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Promoting Business Process Management Excellence in Russia

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Promoting Business Process Management Excellence in Russia

Proceedings and Report of the PropelleR 2012 Workshop held in Moscow, April 24 to 26, 2012

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Promoting Business Process Management Excellence in Russia: Proceedings and Report of the PropelleR 2012 Workshop held in Moscow, April 24 to 26, 2012.

Volume Editors

Jörg Becker is a Full Professor at the University of Muenster, Germany, European Research Center for Information Systems, Chair for Information Systems and Information Management.

Martin Matzner is a Researcher at the University of Muenster, Germany, European Research Center for Information Systems, Chair for Information Systems and Information Management.

Authors

Wil van der Aalst, Vadim Agievich, Lars Algermissen, Jörg Becker, Daniel Beverungen, Nico Clever, Peter Fettke, Igor Fiodorov, Rinat Gimranov, Philipp Griesberger, Justus Holler, Constantin Houy, Martin Instinsky, Florian Johannsen, Harald Kienegger, Helmut Krcmar, Yury Kupriyanov, Susanne Leist, Marco Link, Peter Loos, Erich Ortner, Johannes Püster, Markus Reiter, Holger Schrödl, Johannes Schwall, Armin Stein, Ali Sunyaev, Victor Taratukhin, Jürgen Walter, Mathias Weske, and Holger Wittges

Abstract

BPM research has been of great importance in Germany since the early 1990s. In Russia, increased competition and new IT possibilities have only recently forced both companies and governmental institutions to start taking benefits from BPM. Against this background, the workshop *PropelleR 2012* brought together German and Russian BPM researchers as well as practitioners in order to discuss recent BPM trends and challenges. The guiding question addressed by *PropelleR 2012* was: “How can the growing complexity of business processes in German-Russian relations be addressed by a holistic BPM approach?” This report includes a set of articles that reflect the PropelleR workshop participants’ viewpoints on this question.

Keywords

Business Process Management, PropelleR, Russia, German-Russian Year of Science 2011/2012

Preface

This ERCIS working report is the published proceedings of the workshop “Innovation Forum Promoting Business Process Excellence in Russia – *PropelleR 2012*” that was hosted by the *National Research University – Higher School of Economics* (HSE) in Moscow, Russian Federation, from 24–26 April 2012. In total, 76 Russian and German participants from research and industry registered for the *PropelleR 2012* workshop, making it a truly bilateral exchange of expertise and opinions on the future of Business Process Management (BPM) in Russia.

While the concept of BPM has been discussed intensively by German Business and Information Systems researchers since the early 1990s (at least), the topic is rather new to Russian industry and researchers. In the recent years this situation began to change and it became clear to them that the concept of “process” is helpful in advancing organizational performance while facing global competition. Against this backdrop, the *PropelleR 2012* workshop was intended to break the mold for BPM in Russia by identifying current challenges of the industry. In Paper 1, Dr. Dr. Victor Taratukhine and Yury Kupriyanov outline their view on the future of BPM in Russia. The various opportunities offered through cutting-edge BPM approaches and technology as well as present challenges in BPM in Russia were introduced to the workshop through an introductory talk by Prof. Dr. Jörg Becker (Paper 2) and through two keynote speeches. Our gratitude is extended first to the two keynote speakers: Prof. Dr. Wil van der Aalst (Paper 3) and Rinat Gimranov, CIO at Surgutneftegas (Paper 4), for their inspiring talks.

We approached our goal of increasing the understanding of BPM in Russia as we further oriented our discussions on the life-cycle of a business process: from (organizational) analysis to modeling, to implementation, and to analysis – each of which a specific workshop session was dedicated to. The main results obtained from the workshop sessions are summarized by Dr. Daniel Beverungen and Dr. Armin Stein in Paper 5. The *PropelleR 2012* participants added introductory speeches to this workshop sessions. Together with further colleagues all the presenters also outlined their viewpoints in the form of the articles included in this report. The report is organized by the order of the workshop sessions: *Strategy* (Paper 6 and 7), *Analysis* (Paper 8, 9, and 10), *Modeling* (Paper 11 and 12), and *Implementation* (Paper 13 and 14). Further, Constantin Houy contributed an article to this proceedings (Paper 15) as one of the members of the Pecha Kucha session with four presentations by junior researchers. The report closes with an article by Prof. Dr. Mathias Weske who introduces the “BPM academic initiative” (Paper 16). We thank all the authors for their contributions.

Our sincere thanks are extended to the German Federal Ministry of Education and Research (BMBF) that sponsored the *PropelleR 2012* workshop in the context of the German-Russian Year of Science, Technology and Innovation 2011/12. We further received invaluable assistance from the International Bureau of the BMBF at the German Aerospace Center. Thus, a special thanks to Dr. Jörn Grünewald, Maria Josten, and Anne Kröll.

We are thankful to the National Research University – Higher School of Economics and in particular to Prof. Dr. Andrey Klimenko, Vice-Rector and Director of the Institute for Public Administration and to Prof. Dr. Svetlana Maltseva, Acting Dean of the Faculty of Business Informatics, for providing the infrastructural support to make this workshop a reality. The HSE local organizing team laboured industriously to make the workshop a success – thanks to Ekaterina Bazhenova, Anastasya Pozdnyakova, Victoria Sheer, and Roman Shuvalov. We further would like to acknowledge the support from our partners from industry – SAP University Alliances and T-Systems CIS.

Jörg Becker and Martin Matzner
Münster, July 2012

1 The Future of Business Process Management in Russia

- **Victor Taratukhin**, University of Muenster, European Research Center for Information Systems, Münster, Germany, vita@ercis.uni-muenster.de
- **Yury Kupriyanov**, National Research University 'Higher School of Economics', Faculty of Business Informatics, Moscow, Russian Federation, yukupriyanov@hse.ru

1.1 Introduction and motivation

Companies are constantly facing challenges of decreasing product life cycles, international competition, increasing cost pressure, and demanding customers seeking high quality, low cost products, etc. (vom Brocke & Sinnl, 2011; Gunasekaran, 1999; Neubauer, 2009). Additionally, competition and the power to cope with aforementioned challenges are mainly based on strategic assets and capability of organizations to deploy these assets (McCormack et al., 2009). In order to overcome these intensified challenges, achieve corporate business objectives and competitive advantage, the effective management of an organization's business processes has become an important strategic asset of competition on all market places and in nearly all industries (Ko, Lee, & Lee, 2009; McCormack et al., 2009; Neubauer, 2009). Under this perspective, organizations now are no longer understood as a bundle of functional areas, but as an integration of business processes which require investments and development (McCormack et al., 2009). In this context, business process management (BPM) comes into attention as a methodology that is able "[to support] business processes using methods, techniques, and software to design, enact, control, and analyze operational processes involving humans, organizations, applications, documents and other sources of information" (van der Aalst, ter Hofstede, & Weske, 2003, p. 298). As a result, BPM "allows companies a faster organizational adaptation to the continuously changing requirements of the market and its customers" (Neubauer, 2009, p. 167) as well as to leverage their organization's business processes as strategic assets.

Since the early 1990s BPM has been an intensively discussed topic in the Information Systems (IS) research community and among practitioners (Houy, Fettke, & Loos, 2010b). Today, BPM has reached a certain level of maturity, what can be proofed by the existence of specialized journals (such as the Business Process Management Journal), conferences, and institutionalized degrees at several universities across the world (Houy, Fettke, & Loos, 2010b).

From an empirical point of view, many studies indicate that there is a positive correlation between the adoption of BPM approaches and business success (vom Brocke & Sinnl, 2011). Therefore, numerous companies around the world are striving to adopt and use the BPM concept. In the meanwhile, "consultants and researchers are regularly proposing new methods and concepts based on BPM to further increase corporate profits while leveraging efficiency of value-adding processes" (Neubauer, 2009, p. 167).

However, despite of the growing popularity and maturity of BPM on the global arena, for the past two decades Russia and the whole Commonwealth of Independent States (CIS) region have fallen behind Western developed economies in terms of adopting BPM concept. From an empirical point of view, it is crucial to determine the current status of BPM in Russian practice and research and derive future goals for research and technology transfer. Therefore, this paper analyzes the current state of BPM in the Russian market and attempts to answer the questions:

- *What is the current status of BPM practice and research in Russia?*
- *What is the possible future development of BPM in Russia?*

The purpose in writing this paper is threefold. The first motivation is to provide an insight into the current state of BPM in Russia, as there are no any studies done in this realm. Second, based on the information gathered, several implications and questions will be raised about the future development of business process management in practice and academia. Third, this paper wants to stimulate a future debate about the BPM development in Russia and to draw attention to this topic.

The structure of the paper is as follows: First, the status quo of BPM in Russian academia will be presented and discussed. Second, the nowadays tendencies in Russian BPM market and BPM practice will be outlined.

1.2 The status quo of BPM research in Russia

As said earlier, across the world there are already journals, conferences and institutionalized degrees specialized in BPM (Houy, Fettke, & Loos, 2010b) what indicates that the BPM concept is of great interest and concern among researchers worldwide. Regarding the Russian state of BPM development in academic sphere, the most significant impact had the translation of renown BPM books such as those of August-Wilhelm Scheer (Scheer, 2001) and the Russian version of Becker's book on BPM (J. Becker, Vilkov, Taratoukhine, & Rosemann, 2008).

There are also several BPM conferences and forums held annually, established research groups, and degree programs at the universities which illuminates a gradual establishment of BPM as research topic in Russia. One of the main research and industry conferences related partially to BPM research is the Moscow State University of Economics, Statistics and Informatics International Research Conference "Innovative IT-based business process reengineering. Knowledge management systems" (MESI Conferences). Unfortunately, it is a conference in Russian language only, so there is no English translation of the conference proceedings available.

Also, every year the AHConferences company[1], which is specialized on organizing IT forums and gathering C-level professionals to exchange their knowledge and excel expertize, runs the BPM Forums in Moscow, Russia. By now, AHConferences has successfully conducted eight forums targeted at bringing together CIOs, Business Development managers, Technical managers, and Commercial managers to give them an opportunity to exchange innovative ideas, establish communication, and form new business ideas and strategies.

Another company, CNews Conferences (CNC)[2], which is connected to an Russian IT news portal, was established in 2005 in order to hold IT events on a regularly basis. Since 2009 CNC organizes conferences devoted to the topic of BPM and its development in Russia.

With regard to BPM conferences in Russia, it has to be noted that these events typically are organized by specialized commercial organizations and that it are mostly practitioners working in the BPM field who attain them. Normally, these conferences lack the pure academic focus which can be brought about only by researchers from this field. In this sense, to fill this gap, in the context of the German-Russian Year of Science, Technology and Innovation 2011/12 the Innovation Forum "Promoting business process management excellence in Russia" (PropelleR 2012)[3] was held in Moscow where leading German and Russian researchers and practitioners in the BPM domain came together to discuss BPM trends and challenges, exchange experience, got involved in current German and Russian BPM projects, and established and strengthened relationships for future cooperation. PropelleR 2012 was organized and supported by the Business Informatics

[1] http://www.ahconferences.com/
[2] http://www.events.cnews.ru/
[3] http://propeller.ercis.org/

Department[4] in collaboration with the SAP Academic Department[5] of the Higher School of Economics (HSE) as well as the global academic program SAP University Alliances in partnership with the European Research Center for Information Systems (ERCIS).

Concerning the Higher School of Economics in Russia and in particular its Business Informatics Department and the SAP Academic Department, it is prudent to say that they act as pioneers in the field of BPM research in Russia. The Chair of Business Process Modeling and Optimization[6] at the Business Informatics Department of HSE has an institutionalized bachelor and master degree specialized in BPM what is an evidence of the evolving importance of BPM in the country. The Chair works in cooperation with the Russian branch of the Software AG. This ensures a high integration of scientific research with practical orientation.

The SAP Academic Department of the HSE frequently organizes international projects related to cutting edge IT topics including BPM where bachelor and master students from Russia in collaboration with other students from European universities have an opportunity to transfer their theoretical knowledge into practice. One of these projects was “ProveIT” where five German and eight Russian students developed an efficiency assessment methodology of IT implementation in the banking sector (Borisova, 2009). Also in 2005 and 2006 a further international student project seminar with BPM elements was conducted with sponsorship of SAP and GM-AvtoVAZ (J. Becker, Taratoukhine, Vilkov, & Rieke, 2006). This examples illustrate the progress of BPM into Russian educational programs, and this development will result into extend BPM knowledge and capabilities among Russian students and in the future Russian IT specialists.

In summary, Russian academic research in the field of BPM just began to rise and it is not at the same level of maturity as it is in Western European countries. Conferences specialized in BPM in Russia are rather held among practitioners from the industry than with participants from universities. Hence, the integration between these two sides – practice and academia – is needed in order to empower and deepen BPM development in the region. Few steps towards such integration have been made through the involvement of university students in practice-oriented projects and through cooperations of universities with several IT companies. Nevertheless, some positive tendency is evident: institutionalized degree, few research groups, and conferences devoted specifically to BPM are the first signs of an BPM development in Russia.

1.3 Russian BPM market

In 2012 two major BPM conferences were held. One of these conferences – the 8th BPM Forum – was organized by AHConferences, another one was supported by CNews Conferences and named “BPM 2012: New ways of development”. Both events gathered Russian IT leaders in the sphere of BPM practice in order to determine what the state-of-art of BPM is and what the future trends are.

Before going into Russian specifics of BPM utilization and status, the global tendencies of BPM were outlined during the conferences. Regarding technological trends, S-BPM (Subject-oriented BPM) can be highlighted as the most discussed topic worldwide (AHConferences, 2012). In addition to this trend, the growing portion (which may reach up to 34.2 % of global workforce) of mobile and tablet users among employees of large corporations who have to be on-line and take business-critical decisions regarding all aspect of the company has been acknowledged. This fact determines another trend for BPM tools of the future which is the support of mobility (Cnews, 2012a). Social BPM and the influences of cloud computing also draw a lot of attention of BPM users and researchers. However, they have been on the radar of practitioners’ attention for couple of years now and still in the fashion (AHConferences, 2012).

[4] http://www.bi.hse.ru/en/about/
[5] http://www.bi.hse.ru/en/sap/
[6] http://www.bi.hse.ru/model/

What is the status quo of business process description in Russian companies?	
All processes are modeled.	4 %
Processes are not described at all, and there are no plans to do it.	11 %
Processes will be modeled in a short-term horizon.	12 %
Individual processes are modeled.	30 %
Key processes are modeled.	43 %

Table 1: The status quo of business process description in Russian companies (Global CIO, 2011)

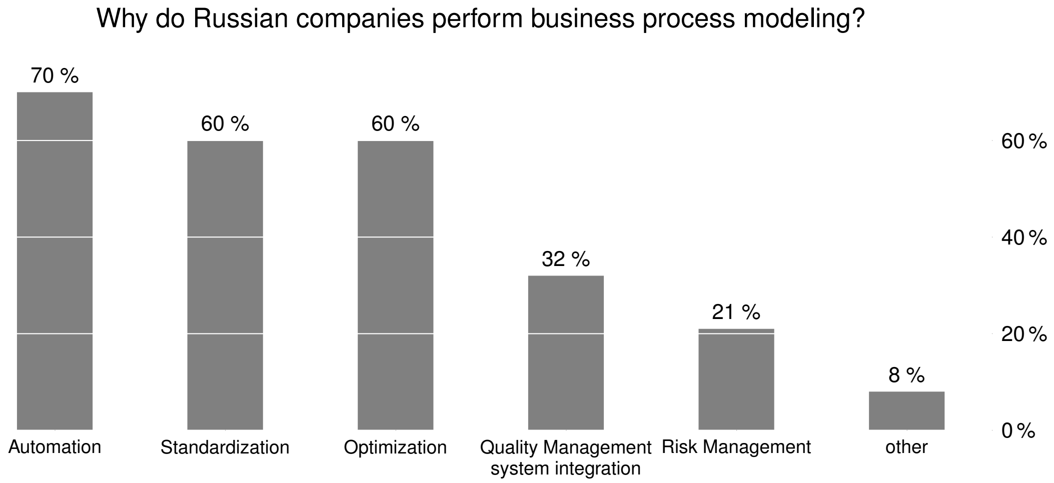

Figure 1: The purposes for business process modeling (Global CIO, 2011)

Russian BPM practice is far from the adoption of the latest BPM paradigms and trends, as it is concerned with more basic or, so-to-say, "primitive" issues such as the description of business processes (Global CIO, 2011). In this regard, some data performed by analytical investigations were discussed during the BPM conferences held in the Russian capital city. Hence, a joint research conducted by Software AG, the analytical company IDC Russia, and the largest community of IT managers Global CIO showed that only 4 % of the Russian companies have fully described their business processes (Global CIO, 2011). Table 1 depicts a complete picture of the status quo of business process description in Russian companies.

