks method uses just two modeling elements: *activities* and a *control flow*. Since these elements are used in all other modeling notations, the icebricks method uses a subset of existing and empirically approved language elements, rather than introducing new ones. The control flow in the icebricks method refrains from complex branching mechanisms and connectors, allowing only for simple, single-level branching with an arbitrary number of successor elements.

Use of this simple element set resulted in clear and understandable process models on both the main processes and the detailed processes. The largest main process contained 11 detailed process elements, and only two main processes included branching logic. The longest detailed process consisted of 13 process bricks. Because of their more specific nature, almost all of the detailed processes were created using branches to depict either parallel or alternative execution logic.

To increase the process models' simplicity and comprehensibility and reduce unnecessary branching, the concept of *process variants,* introduced in the icebricks method, was used in the creation of as-is process models. It is often observed in practice that the result of a process can be achieved in multiple ways (Becker et al. 2013a; Hallerbach et al. 2008), and the processes in the current project were no exception. Without using the variants, all of the alternatives to achieving a process's desired result must be represented in the same graphical model, which often leads to additional process elements to cover every circumstance and, in the end, to complex process models (Hallerbach et al. 2008, 2009). In the current project, nine additional non-standard main process variants and ten additional non-standard detailed process variants were created. The variants overlapped as little as possible. The rule of thumb regarding when to create a new variant is to do so whenever the input and output of a process match but at least one process step differs fundamentally from the steps in the standard execution. This rule of thumb was applied in the current project.

Process models can contain a great deal of information. Especially when the goal of the project is implementation of an ERP system, the detailed processes must be defined precisely in order to be translated correctly into the system workflow logic. In general-purpose process modeling notations, this information is included directly in the graphic process models by using additional model elements like data objects, aspects of the organization, or textual annotations. However, doing so increases the model's size and makes it more difficult to read and interpret, which contradicts with the principle of simplicity. Therefore, icebricks introduces *attributes* to store additional process information. The icebricks method provides a variety of attribute types, including simple textual attributes, numerical attributes for enhanced analyses, and more complex attributes like HTML pages, color annotations, and combination attributes, which allow attributes to be stored in various predefined combinations (Holler 2015). In the current project, such attributes as textual description, average execution time, number of executions per day, external reference, and attachments with relevant documentation were used in creating the process models. icebricks also provides the possibility of annotating a process's elements with hierarchical structures. The current project used this feature to annotate particular process steps with information about organizational responsibilities (elements of the company's organizational structure) and IT system support (elements of the company's IT architecture diagram).

Figure 1 summarizes and gives examples of the main aspects of the icebricks process modeling method.

Process Analysis and Improvement
After the creation of the as-is process models, the information about weaknesses and improvement potentials that was extracted from the semi-structured interviews and information from the literature and experiences of the involved consultants were used to develop improved to-be process models. The focus of these to-be models was on all three of the projects' goals: preparation for implementation of the new SAP Business One ERP system, ISO 9001 recertification, and rigorous documentation of the complete process landscape. The results achieved with the process documentation are presented in the next section.

4 Results Achieved

The company achieved all three of the project's goals: documentation of the process landscape, implementation of the SAP Business One ERP system, and recertification of the company according to the ISO 9001 quality standard.

Process Documentation
The outcomes of the first phase of the project, which is the focus of this case, fully satisfied the company's and the consultants' expectations. After the consultants formally handed over the process descriptions to the company, the new management had a complete and optimized process documentation at their fingertips. Figure 2 depicts the final process framework, which provided the company with structure and orientation in its process landscape. The printed version of the processes' documentation, in which all of the depicted processes and their attributes are described, has 238 pages. The process landscape consists of 17 main processes and 135 detailed processes, for a total of 372 process building blocks, not including the elements of the nine non-standard variants on the main process level and the 11 non-standard variants on the detailed process level. Besides these processes on icebricks' four layers of abstraction, IT infrastructure and organizational charts complemented the process landscape with the help of icebricks' attribution functionality.