According to the same study, the main purpose for Russian companies to model their business processes is the automation of business process. The second place takes standardization and the third place is optimization what is illustrated in Figure 1 (Global CIO, 2011).

Yet another research done by IDC Russia complements the information stated above and shows the list of industries that more often than others have undertaken comprehensive business process models (Cnews, 2012b):

- Oil and Gas (44 %),
- Fast Moving Consumer Goods (FMCG) (41 %),
- Retail (25 %).

On top of that, IDS notes that the sectors which fall behind in terms of BPM adoption are the following (Cnews, 2012b):

- Transportation and Logistics Services (19 %),

- Public Sector (19 %),
- Energy and Utilities (12 %).

These facts retrieved from empirical studies and other interesting aspects of BPM development in Russia presented by conferences' participants were at the heart of the conferences' discussion in 2012. Thus, during the conferences BPM practitioners highlighted the following key findings of BPM practice:

- Major Russian companies perform Business Process Modeling and Management (AHConferences, 2012).
- ARIS modeling tool alongside with EPC notation is still the most popular bundle for modeling business processes at Russian large enterprises (AHConferences, 2012).
- Most of the companies still automate their business processes in ERP and Electronic Document Management Systems (EDMS). Nevertheless, the role of BPMS is getting more important at the expense of slow reduction of EDMS use (AHConferences, 2012).
- More companies set up internal dedicated organizational units which are fully responsible for BPM in the company (AHConferences, 2012).
- There is still a noticeable gap between business and IT teams in terms of how they perceive the role of BPM and approaches to it (Cnews, 2012b).

Regarding future BPM trends, as it was noted earlier, the Russian market is not in the stream of the latest BPM developments. However, some aspects related to emerging needs in Russian BPM practice were mentioned in brief during BPM-devoted conferences in Moscow. Discussed future BPM trends closely correlate with the overall global tendencies and are listed below:

- Handheld tablets as well as extensive usage of smartphones set up a growing demand for mobile BPM tools and platforms.
- Significant portion of mergers and acquisitions in the Russian market raise needs for business process harmonization, including the involvement of different organizational units into process design and modeling. As a result, there is a great demand for supporting collaborative BPM and design coming from business in the nearest future (Cnews, 2012a).
- The earliest explorer of Russian BPM and Enterprise Content Management (ECM) market – the company Logica Business 2.0[7] – actively promotes S-BPM in Russia (AHConferences, 2012).

1.4 Conclusion

In this paper, it was attempted very briefly to identify and present the current status of BPM developments in Russia. We addressed this objective by examining the reports of recent BPM conferences held in Russia. This helped us to get an overview on the status quo of BPM from two perspectives: how it is developed in Russian research field and how widely it is used in practice. The findings reveal that BPM both in research and practice is at an emerging position in the country. Nevertheless, a growing importance of the topic and an increased interest in BPM could be observed.

In the scientific field, there is increased BPM research activity. This is evident from (1) an established degree at Russian universities as well as organized research groups working together with

[7] http://www.blogic20.ru/

business partners (e.g., BPM-specialized bachelor and master degree specialized at HSE) and from (2) international research projects with a focus on BPM conducted at the universities (e.g., project ProveIT held at HSE jointly with ERCIS).

Regarding Russian business community, it can be said that Russian practitioners get more involved into the concept of BPM what can be proved by BPM conferences such as the conferences of CNews Conferences and AHConferences, which are both held annually and targeted at bringing together Russian IT leaders to discuss the topic. We reviewed the reports of these conferences and showed that the adoption of BPM approaches and technology in Russian companies is still at immature, but growing stage what can be concluded industry-related statistics. According to the conference reports the following few future trends of BPM development in Russia can be distinguished: (1) growing demand for mobile BPM tools and platforms; (2) demand for the development of collaborative BPM; (3) promotion of the S-BPM approach in the Russian market.

This paper calls for more awareness of these current challenges and trends in the field of BPM in Russia as well as the establishment of a solid understanding of future development paths of BPM in the region.

2 Business Process Management – the Next Generation

- **Jörg Becker**, University of Muenster, European Research Center for Information Systems, Muenster, Germany becker@ercis.uni-muenster.de
- **Nico Clever**, University of Muenster, European Research Center for Information Systems, Muenster, Germany nico.clever@ercis.uni-muenster.de
- **Justus Holler**, University of Muenster, European Research Center for Information Systems, Muenster, Germany justus.holler@ercis.uni-muenster.de
- **Johannes Püster**, University of Muenster, European Research Center for Information Systems, Muenster, Germany johannes.puester@ercis.uni-muenster.de

2.1 Introduction

Business Process Management (BPM), Business Process Reengineering, Workflow Management, Total Quality Management, and Supply Chain Management are examples of management approaches that rely on high quality process models. The corporate reality is too complex to be entirely represented in a single model, so a representation needs to abstract from that reality and focus on relevant subsets of it. Depending on the application area (cf. Figure 2) the required level of abstraction varies. This article presents a BPM approach that focuses on the organizational design of business processes and that strives to improve transparency within the process landscape of an organization.

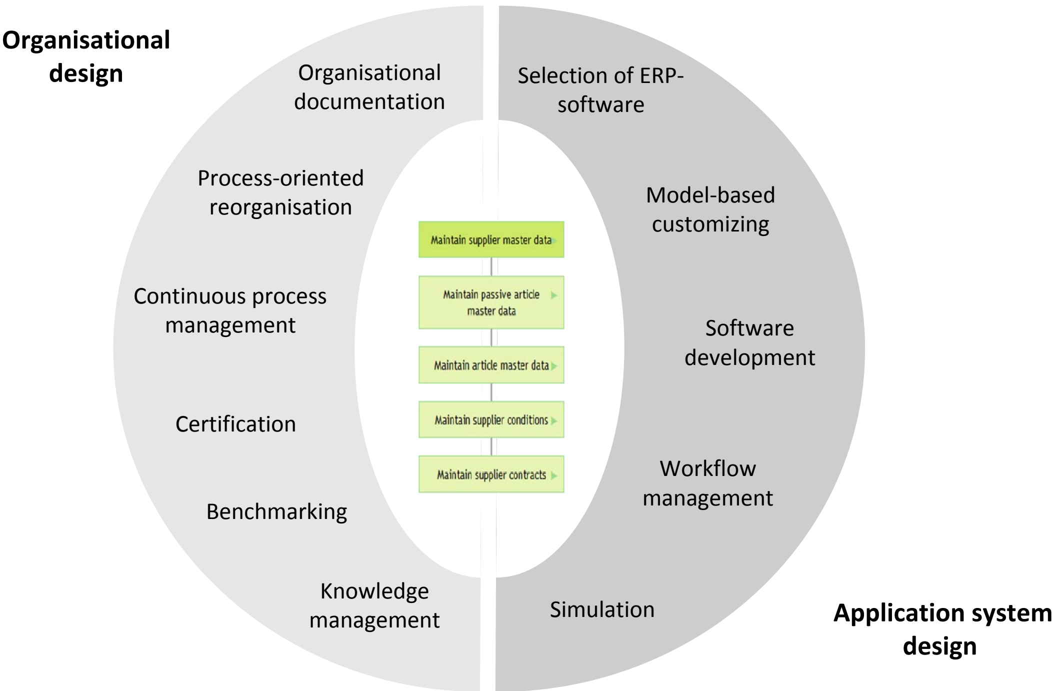

Figure 2: Application areas of business process management (cf. J. Becker, Kugeler, & Rosemann, 2011)

Extant literature gives numerous definitions of the term “business process” (Davenport & Short, 1990; Hagen & Stucky, 2004; Hammer & Champy, 1993; Melão & Pidd, 2000). Generally, a business process can be described as a sequence of logically related tasks, and it accents the existence of a shaping business object (Davenport & Short, 1990; Gou, Huang, Liu, & Li, 2003). This object can be an information object or a physical object. The beginning and the end of a business process are specified by the beginning and end of handling a business object. In this article, taking an Information Systems perspective, a process is seen as "a completely closed, timely and logical sequence of activities which are required to work on a process-oriented business object." (J. Becker et al., 2011, p. 4)

2.2 Procedure Model for Business Process Management

In order to efficiently manage the process landscape of an enterprise, both, a structured procedure model that describes how to handle business process modeling projects and a sufficient computer tool are needed.

As regards the procedure model, previous literature advises that seven major steps need to be regarded. These steps are depicted in Figure 3, and they are described in more detail in the following (cf. J. Becker et al., 2011):

1. *Preparation of modeling*
   Projects (of any type) typically consist of different project phases. Therefore, an underlying plan containing the modeling subject, the modeling perspectives as well as modeling methods and tools has to be defined. Moreover, the level of abstraction that suits the modeling purpose has to be identified.

2. *Strategy and business process framework*
   Based on the corporate strategy, a starting point is determined in line with the top-down approach of the process modeling project. Here, a process framework is depicted containing the major functions of the organization on a high abstraction level. It enables navigating through the more detailed models.

3. *As-is-modeling and as-is-analysis*
   In this phase, the current states of the processes are gathered and modeled. The involved participants become familiar with the modeling methods and tools and the as-is analysis reveals weaknesses and enables potential improvement descriptions.

4. *To-be-modeling and process optimization*
   Exploiting the potentials for process improvement identified in the last step, new processes are created and modeled as well as existing processes are adapted.

5. *Process-oriented organization structure*
   Based on the to-be process models, the organizational structure is derived. This means that certain tasks are assigned to the respective organizational units.

6. *Implementation*
   In this phase, the process improvements are implemented. This may concern changes in processes, changes in the organizational structure, the implementation and/or introduction of new systems.

7. *Continuous process management*
   Process-orientation is in the focus even after the main BPM project is finished. Therefore, continuous process management has to be employed meaning that process improvement has to be understood as a process, as well. It has to become an important task of operative management ensuring the competitive advantage on the long run.

As can be seen from the description of the major steps in a typical BPM project, it is a highly complex endeavor. In order to handle and reduce the complexity of the resulting process models depicting the process landscape of an organization, adherence to the Guidelines of Modeling (GoM) during modeling is proposed besides the support via a process modeling tool.

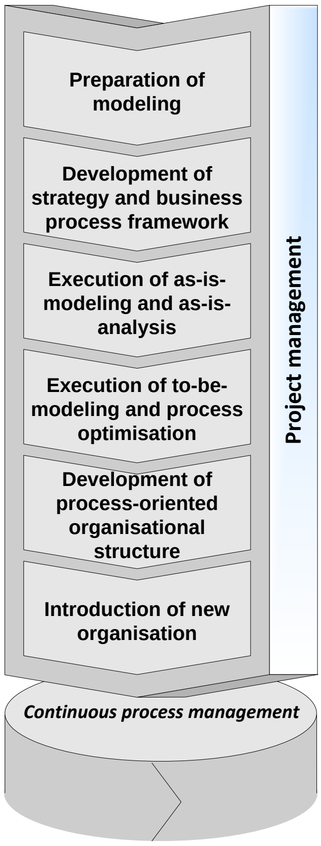

Figure 3: Procedure model for business process management (cf. J. Becker et al., 2011)

2.3 Guidelines of Modeling (GoM)

Because of the usually only partly standardized syntax, vocabulary and especially semantics of element names in semi-formal process modeling languages naming conflicts arise (cf. Breuker, Pfeiffer, & Becker, 2009). Through these inconsistencies the understanding and partially automated analysis of the process models are highly complicated (cf. Delfmann, Herwig, & Lis, 2009a). Furthermore, poorly defined or abided modeling conventions are a main driver for unstructured models on different levels of abstraction. Hence, the herewith necessary a posteriori handling of errors and coping with the complexity usually lead to high costs and hinder the comparability of process models.

One approach to overcome the above mentioned challenges and to foster high quality models throughout the procedure model especially in the context of distributed modeling are the Guidelines of Modeling. In the following, the characteristics of each of the six guidelines are briefly described (cf. J. Becker, Rosemann, & von Uthmann, 2000):

1. *Correctness*
   This indicates the correctness of the part of the real world which is being depicted in the model. This includes the organizational structure as well as the organizational behavior (processes).
2. *Relevance*
   Only the relevant part of the real world is to be depicted in the model.
3. *Economic efficiency*
   The modeling efforts have to be in a reasonable cost-benefit ratio. Therefore, e.g., reference models can be used or existing models can be re-used. Costs related to the modeling project and its benefits have to be kept track off, therefore.
4. *Clarity*
   An adequate level of readability has to be incorporated in the model to be understandable by the addressee.
5. *Comparability*
   Modeling conventions have to be applied consistently within and between individual models to guarantee comparability.
6. *Systematic design*
   As models only depict parts of the real world, well-defined interfaces to other, corresponding models have to be incorporated.

2.4 icebricks

As can be seen from the argumentation above, process models which are in compliance with the guidelines of modeling can be considered high quality models. Nevertheless, it is a challenging task to model in such a compliant manner. Hence, we propose a prototypical process modeling tool — icebricks — which takes the initially described requirements and challenges into account and therefore fosters GoM-compliant process models.

This software tool is realized as a Ruby on Rails web application. Ruby on Rails is a framework based on the programming language Ruby and follows the model-view-controller paradigm (cf. Morsy & Otoo, 2012). Therefore, it provides an elegant solution to separate the underlying data storage, the business logic and the presentation of the data. As the underlying database structure is easily exchangeable, the tool is able to be utilized in the most different of scenarios and organizational IT infrastructures. Moreover, to facilitate an efficient and effective creation as well as utilization of the process models, the user interface for modeling as well as presentation of the models is highly intuitive. This is even enhanced by the use of JavaScript which is a client-side programming language that allows for asynchronous handling of user input. Thus, irritating reloads of web pages are contained in the prototype.

The rationales which form the foundation of the tool and its main characteristics are described in the following subsections.

2.4.1 Layers

In order to address the challenge of process complexity it is common practice to define layers of abstraction differing in their level of detail. The emerging question is how many layers are reasonable to support an adequate fit between necessary detailing of the process steps and constraining the amount of process information in one model with respect to usability and readability.

The most adequate amount of layers varies with respect to the modeling purpose of the modeling project. A workflow management system preparation project demands a higher level of (technical) detail in comparison to a management-oriented process modeling project. Hence, the challenge is to conceptualize a layer architecture which is able to meet the requirements for, e.g., both of the aforementioned scenarios.

Within the prototype, this layer-architecture is realized as four-layer architecture. It consists of the layers process framework, main processes, detail processes and process building blocks (PBB) (cf. Figure 4). On the first layer, a *process framework* provides the modelers and model users alike with a process overview respectively process landscape comprising all relevant main processes within the depicted organization ordered by, e.g., functional areas (cf. Figure 5). The elements of the process framework are further specified on a more detailed level on the *main process layer*. Here, the main process steps are described in order to give a rough overview about the activities usually carried out during this process in the respective business area. To handle parallel steps, branching methods are supported by design on this layer. Each of the main process steps is further refined by a detail process on the *detail process layer*. Like in the superordinate layer, branching methods are provided on this layer to handle parallel activities. Every modeled element on this detailed process layer is represented by a so called process building block. These PBB are defined in detail on the fourth and most detailed layer. Here, the most detailed information about the most atomic activities of the depicted processes can be provided. For example, attachments like videos, documents, hyperlinks, wiki pages, etc. are supported.

2.4.2 Attributes

Despite the possibility to use the layers of abstraction, icebricks proposes attribution as a mean to complement the process models with in-depth information on all process layers where applicable. By extending the process models with attributes, the challenge of complexity can be overcome more easily. Attribution reduces the need for sophisticated branching concepts for the control flow of the processes. Via the possibility to use different attributes on the distinct layers of abstraction, the aforementioned modeling purpose can more easily be supported. Hence, the concept of attribution fosters readability due to complexity reduction and expands the area of application due to the possibility to append attributes on any level.

icebricks features attribution on each of the four model layers. Here, process-enhancing and additional information can be provided for each of the model elements on each layer. The attributes can be specified by the administrators of the tool. Hence, the tool allows for utilization in any

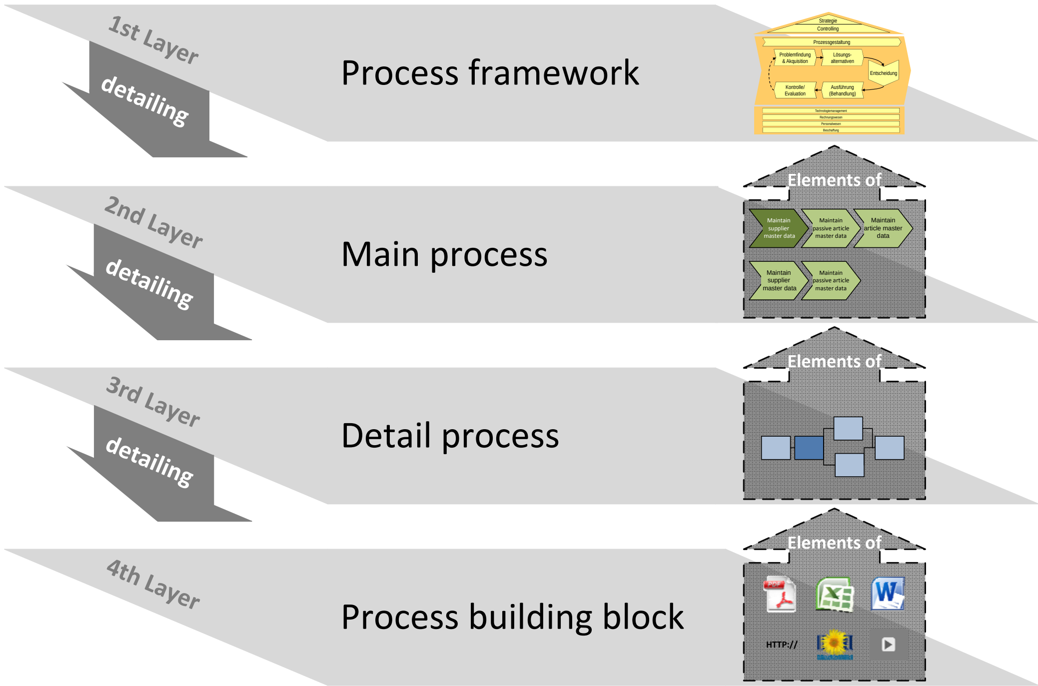

Figure 4: Layer architecture of icebricks

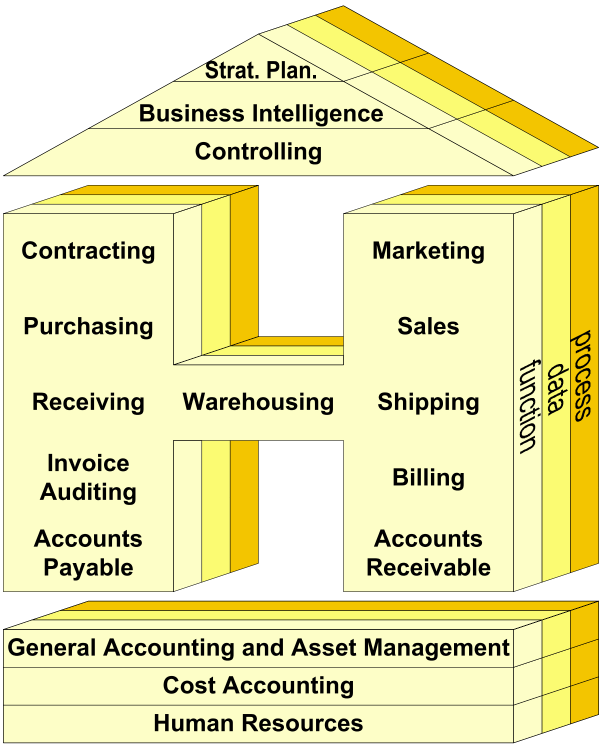

Figure 5: Retail-H (cf. J. Becker & Schütte, 2004)

organization and business area.

Furthermore, these manageable process attributes are an important prerequisite for process analysis and reporting functionalities.

2.4.3 Glossary

As described as a challenge, existing modeling techniques allow for a high degree of freedom in both syntax and semantics. These degrees of freedom also allow the modelers to arbitrarily label process elements, such as events and functions in EPC or BPMN.

Empirical studies verified that the terms used in modeling can vary heavily, especially, when developed timely, personally and regionally distributed (Hadar & Soffer, 2006). On a word-based view, these problems are mainly caused by synonyms. As process element labels are normally composed of multiple words, the phrase structure of these words may also cause naming conflicts. It has been shown, that even when limiting the number of words to two, there are more than 20 different phrase structures being used by process modelers (Delfmann, Herwig, & Lis, 2009b).

These issues, both on a word and phrase structure base are called naming conflicts (Batini, Lenzerini, & Navathe, 1986). The re-use of models flawed in such a way is problematic, as they increase the complexity of the models which are thereby much harder to understand by the model users. Moreover, automated processing and analysis of the models is rendered complicated or even impossible.

The key to prevent naming conflicts is standardizing the choice of words and the phrase structures to use before modeling and enforcing these standards during modeling (Delfmann et al., 2009b). Analogue to the syntax of our modeling technique, the semantic standardization uses the simplest structures available. There is only one phrase structure allowed, namely verb-object labels. Phrase structures of this composition have been proven to be better understandable than other phrase structures (Mendling, Reijers, & Recker, 2010). In the context of process modeling, verb and object can furthermore be interpreted as activity and business object.

Standardization before modeling is achieved through a glossary, which is composed of several business objects. These business objects are again related to the activities resulting in a specific instantiation of the verb-object phrase structure. The free definition of business objects and activities in the glossary allows the modeling technique to be customized for any modeling scenario. This procedure is therefore chosen over the use of existing catalogues such as the MIT process handbook, although it requires more initial work (Malone, Crowston, & Herman, 2003).

The standardization is enforced during modeling, since all process frameworks have to be related to one glossary. Every process element is then labeled by linking the process element to one activity-business object combination specified in the glossary.

With the glossary, the aforementioned naming conflicts are contained. The concrete implementation in the tool allows for the creation of glossaries in which business objects and activities can be maintained. Moreover, an assignment of activities to business objects assures that only correct and volitional combinations can be assigned to process elements. The usage of the glossary and the above mentioned four layer architecture of the prototype are aligned as well. On the process framework layer, the elements – which are the main processes – can be assigned a business object. On the subordinate layers – main processes and detail processes – the elements – detail processes respectively PBB – can be assigned a predefined phrase consisting of a combination of a business object along with an activity. By this, modeling conventions are adhered and costly refinements or corrections are avoided.

2.4.4 Reference Models

Besides the incorporation of the before mentioned rationales into the modeling technique, reference models are incorporated to further enhance model creation. They allow simple and efficient model creation, since their reference character enables the modeler to easily adapt the model to their needs. Moreover, reference models foster models of high quality with respect to their best or common practice character. Furthermore, reference models facilitate storing, relating and finding the models by providing a frame which structures the process model collection in an enterprise.

2.4.5 Variants

There are several scenarios where one outcome of a process is achieved by different process activities. This often leads to complex process models, since they take a range of possible circumstances into account in the sense of additional model components. A smart way to bypass this driver of complexity is to define several variants of one process. By this mean, the process model itself often remains simple with respect to branching and model elements but therefore the amount of simple model variants is increasing. It is a trade-off between complex models and several variants of one process model. Within icebricks, a new model variant is ought to be created whenever the incoming and outgoing information of the process is the same, but at least one process activity is different from the standard procedure.

2.5 Conclusion

Within this paper, a supporting procedure model for business process modeling projects was presented and accompanied with the description of a prototypical business process modeling tool — icebricks — which addresses the outlined main challenges by being compliant with the guidelines of modeling. By this means, a high economic efficiency is reached especially due to the usage of reference models as a base. Furthermore, high flexibility is reached through the individual adaptability.

It can be concluded from first evaluations that icebricks as a web-based and intuitive tool is fast to learn and greatly enhances the process landscape transparency. Nevertheless, further evaluation in business process modeling projects will have to prove that the strict four layer concept and the usage of the glossary will lead to the desired economic efficiencies and higher clarity. Furthermore, enhancements regarding the usability of the tool and analysis or reporting functionalities are yet to be incorporated.

3 Desire Lines in Big Data: Using Event Data for Process Discovery and Conformance Checking

■ **Wil van der Aalst**, Eindhoven University of Technology, Department of Mathematics and Computer Science, Eindhoven, The Netherlands, w.m.p.v.d.aalst@tue.nl

Abstract

Recently, the Task Force on Process Mining released the *Process Mining Manifesto*. The manifesto is supported by 53 organizations and 77 process mining experts contributed to it. The active contributions from end-users, tool vendors, consultants, analysts, and researchers illustrate the growing relevance of process mining as a bridge between data mining and business process modeling. This paper summarizes the manifesto and explains why process mining is a highly relevant, but also very challenging, research area. This way we hope to stimulate the broader IS (Information Systems) and KM (Knowledge Management) communities to look at *process-centric knowledge discovery*. This paper summarizes the manifesto and is based on a paper with the same title that appeared in the December 2011 issue of SIGKDD Explorations (Volume 13, Issue 2).

3.1 Process Mining

Process mining is a relatively young research discipline that sits between computational intelligence and data mining on the one hand, and process modeling and analysis on the other hand. The idea of process mining is to discover, monitor and improve real processes (i.e., not assumed processes) by extracting knowledge from event logs readily available in today's (information) systems (van der Aalst, 2011). Process mining includes (automated) process discovery (i.e., extracting process models from an event log), conformance checking (i.e., monitoring deviations by comparing model and log), social network/organizational mining, automated construction of simulation models, model extension, model repair, case prediction, and history-based recommendations.

Figure 6 illustrates the scope of process mining. Starting point for process mining is an *event log*. All process mining techniques assume that it is possible to *sequentially* record events such that each event refers to an *activity* (i.e., a well-defined step in some process) and is related to a particular *case* (i.e., a process instance). Event logs may store additional information about events. In fact, whenever possible, process mining techniques use extra information such as the *resource* (i.e., person or device) executing or initiating the activity, the timestamp of the event, or *data elements* recorded with the event (e.g., the size of an order).

Event logs can be used to conduct three types of process mining (van der Aalst, 2011; IEEE Task Force on Process Mining, 2011). The first type of process mining is *discovery*. A discovery technique takes an event log and produces a model without using any a-priori information. Process discovery is the most prominent process mining technique. For many organizations it is surprising to see that existing techniques are indeed able to discover real processes merely based on example executions in event logs. The second type of process mining is *conformance*. Here, an existing process model is compared with an event log of the same process. Conformance checking can be used to check if reality, as recorded in the log, conforms to the model and vice versa. The third type of process mining is *enhancement*. Here, the idea is to extend or improve an existing process model using information about the actual process recorded in some event log. Whereas conformance checking measures the alignment between model and reality, this third type of process mining aims at changing or extending the a-priori model. For instance, by using timestamps in the event log one can extend the model to show bottlenecks, service levels, throughput times, and frequencies.

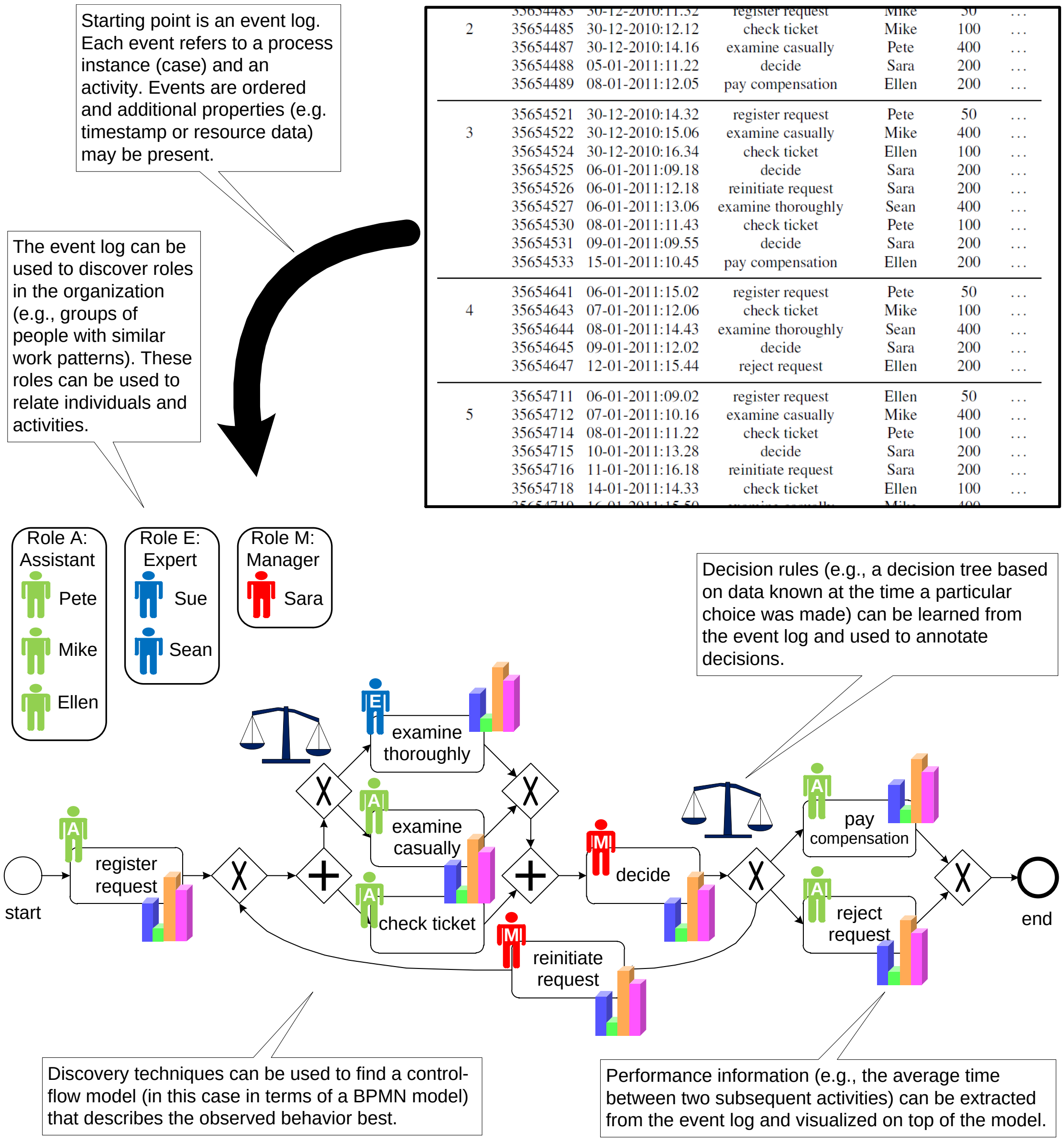

Figure 6: Process mining techniques extract knowledge from event logs in order to discover, monitor and improve processes

Figure 6 shows how first an end-to-end process model is discovered. The model is visualized as a BPMN (Business Process Modeling Notation) model, but internally algorithms are often using more formal notations such as Petri nets, C-nets, and transition systems (van der Aalst, 2011). By replaying the event log on the model it is possible to add information on bottlenecks, decisions, roles, and resources.