From this point on, the manufacturing company's IT department could use the web-based modeling environment for continuous process improvement. The simplicity of the icebricks method facilitated employees' participation in the investigation of the process models, identification of potential improvements, and maintenance of the defined attributes for the process steps. Therefore, the outcome was simple, with mostly linear process models, but expressive enough and full of annotated attributes as a basis for the next two phases of the project: ISO certification and ERP implementation.

Always current process documentation improved new employees' on-the-job training. During periods of high workload the company hires additional workers, who need a quick overview of the processes that are relevant to their tasks. Depending on the terms of employment, new employees receive either a printed version of the relevant processes, including the annotated attributions, or a user

account with read-only access to the web-based tool so they have continuous access to the models. The line managers, who are also process owners, are provided with user accounts with "read and write" access so they can suggest and directly implement changes to the models of the processes for which they are responsibility.

ERP Replacement
The SAP consultants in the EPR-implementation phase of the project relied on the harmonized to-be processes that were directly accessible in the web-based environment to align the ERP system to the desired behavior. This affordance reduced the communication effort with respect to workshops and interviews between the SAP consultants and the company's employees. Hence, the SAP consultants were able to present a system prototype with the expected system behavior in less time than they anticipated, based on their project experience with less-documented companies. This accomplishment was a main driver in introducing the SAP Business One solution within budget and with satisfactory quality in only 1 year. In particular, the company's management appreciated the increased functional range provided by the new system in perfect alignment to the processes. Because the new ERP system was capable of supporting the functional areas and the defined processes directed the system behavior, it was possible to incorporate end-to-end processes. Furthermore, issues regarding non-working material resource planning in combination with new orders because of missing inclusion of bill-of-material logic are now resolved. Another issue that hindered efficient production was the expensive (and all but impossible) adjustments that were needed for the old ERP software. With the new SAP system, the company can adjust the system's behavior more easily through simple customization. The same applies to information demands through ad hoc reports. With the SAP system there is no need for external suppliers to perform ad hoc reports since the SAP system's integrated query functionality allows the IT department to satisfy the departments' information demands, saving time and reducing costs. Finally, end-users' training materials can be built based on the documented processes, aligned with the ERP system functionality.

ISO 9001 Re-certification
The ISO certification had some challenges in terms of the necessary adjustments of the mostly optimized production processes. After overcoming these challenges, the improved and documented to-be processes fully satisfied the requirements of the ISO 9001 quality standard, with some minor remarks for further improvements in on-the-job safety. The ability to view and export the process documentation easily using the icebricks modeling tool eased the certification process. The certifier was given read-only access to the process models in the icebricks web-based modeling tool. Moreover, with the icebricks tool, the certifier could access the most recent documentation within minutes using the integrated Microsoft Word export functionality.

Continuous Process Management
After the project's successful conclusion, a work group made of representatives of the company's middle managers was established to discuss the company's processes regularly and to identify the additional improvements and adjustments necessary for the company to keep pace with its dynamic market. This form of continuous process management is probably the most valuable result of the overall modeling endeavor, and it fits well with the process monitoring and controlling phase of Dumas et al. (2013) BPM lifecycle model.

5 Lessons Learned

The BPM project at hand produced several lessons. From a general, methodological point of view, the selection of a web-based, lightweight modeling tool and a method with a high degree of pre-structuring helped to save time and budget. In particular, it made discussions about the level of model abstraction, naming conventions, and model layout obsolete. This time efficiency is likely also to be achieved in larger companies and in other industries. Nevertheless, certain difficulties arose during each of the project's phases, which are discussed in the next paragraphs. Several lessons can be derived from the ISO certification phase of the project. Since only a continuously recertified company can compete in the market, the conclusion of one successful certification project must mark the beginning of the next one. The certifier's input must be used as a basis for future process adjustments and the continuous process-improvement cycle. The potential of a easily comprehensible and used modeling method like icebricks must be exploited by creating pre- and post-certification versions of the processes. Thus, the certifier's suggestions can be presented transparently in the next certification process, and the company does not endanger its recertification.

Another lesson learned is the need to take full advantage of the web-based modeling and presentation environment. The company's quality-management employee was not accustomed to working with the digital versions of process models and so depended heavily on the print-outs. Although a print-out can be handy in meetings, the advantages of digitally reachable process models in a central repository must be communicated to non-digital naives. In the dynamic setting of the three phases of the project, there was a danger that people would be working with outdated print-outs. In the modeling phase of the project, the models changed regularly, particularly during the first weeks of modeling, so only the models in the central repository were sufficiently resilient for discussions and planning. This issue also applied in the two subsequent phases of the project, although the processes had reached a mostly stable state by that time and were adjusted only for further optimization or for alignment with the ERP system implementation.

Regarding the new ERP system, the implementation of any modern system would have improved the overall situation, but the rigorous selection process was time well invested. Although the external SAP consultants claimed the full budget because of some unforeseen adjustments, the selection of the system that fit best

with respect to functional coverage, interfaces, and customization effort was a main driver of the project's staying on time and on budget with the required quality. Two main areas of improvement from introducing the ERP system were the end-user training and system testing. Because of missing test data and the line managers' commitment to providing test cases, the project manager was too involved in gathering the necessary data and even conducted some of the tests himself. Hence, the system was not tested to the desired extent, which led to some issues in the first 2 weeks after the new ERP system was introduced. The second issue regarding the implementation phase of the project was insufficient end-user training. Since the training was not mandatory before the introduction and offered only for interested employees, some of untrained employees had difficulty understanding the new system when they had to. A mandatory training plan during working hours would have had a clear advantage over training on voluntary basis.

The business process modeling itself had some challenges to overcome regarding the big team of consultants that conducted the interviews and consolidated the information into the final model. In particular, the icebricks modeling tool had no versioning functionality, hindering efficient collaborative modeling. Distinct versions of the models had to be created so information recorded by another consultant was not endangered. Although the diverse alternative solutions for version management worked out for the consultants, a specific versioning approach would have increased clarity and working efficiency. A positive lesson the predefined set of attributes that had to be filled for each activity in the process model, which allowed the IT systems and organizational structures that supported the processes to be compared and managed in a structured and, therefore, easy reporting style.

The use of the employees' knowledge about possible improvements was valuable input for the optimization of the as-is and construction of the to-be processes. This value demonstrated that it is not necessary to apply sophisticated and time-intensive means, such as process simulation or process mining, to perform process improvement. In general, it is enough to ask the subject matter experts *what is the longest action in this process* and *where do errors usually occur*. The year-long experience of the department workers and use of appropriate facilitation techniques in to-be process construction workshops often bring results similar to those of complex analysis techniques but with fewer resources invested.

Overall, the advantages of the web-based process model documentation must be actively introduced in the company and understood by all employees. Only then can possibilities like end-user training support and preparation for certification preparation be exploited to their full extent.

References

Becker, J. (1997). Handelsinformationssysteme und Handelscontrolling – ein methodenorientierter Ansatz. In D. Ahlert & R. Olbrich (Eds.), *Integrierte Warenwirtschaftssysteme und Handelscontrolling: konzeptionelle Grundlagen und Umsetzung in der Handelspraxis* (pp. 173–210). Stuttgart: Schäffer-Poeschel.

Becker, J., & Kahn, D. (2011). The process in focus. In J. Becker, M. Kugeler, & M. Rosemann (Eds.), *Process management: A guide for the design of business processes* (pp. 3–13). Berlin: Springer.

Becker, J., Kugeler, M., & Rosemann, M. (2011). *Process management: A guide for the design of business processes* (2nd ed.). Berlin: Springer.