3.2 IEEE Task Force on Process Mining

The growing interest in log-based process analysis motivated the establishment of the IEEE Task Force on Process Mining. The goal of this task force is to promote the research, development, education, and understanding of process mining. The task force was established in 2009 in the context of the Data Mining Technical Committee of the Computational Intelligence Society of the IEEE. Members of the task force include representatives of more than a dozen commercial software vendors (e.g., Pallas Athena, Software AG, Futura Process Intelligence, HP, IBM, Fujitsu, Infosys, and Fluxicon), ten consultancy firms (e.g., Gartner and Deloitte) and over twenty universities.

Concrete objectives of the task force are: to make end-users, developers, consultants, managers, and researchers aware of the state-of-the-art in process mining, to promote the use of process mining techniques and tools, to stimulate new process mining applications, to play a role in standardization efforts for logging event data, to organize tutorials, special sessions, workshops, panels, and to publish articles, books, videos, and special issues of journals. For example, in 2010 the task force standardized XES (`www.xes-standard.org`), a standard logging format that is extensible and supported by the OpenXES library (`www.openxes.org`) and by tools such as ProM, XESame, Nitro, etc. See `http://www.win.tue.nl/ieeetfpm/` for recent activities of the task force.

3.3 Process Mining Manifesto

The IEEE Task Force on Process Mining recently released a manifesto describing *guiding principles* and *challenges* (IEEE Task Force on Process Mining, 2011). The manifesto aims to increase the visibility of process mining as a new tool to improve the (re)design, control, and support of operational business processes. It is intended to guide software developers, scientists, consultants, and end-users. As an introduction to the state-of-the-art in process mining, we briefly summarize the main findings reported in the manifesto (IEEE Task Force on Process Mining, 2011).

3.3.1 Guiding Principles

As with any new technology, there are obvious mistakes that can be made when applying process mining in real-life settings. Therefore, the six guiding principles listed in Table 2 aim to prevent users/analysts from making such mistakes. As an example, consider guiding principle *GP4*: “Events Should Be Related to Model Elements”. It is a misconception that process mining is limited to control-flow discovery, other perspectives such as the organizational perspective, the time perspective, and the data perspective are equally important. However, the control-flow perspective (i.e., the ordering of activities) serves as the layer connecting the different perspectives. Therefore, it is important to relate events in the log to activities in the model. Conformance checking and model enhancement heavily rely on this relationship. After relating events to model elements, it is possible to “replay” the event log on the model (van der Aalst, 2011). Replay may be used to reveal discrepancies between an event log and a model, e.g., some events in the log are not possible according to the model. Techniques for conformance checking quantify and diagnose such discrepancies. Timestamps in the event log can be used to analyze the temporal behavior during replay. Time differences between causally related activities can be used to add average/expected waiting times to the model. These examples illustrate the importance of guiding principle GP4; the relation between events in the log and elements in the model serves as a starting point for different types of analysis.

GP 1	**Event Data Should Be Treated as First-Class Citizens**: Event should be *trustworthy*, i.e., it should be safe to assume that the recorded events actually happened and that the attributes of events are correct. Event logs should be *complete*, i.e., given a particular scope, no events may be missing. Any recorded event should have well-defined *semantics*. Moreover, the event data should be *safe* in the sense that privacy and security concerns are addressed when recording the event log.
GP 2	**Log Extraction Should Be Driven by Questions**: Without concrete questions it is very difficult to extract meaningful event data. Consider, for example, the thousands of tables in the database of an ERP system like SAP. Without questions one does not know where to start.
GP 3	**Concurrency, Choice and Other Basic Control-Flow Constructs Should be Supported**: Basic workflow *patterns* supported by all mainstream languages (e.g., BPMN, EPCs, Petri nets, BPEL, and UML activity diagrams) are *sequence, parallel routing* (AND-splits/joins), *choice* (XOR-splits/joins), and *loops*. Obviously, these patterns should be supported by process mining techniques.
GP 4	**Events Should Be Related to Model Elements**: Conformance checking and enhancement heavily rely on the relationship between *elements in the model* and *events in the log*. This relationship may be used to “replay” the event log on the model. Replay can be used to reveal discrepancies between event log and model (e.g., some events in the log are not possible according to the model) and can be used to enrich the model with additional information extracted from the event log (e.g., bottlenecks are identified by using the timestamps in the event log).
GP 5	**Models Should Be Treated as Purposeful Abstractions of Reality**: A model derived from event data provides a *view on reality*. Such a view should serve as a purposeful abstraction of the behavior captured in the event log. Given an event log, there may be multiple views that are useful.
GP 6	**Process Mining Should Be a Continuous Process**: Given the dynamical nature of processes, it is not advisable to see process mining as a one-time activity. The goal should not be to create a fixed model, but to breathe life into process models such that users and analysts are encouraged to look at them on a daily basis.

Table 2: Six guiding principles listed in the manifesto

3.3.2 Challenges

Process mining is an important tool for modern organizations that need to manage non-trivial operational processes. On the one hand, there is an incredible growth of event data. On the other hand, processes and information need to be aligned perfectly in order to meet requirements related to compliance, efficiency, and customer service. Despite the applicability of process mining there are still important challenges that need to be addressed; these illustrate that process mining is an emerging discipline. Table 3 lists the eleven challenges described in the manifesto (IEEE Task Force on Process Mining, 2011). As an example consider Challenge *C4*: “Dealing with Concept Drift”. The term *concept drift* refers to the situation in which the process is changing while being analyzed. For instance, in the beginning of the event log two activities may be concurrent whereas later in the log these activities become sequential. Processes may change due to periodic/seasonal changes (e.g., “in December there is more demand” or “on Friday afternoon there are fewer employees available”) or due to changing conditions (e.g., “the market is getting more competitive”). Such changes impact processes and it is vital to detect and analyze them. However, most process mining techniques analyze processes as if they are in steady-state.

C 1	**Finding, Merging, and Cleaning Event Data**: When extracting event data suitable for process mining several challenges need to be addressed: data may be *distributed* over a variety of sources, event data may be *incomplete*, an event log may contain *outliers*, logs may contain events at *different level of granularity*, etc.
C 2	**Dealing with Complex Event Logs Having Diverse Characteristics**: Event logs may have very different characteristics. Some event logs may be extremely large making them difficult to handle whereas other event logs are so small that not enough data is available to make reliable conclusions.
C 3	**Creating Representative Benchmarks**: Good benchmarks consisting of example data sets and representative quality criteria are needed to compare and improve the various tools and algorithms.
C 4	**Dealing with Concept Drift**: The process may be changing while being analyzed. Understanding such concept drifts is of prime importance for the management of processes.
C 5	**Improving the Representational Bias Used for Process Discovery**: A more careful and refined selection of the representational bias is needed to ensure high-quality process mining results.
C 6	**Balancing Between Quality Criteria such as Fitness, Simplicity, Precision, and Generalization**: There are four competing quality dimensions: (a) fitness, (b) simplicity, (c) precision, and (d) generalization. The challenge is to find models that score good in all four dimensions.
C 7	**Cross-Organizational Mining**: There are various use cases where event logs of multiple organizations are available for analysis. Some organizations work together to handle process instances (e.g., supply chain partners) or organizations are executing essentially the same process while sharing experiences, knowledge, or a common infrastructure. However, traditional process mining techniques typically consider one event log in one organization.
C 8	**Providing Operational Support**: Process mining is not restricted to off-line analysis and can also be used for online operational support. Three operational support activities can be identified: *detect*, *predict*, and *recommend*.
C 9	**Combining Process Mining With Other Types of Analysis**: The challenge is to combine automated process mining techniques with other analysis approaches (optimization techniques, data mining, simulation, visual analytics, etc.) to extract more insights from event data.
C 10	**Improving Usability for Non-Experts**: The challenge is to hide the sophisticated process mining algorithms behind user-friendly interfaces that automatically set parameters and suggest suitable types of analysis.
C 11	**Improving Understandability for Non-Experts**: The user may have problems understanding the output or is tempted to infer incorrect conclusions. To avoid such problems, the results should be presented using a suitable representation and the trustworthiness of the results should always be clearly indicated.

Table 3: Some of the most important process mining challenges identified in the manifesto

3.4 What Makes Process Discovery Challenging?

Although the process mining spectrum is much broader than just learning process models (see for example conformance checking and model enhancement), process discovery is by far the toughest problem. Discovering end-to-end processes is much more challenging than classical data mining problems such as classification, clustering, regression, association rule learning, and sequence/episode mining.

Why is process mining such a difficult problem? There are obvious reasons that also apply to many other data mining and machine learning problems, e.g., dealing with noise, concept drift, and a complex and large search space. However, there are also some specific problems:

- there are *no negative examples* (i.e., a log shows what has happened but does not show what could not happen);
- due to concurrency, loops, and choices the *search space has a complex structure* and the log typically contains only a *fraction* of all possible behaviors;
- there is no clear *relation between the size of a model and its behavior* (i.e., a smaller model may generate more or less behavior although classical analysis and evaluation methods typically assume some monotonicity property); and
- there is a need to balance between four (often) *competing quality criteria* (see Challenge C6): (a) *fitness* (be able to generate the observed behavior), (b) *simplicity* (avoid large and complex models), (c) *precision* (avoid "underfitting"), and (d) generalization (avoid "overfitting").

To illustrate the challenging nature of process mining we consider the process model shown in Figure 7. This Petri net models the process that starts with a and ends with d. In-between k activities can occur in parallel. For parallel branch i there is choice between b_i and c_i. The process model is able to generate $2^k k!$ different traces, i.e., for $k = 10$ there are 3,715,891,200 possible execution sequences. Two example traces are $a\ c5\ b3\ c1\ b2\ b4\ c6\ c8\ b7\ c9\ c10\ d$ and $a\ b1\ c2\ b3\ c4\ b5\ c6\ b7\ c8\ b9\ c10\ d$. Concurrency and choice typically result in heaps of possible traces. In fact, if there are loops, there are potentially infinitely many traces. Hence, it is completely unrealistic to assume that all possible traces will be observed in some event log. Even for smaller values of k and event logs with millions of cases, it is often still unlikely that all possible traces will be seen.

Fortunately, existing process discovery algorithms do not need to see all possible interleavings to learn a model with concurrency. For example, the classical α algorithm can learn the Petri net based on less than $4k(k-1)$ example traces. For the α algorithm it is sufficient to see all "direct successions" rather than all "interleavings", i.e., if x can be directly followed by y it should be observed at least once.

Traditional knowledge discovery techniques are unable to discover the process model shown in Figure 7. However, for organizations interested in process improvement and compliance it is essential to discover the actual processes and these exhibit the control-flow patterns used in Figure 7. Various management trends related to process improvement (e.g., Six Sigma, TQM, CPI, and CPM) and compliance (SOX, BAM, etc.) can benefit from process mining.

Therefore, we hope that the manifesto will stimulate the IS and KM communities to think about new techniques for process-centric knowledge discovery.

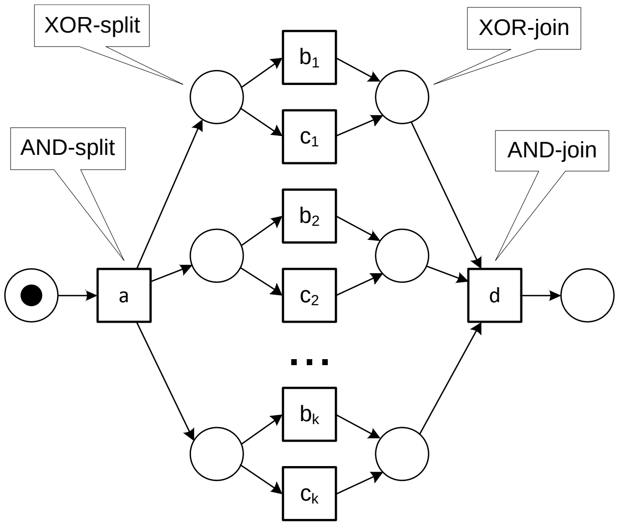

Figure 7: A Petri net with $2^k \cdot k!$ possible execution sequences

3.5 Learn More About Process Mining?

The process mining manifesto can be obtained from http://www.win.tue.nl/ieeetfpm/. The manifesto has been translated into Chinese, German, French, Spanish, Greek, Italian, Korean, Dutch, Portuguese, Turkish, and Japanese. The reader interested in process mining is also referred to the recent book on process mining (van der Aalst, 2011). Also visit www.processmining.org for sample logs, videos, slides, articles, and software.

4 BPM in Russian Oil & Gas Sector: Towards Research Cooperation and Co-innovation

- **Vadim Agievich**, Surgutneftegas, Surgut, Russian Federation, agievich_va@surgutneftegas.ru
- **Rinat Gimranov**, Surgutneftegas, Surgut, Russian Federation, gimranov_rd@surgutneftegas.ru
- **Victor Taratukhin**, University of Muenster, European Research Center for Information Systems, Münster, Germany, vita@ercis.uni-muenster.de
- **Jörg Becker**, University of Muenster, European Research Center for Information Systems, Münster, Germany, becker@ercis.uni-muenster.de

4.1 Co-innovation R&D model

The word “innovation” is derived from the Latin word novus or “new”, and is alternately defined as “a new idea, method or device” or “the process of introducing something new” (Gopalakrishnan & Damanpour, 1994). From the managers’ perspective, the primary purpose of innovation is to introduce change in the organization to create new opportunities or exploit the existing ones. Organizations operating under the present conditions of global competition, rapid technological advances, and resource scarcity must innovate in order to grow, to be effective, and even to survive. Thus, fostering innovation remains a major challenge for business executives, and an area in which academic research can make valuable contributions (Damanpour & Wischnevsky, 2006).

Innovation activities consume much expertise in different disciplines that cannot be concentrated within a particular company. The consequence of the fact is the tendency to co-innovation and R&D cooperation. Nowadays firms engaged in the innovation process are aware of the necessity of establishing R&D cooperation to obtain expertise which cannot be generated in-house. Collaboration with other firms and institutions in R&D is a crucial way to make external resources usable. It offers possibilities of efficient knowledge transfer, resource exchange and organizational learning. Agreements in well-defined research fields, leaving aside the possibility of competition in the market (pre-competitive stage), allow the stable and comprehensive adaptation of needed resources. Complementary assets and re-sources can be combined and pooled, thus generating synergies and cross-fertilization effects (W. Becker & Dietz, 2004).