Becker, J., Clever, N., Holler, J., Püster, J., et al. (2013a). Semantically standardized and transparent process model collections via process building blocks. In *Proceedings of the The Fifth International Conference on Information, Process, and Knowledge Management – eKNOW 2013*, Nice (pp. 172–177).

Becker, J., Clever, N., Holler, J., & Shitkova, M. (2013b). icebricks – Business process modeling on the basis of semantic standardization. In *Proceedings of the Design Science Research in Information Systems and Technologies (DESRIST) 2013*, Helsinki.

Berente, N., Vandenbosch, B., & Aubert, B. (2009). Information flows and business process integration. *Business Process Management Journal, 15*(1), 119–141.

Chen, R., & Scheer, A.-W. (1994). *Modellierung von Prozessketten mittels Petri-Netz-Theorie*. Saarbrücken.

Dehnert, J., & Rittgen, P. (2001). Relaxed soundness of business processes. In K. R. Dittrich, A. Geppert, & M. C. Norrie (Eds.), *Advanced Information Systems Engineering. 13th International Conference, CAiSE 2001 Interlaken, Switzerland, June 4–8, 2001 Proceedings* (pp. 157–170).

Delfmann, P., Herwig, S., & Lis, L. (2009). Unified enterprise knowledge representation with conceptual models – Capturing corporate language in naming conventions. In *30th International Conference on Information Systems (ICIS 2009)*. Phoenix, AZ.

Dumas, M., et al. (2013). *Fundamentals of business process management*. Heidelberg: Springer.

Hallerbach, A., Bauer, T., & Reichert, M. (2008). Modellierung und Darstellung von Prozessvarianten in PROVOP. In *Modellierung'08 Conference* (pp. 41–56).

Hallerbach, A., Bauer, T., & Reichert, M. (2009). Issues in modeling process variants with provop. In *BPM 2008 International Workshops* (pp. 56–67).

Holler, J. (2015). *Tool support for consultants in business process modeling projects. Design and evaluation of the business process modeling tool icebricks*.

Kindler, E. (2006). On the semantics of EPCs: Resolving the vicious circle. *Data and Knowledge Engineering, 56*(1), 23–40.

Kugeler, M. (2000). *Informationsmodellbasierte Organisationsgestaltung: Modellierungskonventionen und Referenzvorgehensmodell zur prozessorientierten Reorganisation*. Berlin: Logos-Verlag.

Langner, P., Schneider, C., & Wehler, J. (1998). Petri net based certification of event-driven process chains. In *19th International Conference on Application and Theory of Petri Nets and Other Models of Concurrency (ICATPN 2001)* (pp. 286–305).

Leymann, F., & Altenhuber, W. (1994). Managing business processes as an information resource. *IBM Systems Journal, 33*(2), 326–348.

Meise, V. (2001). *Ordnungsrahmen zur prozessorientierten Organisationsgestaltung. Modelle für das Management komplexer Reorganisationsprojekte*. Hamburg: University of Münster.

Mendling, J., Reijers, H. A., & Recker, J. (2010a). Activity labeling in process modeling: Empirical insights and recommendations. *Information Systems, 35*(4), 467–482.

Mendling, J., Reijers, H. A., & van der Aalst, W. M. P. (2010b). Seven process modeling guidelines (7PMG). *Information and Software Technology, 52*(2), 127–136.

Nüttgens, M., & Rump, F. J. (2002). Syntax und Semantik Ereignisgesteuerter Prozessketten (EPK). *Prozessorientierte Methoden und Werkzeuge für die Entwicklung von Informationssystemen, P-21*(6), 64–77.

Porter, M. E., & Millar, V. E. (1985). How information gives you competitive advantage. *Harvard Business Review, 63*(4), 149.

Rosemann, M. (1996). *Komplexitätsmanagement in Prozessmodellen: methodenspezifische Gestaltungsempfehlungen für die Informationsmodellierung* (p. 297). Wiesbaden: Gabler Verlag.