As it is shown in some researches (Jiménez-Jiménez & Sanz-Valle, 2011), organizational performance is influenced by organizational learning mainly by facilitating innovation. Organizational learning allows the company to develop capabilities that enhance innovation and that innovation is what positively affects performance. Innovation in its turn requires that individuals acquire existing knowledge and that they share this knowledge within the organization.

A possible way for companies to obtain expert knowledge and put them in practice is taking part in industrial PhD programs. One of the leading Russian research universities Higher School of Economics (HSE) in the partnership with ERCIS and SAP University Alliances has established an industrial PhD. The program is concentrated on training of the most perspective employees of industrial companies as researches. The industrial PhD at HSE implies cooperative goal setting of research made by the PhD-students. As far as the companies are interested not only in the results of training but in the application of research results in practice, it is crucial to involve in the research other institutions that cooperate with vendors of products that are used by the industry. In this case the issues and objectives indicated in the beginning of PhD training have a chance to find their reflection in innovations that become a new product (see Figure 8). When a research project is conducted using the data of a real company and concentrated on company’s problems both parties win and the research brings value immediately.

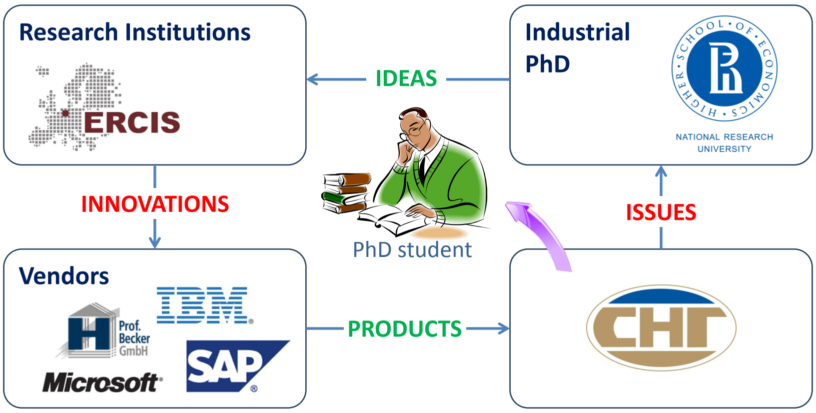

Figure 8: Co-innovation R&D model

Surgutneftegas company takes part in the industrial PhD program since 2011. Research interests of the participants from Surgutneftegas are concentrated within Enterprise Architecture and Business Process Management disciplines. The paper depicts shortly current activities in these areas and issues that IT organization of Surgutneftegas faced. Also it discusses some corresponding research prospectives.

4.2 Surgutneftegas today

Oil and gas producer Surgutneftegas is one of the largest companies in the Russian oil sector. It accounts for almost 13% of the country's crude output and 25% of gas produced by domestic oil companies. The company's refinery Kirishinefteorgsintez, one of the largest in Russia, accounts for almost 9% of the country's refining throughput. Marketing subsidiaries owe much to their geographical position: they are located close to the company's refinery and heavy traffic intercity and international highways going through the area of the company's activity. The Company has two major research centers: R&D institute "SurgutNIPIneft" and Oil Refining and Petrochemical Enterprises Design Institute "Lengiproneftekhim".

Surgutneftegas is among leading Russian companies that highly adopt and effectively use ITCs.

4.3 Evolution of organizational applications and complexity issues

Today's CEOs know that the effective management and exploitation of information through IT is a key factor to business success, and an indispensable means to achieving competitive advantage. Organizational applications evolve from the first-line management level to the top management level. 20-30 years ago they had an operational character, processed past data and reflected "programmed" business-processes or functions. Business applications in modern companies work in the area of strategy, plans and non-programmed business functions. They have grown from transaction-systems up to strategic-weapon-systems (both internal and external) using ERPs, intranets, extranets, E-Commerce etc. This growth is inevitably accompanied by the growth of systems complexity. But the more complex a system becomes the harder and longer the implementation gets. Labor content of modern IT projects is doubled by requirements for systems integration that spring from strong aspiration for business information consolidation.

Nowadays landscape complexity in conjunction with obsolete Functional Approach for implementation and a lot of legacy home-grown applications generates in some large companies the following issues in IT:

- Long times of business requests processing
- Local automation
- Data duplication and incoordination
- High labor content of development and support of heterogeneous user interfaces
- Duplication of functionality in different systems and lots of manual development
- Isolation of systems
- Lots of point-to-point connections
- Analytical information is duplicated, uncoordinated and unstructured

These issues and growing complexity force companies to look for new methods of systems implementation and IT management.

4.4 Process Approach for IT-solutions design and implementation of ERP

Business-process modeling may reduce considerably the effort and costs of ERP-systems implementation. ERP implementation should involve the analysis of current business processes and the chance of reengineering, rather than designing an application system that makes only the best of bad processes. Due to the fact that business processes are very complex, in many cases analysis cannot be done directly on the real-world application. Thus, modeling aims at reducing the complexity of the reality in order to better understand business processes and their required software support (Scheer & Habermann, 2000).

According to (Scheer & Habermann, 2000), modeling methods, architectures, and tools have become increasingly popular because they can help to reduce the cost of software implementation and at the same time increase user acceptance of ERP software solutions. Several modeling approaches are possible:

- Reduce the effort necessary for creating the target concept by leveraging “best practice case” knowledge available in reference models.
- Create a requirements definition by leveraging modeling techniques to detail the description.
- Document the system requirements definition by means of conceptual modeling methods, making the business logic more understandable.
- Leverage conceptual models as a starting point for maximum automation of system and configuration customizing.

Process modeling is a widely-used approach to achieve the required visibility for existing processes and future process scenarios as part of business process improvement projects. The intellectual challenges related to process modeling keep many academics entertained and a plethora of tools, methodologies and educational material in the form of publications and seminars is available. However, process modeling has also strong opponents. It is criticized for being over-engineered, time-consuming, costly and without (sufficient) value. Thus, the challenge is to find the right level of modeling for the underlying purpose (Rosemann, 2006).

For about three years IT-solutions in Surgutneftegas based on ERP-systems are designed and implemented using Process Approach. The purposes of business-process modeling for IT organization of Surgutneftegas reflect modeling approaches indicated above. The models serve like a common language between IT and business people, they provide better understanding of requirements. With the models IT project teams have the ability to present future business operations graphically and get feedback from the business on early stages. The models allow creating more holistic IT-solutions, obtaining quality solution documentation. The more complex (involving several organizational units) processes are the more Process Approach pays for implementation of EPR-systems.

Model-driven development and creating process repository are important BPM activities for companies where IT makes changes to processes and the changes are frequent (Figure 9). It was also one of the reasoning for using Process Approach by the IT organization of Surgutneftegas.

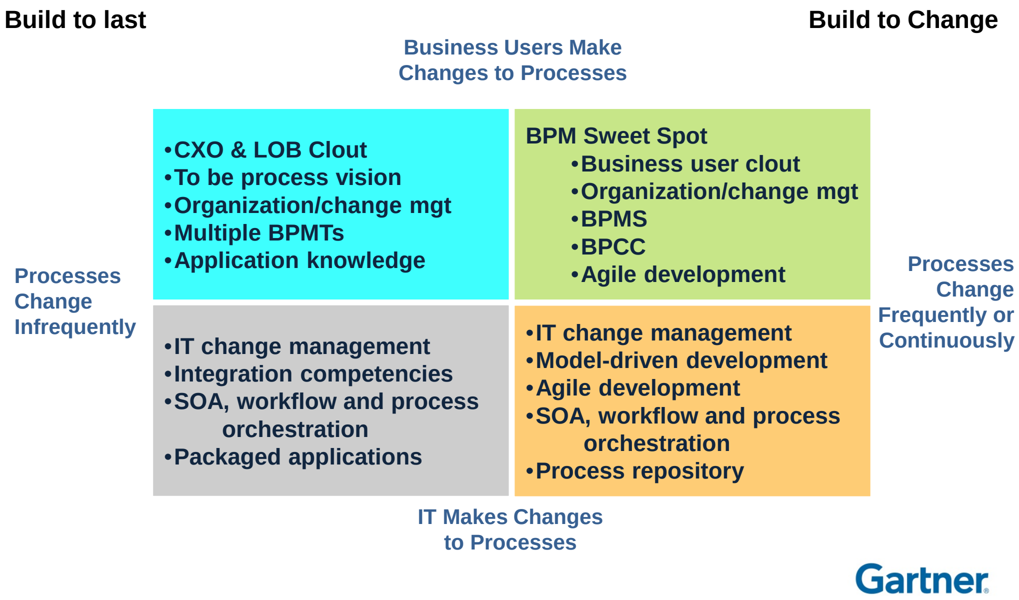

Figure 9: Gartner four corner framework for BPM

Usage of Business Process models by IT project teams in Surgutneftegas is shown on Figure 10. During the step 1 models describing the current state of subject area are created together with business users. Then the models are analysed during solution architecture design. The result of the step 2 is models describing a possible future automated process state. Models created by an IT project team are subject to audit (3) by Surgutneftegas Process Office that is also responsible for methodology and consistency of the models repository. Models approved by the business customer are used for low-level design and implementation of the IT-solution.

Nowadays besides the "traditional" use of process models within software engineering these models are more and more used for pure organizational purposes like process reorganization, certification, Activity-based Costing or human resource planning (J. Becker et al., 2000). IT organization is not the only in Surgutneftegas who use process models they are also used by some other organizational units for non-IT purposes.

4.5 Towards Enterprise Architecture: Issues and Research Prospectives

Process Approach works well for IT-solutions but it is unable to solve all IT problems depicted above. In order to get rid of them an organization should implement a comprehensive and sys-

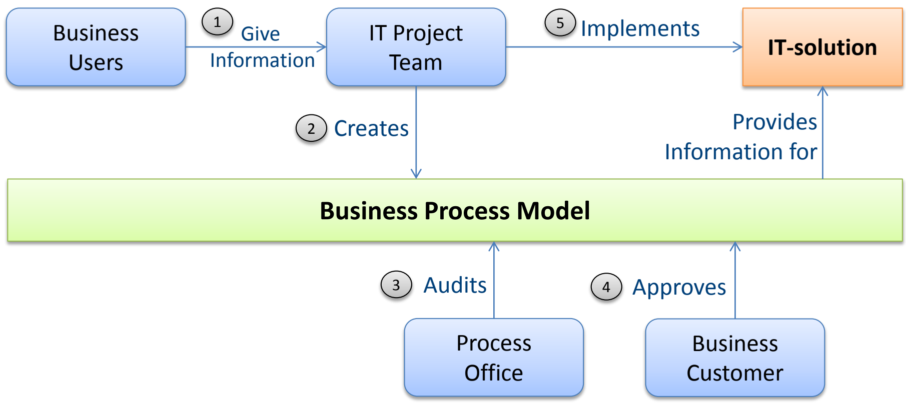

Figure 10: IT-solutions design using business process models

tematic methodology for IT management that comprises business goals and processes, data flows and technologies. Such methodologies are proposed by the Enterprise Architecture discipline.

Enterprise Architecture is often referred as a blueprint for how an organization achieves the current and future business objectives using IT. It examines the key business, information, application, and technology strategies and their impact on business functions. It provides the framework for planning and implementing a rich, standards-based, digital information infrastructure with well-integrated services and activities (Dahalin, Razak, Ibrahim, Yusop, & Kasiran, 2010). It's a strategic information asset base, which defines the mission, the information necessary to perform the mission, the technology, and the transformational processes for implementing new technologies in response to the changing mission needs. An Enterprise Architecture includes a baseline Enterprise Architecture, target Enterprise Architecture, and a transition plan (Schekkerman, 2008).

Enterprise Architecture Centre of Surgutneftegas was created in 2011 with the following tasks:

- Support and control of enterprise architecture methodology and modeling activities
- IT management on the basis of architecture approach
- Analysis of a baseline IT architecture, describing issues and solutions
- IT-strategy formation
- IT regulations and standards development
- Applications and technologies standardization
- Standardization of IT-solutions
- Software and hardware procurement support
- Studying and tracing of innovations
- Control of IT-projects (architecture quality management)

Today the Enterprise Architecture Centre works predominantly in the areas of Enterprise Architecture modeling and IT regulations and standards development. The Open Group Architecture Framework is accepted as the methodology. But its implementation becomes not a purely engineering task as it seemed before. As H.Shah and M.Kourdi describe, at the moment a number of different Enterprise Architecture frameworks and tools exist but challenges still remain both from framework and organizational perspectives (Shah & Kourdi, 2007). Some conditions of large companies generate even more challenges. Changes in IT environment there are never ending. It's a common place situation when several IT projects are running simultaneously conducted by different organizational structures. How can a team of several architects track all the changes in the architecture?

The other problem the team came across is the problem of different non-integrated methodologies for Enterprise Architecture, BPM and SOA.

EA, BPM and SOA have always been related, but are now beginning to converge in the sense that they are working with the same problems but with different "label" on the nature of activity (© 2010 Computas AS). In order to minimize waist activities and fit models together organizations need a united framework and a standard supported by an integrated toolset instead of multiple different standards and tools in this area.

4.6 Conclusion

Innovation is the realization of a creative idea being applied to an existing problem. This application may be either of a new idea or the adoption of an existing idea (Mayfield, 2011). As we could see some aspects of Enterprise Architecture development and other activities in large organizations may grow from supposed purely engineering tasks to real research problems. And this is a soil for cooperation and co-innovation in research and development that may be of a great value for both science and industry.

5 Breakout Sessions

- **Daniel Beverungen**, University of Muenster, European Research Center for Information Systems, Muenster, Germany daniel.beverungen@ercis.uni-muenster.de
- **Armin Stein**, University of Muenster, European Research Center for Information Systems, Muenster, Germany armin.stein@ercis.uni-muenster.de

5.1 Setting and organization

In line with the general areas for BPM investigated in the workshop, we conducted one breakout session for each of the core topics of Business Process Management Strategy, Business Process Modeling, Business Process Implementation, and Business Process Analysis. The breakout sessions were purposefully designed in order to allow for a stimulating setting for developing new ideas and German-Russian research cooperation. On the first day, the workshops of BPM Strategy and Business Process Analysis were conducted, whereas the sessions of Business Process Modeling and Business Process Implementation were performed on the second day. These two sessions were conducted simultaneously, such that the participants were motivated to get involved into one subject area they were experienced in.

Each of the sessions was designed as a two-step process. First, selected participants presented their own point of view of the topic by presenting recent research results and highlighting new research prospects. Second, a moderated group discussion was performed in order to provide an open setting in which new ideas could be generated and integrated with each other.

In order to guide the breakout sessions, the discussion phase was structured by providing the participants with a framework that consisted of three dimensions (cf. Figure 11). First, the participants were asked to frame their ideas with respect to BPM research, industrial application of BPM, and teaching in BPM. The idea was to get all types of stakeholders in the workshop involved, since researchers, lecturers, and industry representatives attended each workshop. Second, the participants were asked to highlight the relevance for their suggestions for Russia, Germany, or both. This was done in order to identify research areas that could be investigated in cooperative research settings. Third, the research ideas were framed with respect to the time it would take to realize them. The participants were asked to think about topics that would need to be addressed in a rather short-term, middle-term, or long-term period of time.

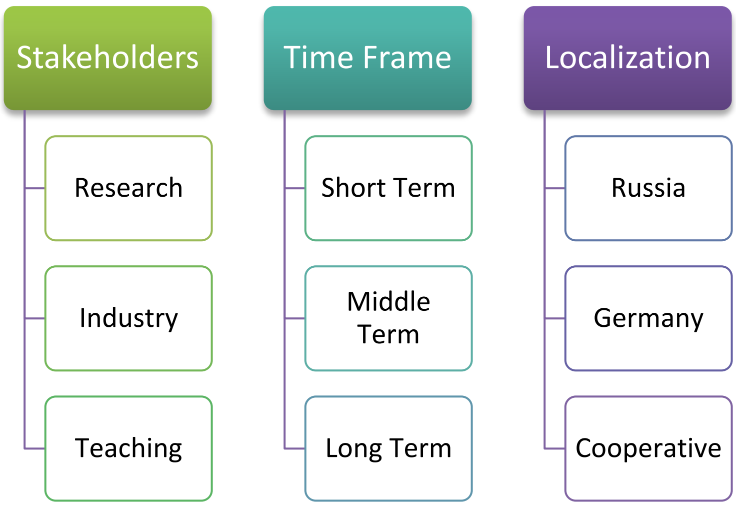

Figure 11: Framework for stimulating ideas in each breakout session

The resulting ideas were documented by one of the moderators in each workshop. Subsequently, the moderators consolidated and triangulated the ideas provided in each of the workshop with each other. On the second day of the PropelleR workshop, they presented the resulting ideas to the general audience of the workshop. This was done in order to further share and extend the results from the sessions, since none of the participants could have attended all sessions. Following up on the results, another discussion round was performed with the entire group of researchers.

In the subsequent sections, we report on the results from each break out session separately, before concluding with a consolidation of the findings of all four sessions.

5.2 Business Process Strategy

The Business Process Strategy Session featured two presentation held by Martin Instinsky and Johannes Schwall from PICTURE GmbH and Yuri Kuprianov from the National Research University Higher School of Economics, Moscow. During the first presentation, a network of users of a modeling methodology developed and maintained by the PICTURE Company was presented. PICTURE as consulting company offers this build-to-fit solution for governmental institutions to analyze and improve their business processes. The suggested network of users, their meetings, and their discussions serve as generator of new features of the underlying software system, thus directly affecting the strategy of the company. Furthermore, users exchange best practice applications. Like this, both client and company benefit from this network.

As in high intensity IS companies leadership is very volatile, leadership on an executive, but also on a managerial level tends to change regularly. Those chances often get along hand in hand with transformation projects, which do not only affect the IT landscape but also the whole company. Yuri Kuprianov presented an approach to formally and systematically support enterprise transformation by the means of information systems. His approach provides companies with a tool to identify the best-fitting combination of activities, measures, and investments to support enterprise transformation.

The resulting discussion very much pointed towards the wide-spread reluctance of Russian companies to adapt BPM approaches. This indicates a local focus on Russia. There, according to contributions to the discussion from Russian participants, in all addressed areas (practice, research, and education), fundamentals of strategic business transformations towards a BPM approach are not well established yet. In many cases, decision-makers continue running their business the way they did the last decades, fearing to lose control over or influence in the company. For this, Russian participants suggested to start with a European-supported community of BPM enthusiasts, spreading the word not just at University level, but beginning earlier during education at school. It would be beneficial to have access to people in influencing positions and to motivate them to join the initiative. Furthermore, companies and industry have to be involved into this community, discussing issues related to BPM and stimulating researchers on their way towards a BPM way of thinking. It was agreed that such a change in societal thinking cannot be performed in short-term, but might take decades. However, setting up a community of BPM researchers could be a first step. The initial task of such a community has to be the generation and definition of a common understanding and terminology of BPM, which up to now is still missing. On University level, however, the exchange of students from Europe to Russia and vice versa should support the building of a mutual BPM understanding. For this joint education programs should be initiated on bot Bachelor and Master Level. Once this is done, next steps could be planned. It was also agreed that single BPM projects will not be means to establish a wide-spread understand of BPM benefits.

5.3 Business Process Modeling

In the area of Business Process Modeling, the breakout session started with two presentations. First Prof. Dr. Erich Ortner (Technum) introduced the concept of resilience as a new paradigm for engineering and management of an enterprise. This approach emphasizes the prolonged need to maintain responsive towards change going on in the environment of an organization. Second, Prof. Dr. Peter Loos (University of Saarbrücken) presented an approach for identifying and designing successful business process models based on constructing reference models in an inductive way. As opposed to a deductive development based on theory, inductive development is conducted by analyzing business process instances in the field, from which best practice knowledge about the process is built. Recent contributions in process mining can provide for the required functionality towards that end.

In the discussion, a collection of emerging areas for cooperation with regards to research, industry, and teaching in the area of business process modeling was identified. We report on them separately in the following subsections.

With respect to industry, the concept of resilience was debated further. It was stated that maintaining responsive towards change in the environment requires companies to build up competences and resources in excess of what is needed for performing the daily operations in a company. Since building up these resources is a costly endeavor, companies have to determine the desired degree of resilience that is needed. First of all, they need to develop mechanisms to detect what is actually going on in their environment. This can be done with business process analysis techniques such as process mining, as long as sufficiently large and rich data repositories are in place to allow for drawing sound conclusions. A subcategory of methods is to build up reference models from business process instances with which new business processes can be compared in order to detect possible changes in the environment. Such reference models would need to be build up for different industry sectors in order to document best practice knowledge on business processes. On the other hand, adapting reference models does not come for free, since companies striving to implement reference models into their own organization have to carry out resource-intensive adaptation processes in order to make this knowledge applicable to their own organization.

With respect to research, it was stated that a plethora of reference models exists, covering difference industry sectors (such as manufacturing, supply chain integration, retail, insurance) and business process types (such as order-to-cash processes, materials planning, invoicing). However, most of these models have been developed from scratch without a clear reference to real-life business processes. An automatic design of new reference models that is based on business process mining can add another valuable perspective that is intimately rooted in analyzing real-life process data. However, such analyses are restrictive since they require high quality data to be in place that can be analyzed in a meaningful way. This process might be supported by developing or revising reference models in a collaborative effort of researchers, such as performed in the Open Model Initiative (`http://openmodels.org/`). After a reference model is developed, it might be subjected to further testing in the field in order to underline a goodness of fit with data gathered from business process instances. To that end, inductive and deductive strategies for developing reference models complement each other and might help to develop more elaborate reference models in the future. Another promising area for research on business process modeling is to further develop business processes for networking organizations with each other and with end consumers. Examples are coordination patterns, a collaborative design of reference models, and the standardization of business processes and their interfaces in order to be able to orchestrate them in interorganizational settings.

With regards to BPM education, the break out session revealed that BPM education in Russia has a history of focusing on humanitarian topics, whereas BPM education in Germany was developed in the course of business process reengineering in companies in the mid nineteen nineties. Further prospects with regards to BPM education are to improve students' skills regarding modeling languages and techniques. These skills shall not only be taught at universities, but can also start by introducing process-thinking into secondary school education. With regards to skills in industry, the participants highlighted the necessity of establishing further means to make industry representatives fit for managing the business processes in their own organizations. One important step towards that end is to foster executive education in the BPM field.

5.4 Business Process Analysis

The break out session on business process analysis started with three presentations. First, Prof. Dr. Susanne Leist (University of Regensburg) presented “A systematic approach for improving business processes”. Second, Prof. Dr. Ali Sunyaev (University of Cologne) argued for a stronger interrelation of BPM with Data Quality Management in his talk “A business process and data quality management perspective on ERP systems development in the financial service sector”. Third, Prof. Dr. Igor Fiodorov (Moscow State University of Economics, Statistics and Informatics) provided an overview of the capabilities of selected business process modeling approaches by reflecting on an insurance business scenario in his presentation “An aspect based analysis of integrated business process models”.

In the discussion, a collection of emerging areas for cooperation with regards to research, industry, and teaching in the area of business process analysis was identified. We report on them separately in the following subsections.

With respect to industry, the participants emphasized that BPM is still a top priority to be addressed by industry companies in both countries. However, industry representatives seem to sometimes lack a toolkit of methods for analyzing business processes that fit the needs of conducting such analyses at a company level, with reasonable resource consumption. The current collection of process modeling techniques is exhaustive and lacks a clear differentiation, such that selecting an appropriate method is the first step required in most industry settings. However, a clear distinction of business process models at build time and run time must be made, since business process models need to be implemented in order to run on IT systems and to really impact the business of the firm. Both tasks require implementing process driven procedures, in particular a mind-set of managing the firm in a process-oriented way, into the organization. With regards to the specific differences between companies in Germany and Russia, the participants highlighted that some of the leading edge companies in Russia represent industry sectors that are not addressed in Germany. Premium examples are large oil and gas companies. These companies have specific needs for managing and analysing business processes, due to their size, distribution, and the international scope of their business. Another crucial issue is to account for differences with respect to entanglements between companies and government that might be more present in Russia than in Germany.

With respect to BPM research, a lively discussion emerged with regards to identifying topics for joint research in the future. The participants highlighted cultural differences between BPM research in Russia and Germany. In particular, some Russian researchers argued that BPM research is still all but forming in Russia, but has significantly grown during recent years. The participants felt that this setting is promising for enabling further cooperation with German universities having a tradition in BPM research. With regards to business process analysis, it must be ensured that process logs are large enough and feature a sufficient semantic quality, since otherwise no meaningful patterns can be identified from the data. Future BPM research could improve the modeling and analysis of these data to a great extent. In particular, rich data could be utilized to trace the evolution of business processes in a longitudinal way, which would help to trace and analyze changes in a company’s business model and operational efficiency. Since performance issues related to business processes are a socio-technical phenomenon that depends not only on the technical implementation of the processes in IT landscapes, but are subject to their organizational embedding, effects between the technical level and the business level must be considered more clearly. Furthermore, more elaborate tool support for business process integration is needed in order to analyze business processes coherently in an organization. Current tool support lacks the ability to monitor and analyze business processes in the large, but is focused on performing rather detailed analyses on a small scope. Another crucial issue is to provide for business process patterns that can help companies to further integrate their business with other companies. A reference set of formal interaction patterns might be valuable not only to get business processes working to establish and maintain interorganizational business models; they might also boost the analysis of business process data on a dyad level of analysis that has been largely neglected in BPMN research so far. A particular challenge is to develop patterns that are able to adapt to their context dynamically, since a reference set of patterns can never be completely designed at build time, but must support unforeseen interactions in new network constellations as well. In-memory technology is perceived as a promising shift in order to provide the foundation of real-time data analytics in the future. The traditional model of migrating transaction data to a data warehouse in which analyses of business processes is performed might be deprecated in favour of establishing ways to analyse data in transaction systems already. One crucial merit is to use insights from data analytics for dynamically influencing the further progression of business processes as soon any meaningful events have been identified.

With regards to BPM education, the participants pointed out that the current diversity of methods in BPM makes it hard for novice users to find their way into the management of business processes. In order to sufficiently train newcomers, it is required to conduct project work and case studies on modeling, implementing, and analyzing business processes with respect to real-life cases. In particular, the Russian participants emphasized that the current curriculum is still developing and needs further improvement in order to convey such a learning experience. A solution might be to join the BPM academic initiative which is an organization that provides course material and best practice solutions in this area.

5.5 Business Process Implementation

The goal of the implementation Session was to discuss either implementations of BPM in terms of software realizations or implementations of BPM approaches in companies. Holger Schrödel presented an approach to an Aligned BPM for Future Data Centers, based on his experiences in the SAP UCC surrounding. The presentation showed ways of how to gain experiences from existing reference models in the area of Supply Chain Management that can be transferred to the dedicated setting of Data Centers as those run by SAP. The question was raised how the software industry can learn from manufacturers. There are several similarities which under certain circumstances can be treated the same way. An example “stock management” in the manufacturing area can be related to “ERP-as-a-service” solution in the software industry. Until now, such a perspective on the product can be rarely found. Principles that can be adopted are those of standardization and automation, modularization, continuous improvement processes, or the concentration on core competencies. Furthermore, a tighter integration between people processes and “machine” processes is required in line with an improvement of decision modeling and decision execution. Lastly, a demand for common agreed semantics data models for people-technology integration can be identified.

Holger Wittges from the Technical University of Munich followed with his speech on the implementation of BPM using SAP Process Integration together with SAP Business ByDesign. The initial point to be discussed was the use of appropriate tools to transform informal business models into executable ones and which tools can be used for this. Required steps for transformation were identified as being of highly manual quality; however predefined reference content in SAP ByDesign can be used. Therefore, instead of technical skills, business skills and knowledge are required to be able to use the combination of SAP NetWeaver Process Integration and SAP ByDesign.

During the discussing, a focus was set on the transformation of semi-formal process and data models to ready-to-use implementation models. It was agreed that a full automatic transformation is not possible until now due to semantics included in the business model which cannot be unambiguously analyzed and transformed by IT infrastructure such as, e.g., Workflow Management Systems or Enterprise Resource Planning Systems. Despite this, the mentioned lack of mutual understanding of terms and processes between IT and business was addressed. As a result, standardization was identified as a very important aspect, spanning not only process, but also terminology in terms of vocabularies, methodology, and documentation. The discussants suggested a reference process and data model for an at least semi-automatic model transformation from informal to implementation. This model cannot be specified to the smallest detail, it should however provide a constant data model and a module-like process structure that allows the re-arrangement of their execution.

From a temporal perspective, this issue was identified as being relevant in short term because it can be started right away, it's duration however was defined as long term, as the reference model has to be constantly revised and can thus never be described as being finished.

6 Formalized Approach for Managing IS-Enabled Organizational Transformation

- **Yury Kupriyanov**, National Research University 'Higher School of Economics', Faculty of Business Informatics, Moscow, Russian Federation, yukupriyanov@hse.ru
- **Victor Taratukhin**, University of Muenster, European Research Center for Information Systems, Münster, Germany, vita@ercis.uni-muenster.de

Abstract

Within this paper authors present the formalized approach vastly based on the adaptation of a well-known technique House of Quality for managing IS-enabled organizational transformation. The provided approach is meant to support designing rational set of organizational change management measures during information system implementation project under the condition of cost and time constraints and thus build an explicit link with quantified coefficients showing the relations between organizational business benefits and organizational change management measures.

6.1 Introduction

Information technology and enterprise information systems have become an increasingly growing and essential part of the modern company since they affect performance, at the operational and strategic levels (J. Becker, Vilkov, Taratoukhine, Kugeler, & Rosemann, 2007). The results of recent research show that IT/IS implementations lead to significant amounts of organizational change (Markus, 2004; Peppard, Ward, & Daniel, 2007). For example, the introduction of integrated ERP-system may impact organization's business processes, structure, culture and enterprise level performance, as well as the motivation, job specifications and performance of individual employees (J. Becker et al., 2007; Markus, 2004). Deployed in very similar organizational settings, identical information systems (IS) can give rise to significantly different outcomes (Orlikowski & Hofman, 1997). Studies continue to show that investments in information technology are failing to deliver expected benefits with success rate lower than 30%. In many instances the planned organizational impacts, i.e. benefits, fail to materialize and due to that fact there is a growing consensus that the significant amount of systems development projects lack effective management of IS-enabled organizational change (Peppard et al., 2007).

In this paper authors argue an approach that will increase the likelihood of IS-investment business benefits realization through a provision of a formalized model to explicitly show how each IS-enabled organizational transformation management (ISEOTM) measure contributes to the attainment of every projected business benefit within IS implementation project. Such an approach is meant to lower the costs of ISEOTM activities while safeguarding the constant business value of IS-implementation project.

6.2 Key principles of the approach and results of benefits assessment study

Conducted literature review on the topic of organizational and benefits management during IS-implementation shows that these practices are to be realized to a number of guiding baseline principles:

- Information systems have no value per se. (Peppard et al., 2007)

Just having IS deployed does not create any value. However, possession of an information system incurs cost.