Scheer, A.-W. (1997). *Wirtschaftsinformatik – Referenzmodelle für industrielle Geschäftsprozesse* (7th ed.). Berlin: Springer.

Schütte, R., & Rotthowe, T. (1998). The guidelines of modeling – An approach to enhance the quality in information models. In T. W. Ling, S. Ram, & M.-L. Lee (Eds.), *Proceedings of the 17th International Conference on Conceptual Modeling* (pp. 240–254). Singapore: Springer.

Stachowiak, H. (1973). *Allgemeine Modelltheorie*. Wien: Springer.

van der Aalst, W. M. P. (1999). Formalization and verification of event-driven process chains. *Information and Software Technology, 41*(10), 639–650.

van der Aalst, W. M. P., & ter Hofstede, A. H. M. (2005). YAWL: Yet another workflow language. *Information Systems, 30*(4), 245–275.

Wynn, M. T., et al. (2005). Achieving a general, formal and decidable approach to the OR-join in workflow using reset nets. In G. Ciardo & P. Darondeau (Eds.), *Proceedings of the 26th International Conference on Application and Theory of Petri Nets and Other Models of Concurrency (ICATPN 2005)* (pp. 423–443). Berlin: Springer.

Jörg Becker is head of the Department of Information Systems of the University of Münster and of the European Research Center for Information Systems (ERCIS). He is Professor of Information Systems and directs the Chair for Information Systems and Information Management. He holds an honorary professorship at the National Research University—Higher School of Economics (NRU-HSE) in Moscow and is member of the North Rhine-Westphalian Academy of Sciences, Humanities and the Arts. His research interests cover Information Modelling including Reference Modelling, Hybrid Value Creation, Business Process Management, E-Government, and Retail Information Systems. Jörg has published in renowned outlets, including MIS Quarterly (MISQ), European Journal of Information Systems (EJIS), Business & Information Systems Engineering (BISE), Information Systems Frontiers (ISF), Information Systems Journal (ISJ), and Business Process Management Journal (BPMJ). He has authored and edited numerous books, including Retail Information Systems, Process Management, Modernizing Processes in Public Administrations, and Reference Modeling.

Nico Clever is a postdoctoral research assistant at the Chair for Information Systems and Information Management at the Department of Information Systems of the University of Münster. He received his Master's degree in Information Systems from the University of Münster. In his Ph.D. thesis, Nico covered the holistic design and application of the process modelling tool icebricks which is actively utilized in a number of practical consulting projects as well as further developed on an academic basis and applied in his teaching. Additional research interests lie in the areas of Compliance Management, Data Management, Business Intelligence, Software Engineering, and Test Management. Nico has presented and published his work at renowned conferences, including the European Conference on Information Systems (ECIS), Design Science Research in Information Systems and Technologies (DESRIST), and IEEE Conference on Business Informatics (CBI).

Justus Tillmann Holler is part of the European Research Institute for Information Systems (ERCIS) at the University of Muenster and consultant at the Prof. Becker GmbH with a focus on Business Process Management, Business Intelligence and ERP Implementation. Justus has conducted diverse studies in the area of BPM and ERP with extensive implementation and evaluation studies of web-based business process modelling tools in manufacturing and retail industry companies. He published in renowned conferences and books including the European Conference for Information Systems (ECIS).

Maria Neumann is a postdoctoral research assistant at the Chair for Information Systems and Information Management at the Department of Information Systems of the University of Münster and got her Ph.D. in the area of Business Process Management. Her research interests span a broad range of topics focusing largely on the design and development of business process modelling tools through application of usability engineering methods. Maria has scientific publications in international outlets and conference proceedings, including the European Conference on Information Systems (ECIS), Design Science Research in Information Systems and Technologies (DESRIST), and IEEE Conference on Business Informatics (CBI).