- Information systems enables people to work differently and helps freeze effective practices across organization. (Peppard et al., 2007)

Individuals and groups get possession of the information management tools which enable them to be efficient and effective in performing their daily operations.

- Cooperative responsibility of project and business team for benefits realization. (Peppard et al., 2007; Ashurst, Doherty, & Peppard, 2008)

Project team cannot be held solely accountable for realizing the business benefits of IS investments. Business process and function owners must take on the responsibility and change their business practices in accordance with principle 2 in order to gain the value from IS.

- Benefits realization implies proactive management and has a longer lifecycle that the one of IS implementation project. (Peppard et al., 2007)

Managing for the benefits does not stop when the technical implementation is completed. Benefits management has to go till the moment when all projected benefits have either been achieved, or it is clear they will not materialize.

Described principles serve a basis for the conceptual model (Kupriyanov & Taratoukhine, 2011; Tiernan & Peppard, 2004) of the IS-implementation project. On Figure 12 two major domains of project activities are distinguished: organizational transformation and technical deployment and configuration of the IS.

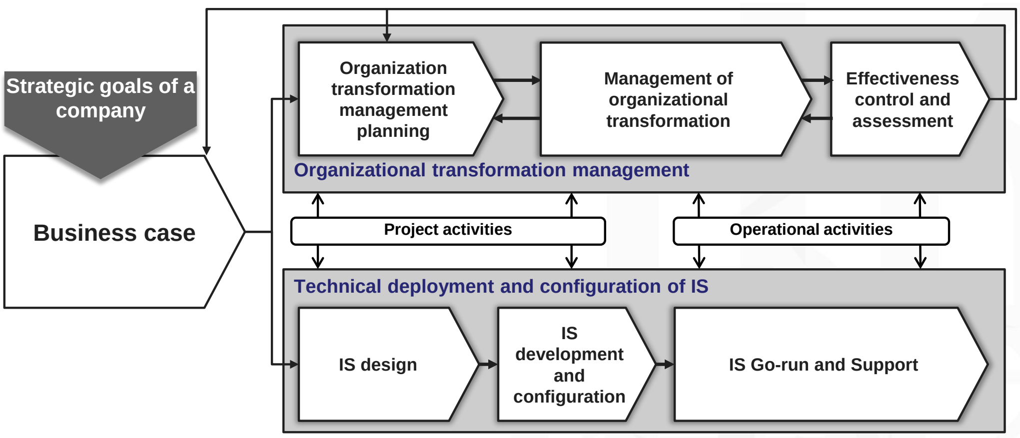

Figure 12: Conceptual model of IS-project

Another conclusion of the principles identification is that business benefits can be realized only through changes in organizational artifacts and thus explicit management of the latter is required. Results of the conducted research on the business value realization of SAP ERP implementation in CIS reinforces above mentioned conclusion and showed that major IS-project business benefits are gained not through routine operations automation but rather through end-to-end business process re-engineering followed by intensive organizational transformation management activities (cf. Figure 13). It should be noted that in the large ERP-implementation projects the cost of

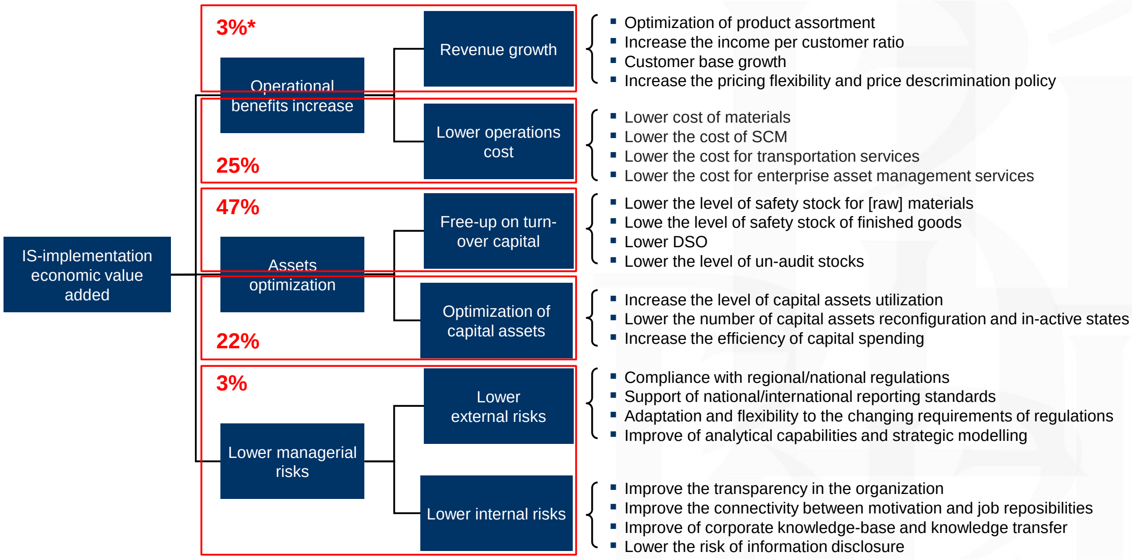

Figure 13: Value tree of IS-implementation project

organizational transformation management activities could raise up to 10% of the total cost of the project (Galoppin & Caems, 2007).

Due to the focus of the research further investigation in the paper will be one of Organizational transformation management domain.

Organization transformation management planning step is aimed at defining set of methods and measures to be used in order to gain project business benefits listed in business case. According to the identified principles each business benefit is aligned with the corresponding organizational change, which are being delivered with the help of ISEOTM measures (cf. Figure 14). So one can speak of an implicit bundle: business benefit-organizational change and organizational change – ISEOTM measures.

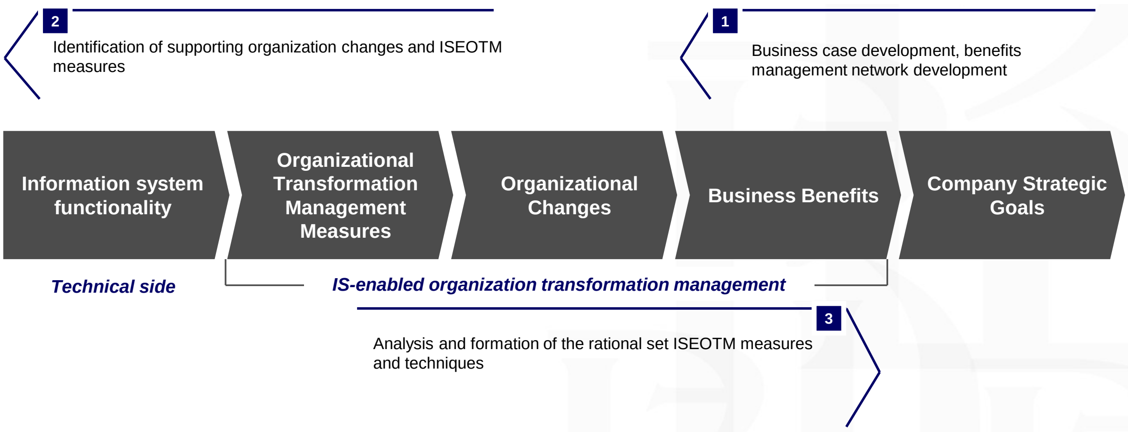

Figure 14: Business benefits realization model

Management of ISEOT is operational management at the level of the project activities.

Effectiveness control and assessment is meant to diagnose the current progress and minimize deviations of the projected business benefits from the ones stated in the business case. From that perspective a designated technique is required to show the connection between activities aimed at delivering organizational changes supporting realization of the benefits stated in the business case. Application of well-known in the area of quality management and industrial design technique called House of Quality – HOQ, Quality Function Deployment – QFD (Hauser & Clausing, 1988) could be one of the options to build an explicit link between business benefits and on one hand and provide for optimization solution allowing to cut the cost of ISEOTM activities.

6.3 Formalized Organizational Transformation Management Approach Development

As previously mentioned application of QFD technic allows for various types of formalization to build explicit links with the use of the numerous mathematical techniques (Zhai, Khoo, & Zhong, 2008; Chan & Wu, 2005; Sullivan, 1986; Park & Kim, 1998; Mu, Tang, Chen, & Kwong, 2008). In the presented paper the formalization and quantification of relation between organizational changes, ISEOTM measures and business benefits will is built within QFD using SMARTS (Edwards & Barron, 1994) and AHP-method (Saaty, 2003).

The original **F**ormalized **O**rganization **Tr**ansformation **M**anagement (FOrTraM) approach (for graphical representation cf. Figure 15) described in the paper meets the requirements of identified above principles and IS-implementation project environment stated in the conceptual model of IS-implementation project. The following assumptions are also to be mentioned to properly position the mentioned method:

- approach is an integral part of IS implementation project
- suitable for large scale ERP-implementation with clearly defined goals, organizational, and functional scope
- cannot be regarded solely as a stand-alone organizational transformation management approach

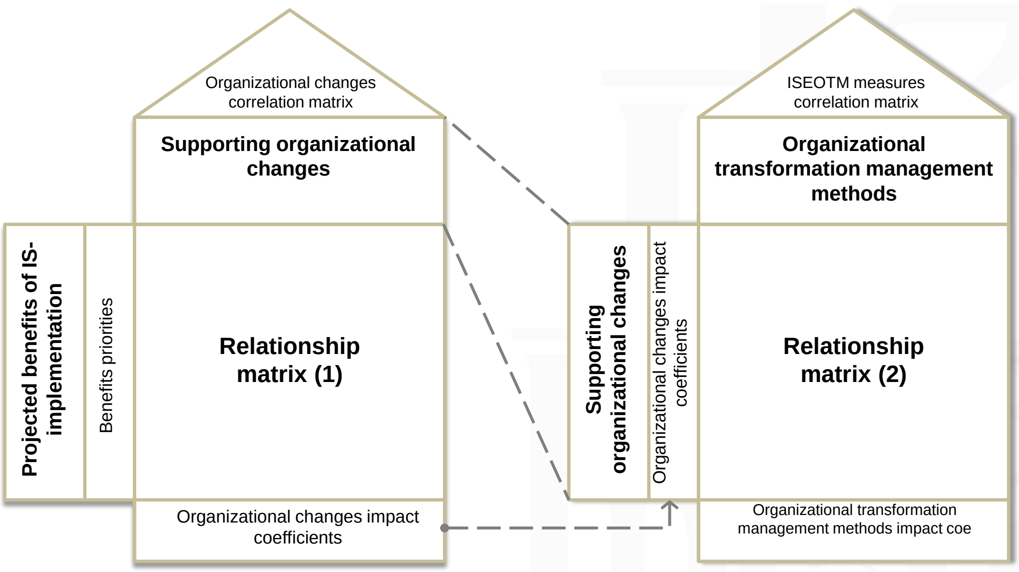

Figure 15: House of quality adaptation

The graphical illustration and adaptation of authentic QFD methods for the purposes of FOrTraM is provided below (Figure 16). Procedural mode of FOrTraM approach requires 5 key steps:

1. Primary project data input
2. Definition of a set of organizational changes
3. Definition of a rational set of ISEOTM measures
4. ISEOTM plan development
5. Approach analysis and effectiveness control

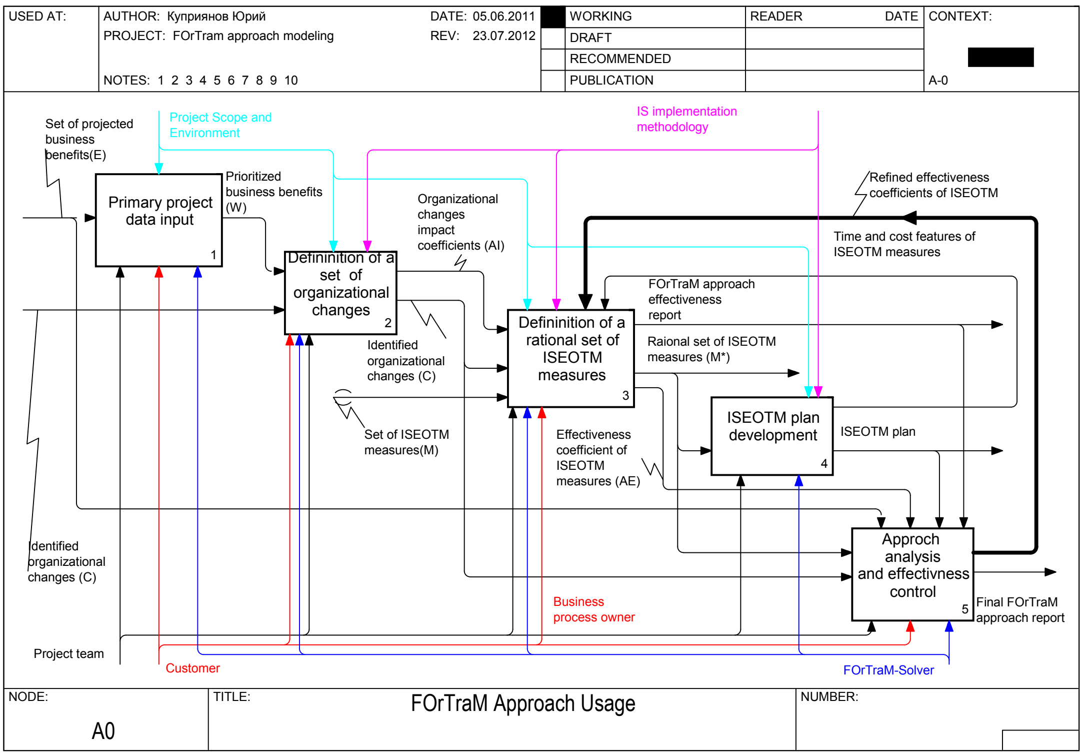

Figure 16: Procedure model of FOrTraM approach

Each of the steps can be further decomposed and assuming the necessity of performing expert valuation using SMARTS and AHP methods 4 separate roles entitled with different competence and expertise are subsumed to be involved in the realization of FOrTraM scenario (cf. Figure 17).

The formalized description of the FOrTraM with assignment of variables and factor weights to different aspect of the approach is provided below starting with the first step – definition of the business benefits of the project.

1. Define a set of business benefits $\vec{E} = (E_1, \ldots, E_m)$, where m is the number of business benefits of the project.
2. Prioritize identified business benefits $\vec{W} = \{w_i\}^T$. Ranking of economic results and assignment of relative importance factors to them – $w_i \in [0, 1], i = 1, \ldots, m$ – is completed with the use of AHP.
3. Identify organizational changes $\vec{C} = (C_1, \ldots, C_n)$, where n is the number of organizational changes.

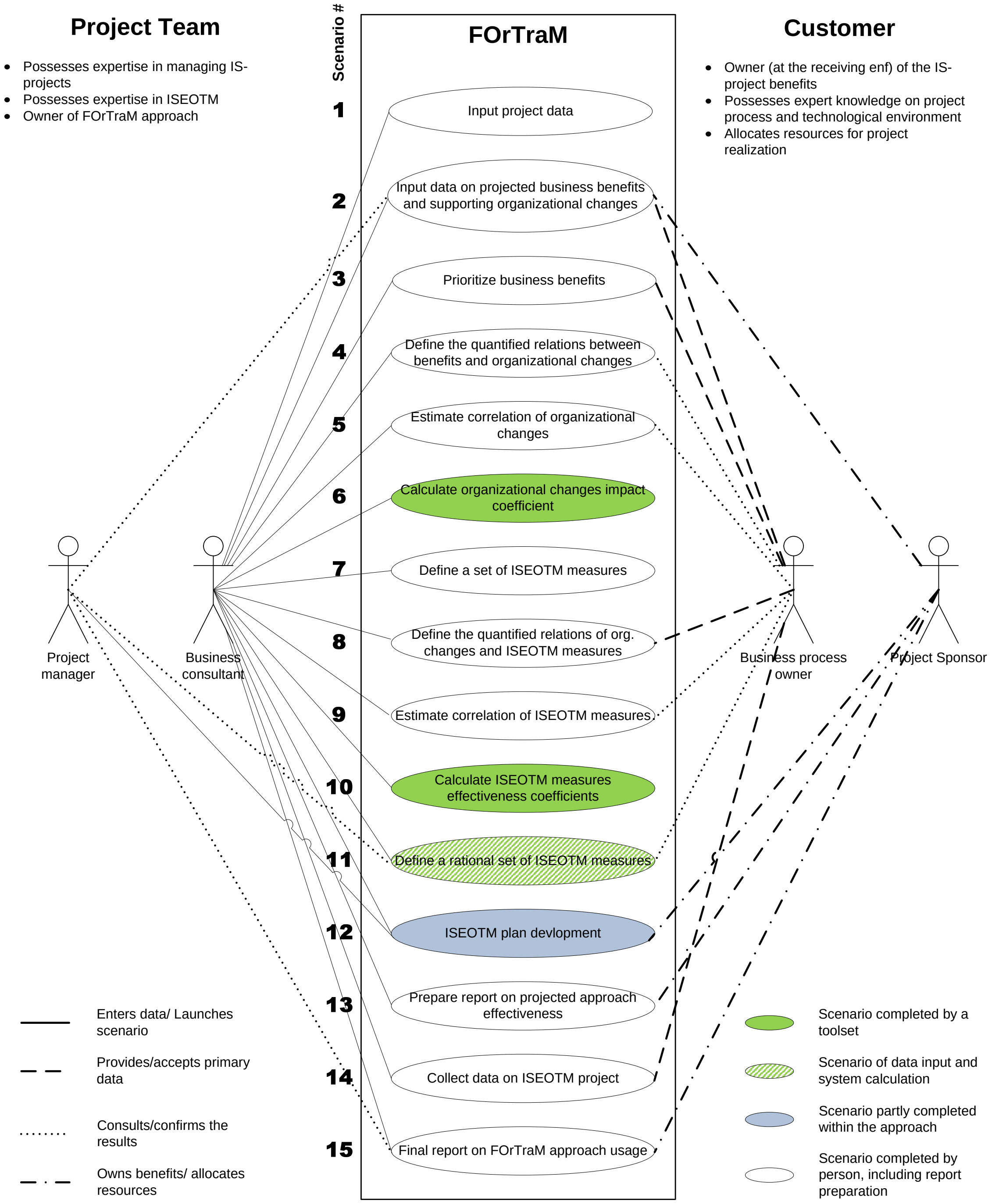

Figure 17: Scenario for using FOrTraM approach

4. Design correlation matrix and calculate correlation coefficient of organizational changes, $\sum\limits_{n\times n}\{r_{hl}\}$, where $h = 1,\ldots,n$, $l = 1,\ldots,n$.

5. Design relationship matrix $\mathbf{R}_{m\times n} = \{R_{ij}\}$, where elements of the matrix $R_{ij} \in [0;1]$ are determined using SMARTS method and characterize the contribution of the j-th organizational change to ensure the realization of the i-th business benefit stated on the step 1. A normalized coefficient $R_{ij}^{'}$ is introduced to account for the correlation of organizational changes:

$$R_{ij}^{'} = \frac{\sum\limits_{k=1}^{n} R_{ik}r_{kj}}{\sum\limits_{j=1}^{n}\sum\limits_{k=1}^{n} R_{ik}r_{kj}} \tag{1}$$

Thus, the matrix of relations of the normalized coefficients has the following form: $\mathbf{R}_{m\times n}^{'} = \left\{R_{ij}^{'}\right\}$.

6. Determine impact coefficient of organizational changes, $\vec{AI} = \{AI_j\}$. The $\vec{AI}$ vector describes the impact of the j-th organizational change to support realization of corresponding business benefits. The values of the elements of the $\vec{AI}$ vector is a linear convolution:

$$AI_j = \sum_{i=1}^{m} w_i R_{ij}^{'} \tag{2}$$

7. Define a set of ISEOTM measures that are relevant to the identified organizational changes, $\vec{M} = (M_1,\ldots,M_p)$, where p is number of ISEOTM measures and techniques. Each measure is defined by financial – s_k, and time – t_k resource demand: $M_k = \langle s_k, t_k\rangle$, where $k = 1,\ldots,p$.

8. Design of correlation matrix and determine correlation coefficient of ISEOTM measures, $\sum_{p\times p} = \{v_{fg}\}$, where $f = 1,\ldots,p$, $g = 1,\ldots,p$. Coefficient $v_{fg} \in [-1;1]$ characterizes the degree of relation between the f-th and g-th ISEOTM measure.

9. Design of relationship matrix $\mathbf{V}_{n\times p} = \{V_{jk}\}$, where elements are the coefficients of the relation $V_{jk} \in [0;1]$, determined by defuzzification of linguistic variables of the form: “fully complies” with respectful fuzzy numerical values: $(0.8, 0.9, 1)$, $(0.2, 0.3, 0.4)$, $(0, 0.1, 0.2)$, $(0, 0, 0)$ and membership function in the form:

$$\mu_{\tilde{s}}(V_{jk}) = \begin{cases} 10(V_{jk} - 0,8) & 0,8 \le V_{jk} \le 0,9 \\ 10(1 - V_{jk}) & 0,9 \le V_{jk} \le 1 \end{cases}, j = 1,\ldots,n; k = 1,\ldots,p \tag{3}$$

and the normalized ratio is equal to:

$$V_{jk}^{'} = \frac{\sum\limits_{l=1}^{p} V_{jl}v_{lk}}{\sum\limits_{h=1}^{p}\sum\limits_{l=1}^{p} V_{jl}v_{lh}} \tag{4}$$

The normalized relationship matrix is $\mathbf{V}^{'} = \left\{V_{ik}^{'}\right\}$.

10. Determine coefficient of the effectiveness ISEOTM measure, $\vec{AE} = \{AE_k\}$, $k = 1,\ldots,p$, where p is number of relevant ISEOTM measures and techniques.

    The $\vec{AE}$ vector characterizes the efficiency of k-th measure of ISEOTM in terms of providing for necessary organizational changes implementation, normalized to the corresponding value of the $\vec{AI}$ impact coefficient vector:

$$AE_k = \sum_{j=1}^{n} AI_j V_{jk}^{'} \tag{5}$$

11. Construct linear programming model to determine the rational set of ISEOTM measures – $\vec{M}^* = \{M_{k^*}\}$, where $k^* = 1, \ldots, q,\ q \leq p, q$ is number of elements of the rational set of methods for organizational transformation.

Linear integer programming problem in the terms of conventional system control form is formulated the following way:

$$\max_{x_k} f(x_k) = \sum_{k=1}^{p} AE_k x_k, \tag{6}$$

$$\begin{cases} \sum\limits_{k=1}^{p} s_k x_k \leq S, \\ \sum\limits_{k=1}^{p} t_k x_k \leq T \end{cases}$$

where $x_k = \{0, 1\}$ – reflects a decision on the k-th ISEOTM measure: 0 – no use k-th method, 1 – use of k-th measure and S – aggregate amount of financial resources; T – aggregate amount of time resources.

6.4 Conclusions

The proposed approach allows to implement the rational set of ISEOTM measures and cut costs while ensuring the constant level – for instance application of FOrTraM approach at United Metallurgical Company allowed to save 9% of the corresponding spending of ISEOTM activities. As a further step a development of software tool prototype to be developed to serve as an expert system and collect statistical values on coefficient values.

7 BPM as a Strategic Tool for Administrative Modernization: The IMPROVE Approach

- **Lars Algermissen**, PICTURE GmbH, Münster, Germany, algermissen@picture-gmbh.de
- **Martin Instinsky**, PICTURE GmbH, Münster, Germany, instinsky@picture-gmbh.de
- **Johannes Schwall**, PICTURE GmbH, Münster, Germany, schwall@picture-gmbh.de

7.1 Process management made easy

Public administrations are undergoing constant change as well as being exposed to continuously growing requirements and challenges from different interest groups, such as citizens, legislation and industry. Rising costs and demographic change are additional influencing factors and staff reductions a daily occurrence. The resulting challenge is to keep or even raise the performance level of the administration utilizing declining resources.

The reduction of performance levels and service standards are mostly not supported by the political leadership. Process management and continuous improvement of business processes are thus more and more accepted as an appropriate means to bridge the gap between requirements and achievement potential. In this context, particularly in the municipal field, the need for additional synergies through cooperation and the reduction or even avoidance of duplication of work is being expressed more and more often.

Complying with this request, the *PICTURE improve* network has been designed. The idea is to combine all elements for successful and sustainable process improvement into one solution bundle, thereby lowering the time and effort for process improvements while simultaneously providing added value for all participants. The network model has been fashioned for first-time users and professional process managers alike, enabling municipalities starting from 5,000 residents to immediately begin analyzing and sustainably improving their processes.

PICTURE improve is an advancement in the field of cooperative process management. It is built on the knowledge gathered during the creation of the first statewide process registers in Germany and process management projects in more than 80 administrations on federal, state and municipal levels.It furthers process management especially in small and medium-sized municipalities which, until now, were not able to enhance their respective efforts due to high entry barriers in form of financial costs, organizational size and personnel capacity.

The greater goal is to provide the technical, methodical and organizational framework for virtual and real networking while advancing two strategic tasks at the same time: intercommunal cooperation and process-oriented administration modernization.

7.2 Components of the network

The improve network is the culmination of this cooperative approach: Within the network, all necessary technical tools, content and services are provided to identify and visualize administrative processes and sustainably improve them (cf. Figure 18).

The PICTURE method works as the methodical basis, using 24 specialized building blocks to easily describe, depict and intuitively analyze administrative business processes (Figure 19). The method is used to economically conduct process modeling on a large scale with the goal to create transparency and sharpen the understanding of overall coherence. Using the given building blocks

Figure 18: Components of the improve network

ensures comparability of process models between organizations independent of the modeler as well as an efficient modeling workflow. The PICTURE method has proven its worth in numerous real life projects as well as scientific studies. For more information see J. Becker, Algermissen, & Falk, 2012.

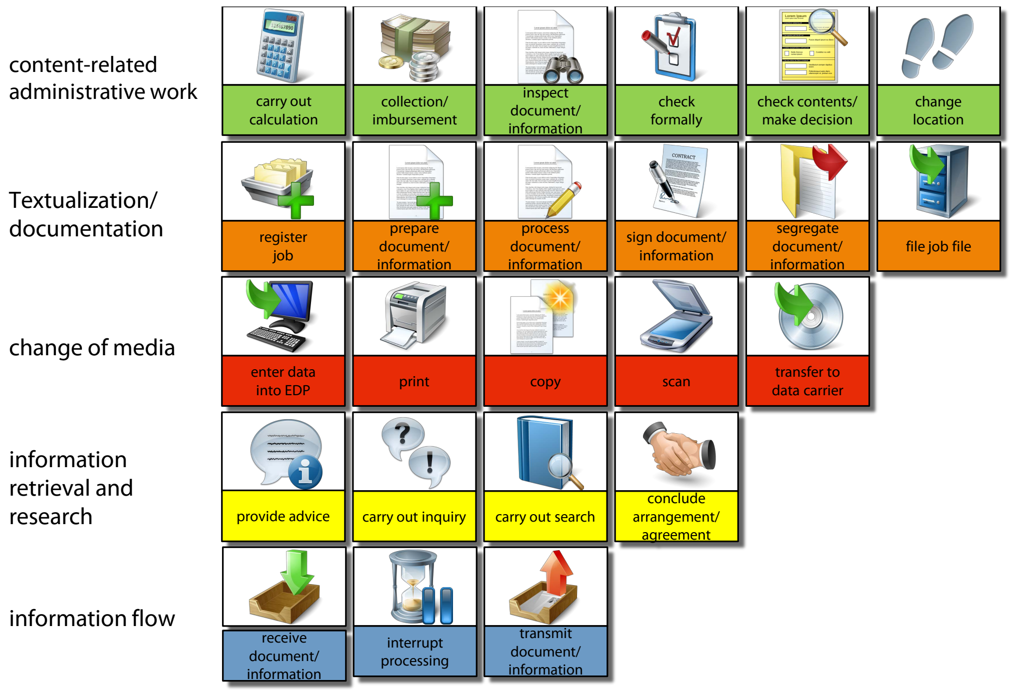

Figure 19: PICTURE process building blocks

As the technical basis for working with the PICTURE method on large numbers of processes, the PICTURE process platform is deployed. The tool enables the users to understandably, consistently and comparably model, store, display and analyze processes. The software is especially well suited to supporting organization-wide projects as well as work in an inter-administrational context. As a web-based tool without the necessity for download or installation it provides a wide range of functionality, including the generation of analytical reports and the visualization of process information on varying levels of detail. Additionally, all participating employees of the member administrations get individual access to the process platform and can make use of technical and specialist support.

Software can only ever function as effective as it's user allows it to. A field as complex as process management requires technical competence as well as confidence in the application of the underlying methods. The network approach addresses both aspects by providing periodical trainings and coachings for the users. These courses encompass strategy as well as organization and technical aspects and are tailored for managers and users on all levels of experience. Trainings are being held in regular intervals in different cities all over Germany and members of the network are free to make use of these opportunities as they need. Furthermore these events are tailored to be ideal opportunities for active networking among the attendants.

Oftentimes successful process changes fail due to uncertainness of how to apply process management tools to concrete problems in administrations or how to implement resulting changes in the organization. In order to bring answers to these questions regular workshops addressing current issues will be held, e.g. the roll out of a document management system, consolidation of public finances, renegotiation of wage agreements or the utilization of modern geographic information systems. Attendants will learn how to goal oriented address strategic issues utilizing a combined methodical and technical approach.

Further contact between network members is enabled through regular cooperative workshops. In order to realize synergies attendants break down strategic issues on the operative level. Networkers model and discuss processes relevant to the chosen issues (e.g. DMS, financial consolidation) with network partners, taking home results and best practices for their own organizations. During the network kickoff in early 2012 concrete cooperative projects spanning several federal states were developed. Network members foremost desire an exchange of ideas regarding process orientated DMS-rollout, process orientated consolidation of finances and knowledge management. In the DMS-workshop for example the questions of which departments are particularly suited to pilot a DMS-rollout and how to inspire workers for the project will be answered.

As well as allowing it's users to personally exchange ideas the network facilitates the implementation of process changes on the basis of available knowledge in the form of process examples. Several scenarios for the automatic exchange of process models have been conceived and realized.

The intensity of cooperation between municipalities differs in our experience vastly and ranges from completely autonomous approaches (cf. scenario 1 in Figure 20) over loose exchange (scenarios 3 and 4 in Figure 20) up to intensive concerted projects (scenario 2 in Figure 20).

Users can establish shared project spaces for concerted projects in several organizations, like planning a DMS roll out together. Other users can be invited into these so called process studios in order to exchange process knowledge. For example, two administrations may share their specific version of the process for issuing a building permit and compare them in order to figure out the differences and similarities as well the underlying causes for both.

A more open and comprehensive exchange of knowledge is possible in the process forum, the public part of the network. All municipal members have access to the knowledge stored here. The forum provides and makes usable a great amount of knowledge as a template for individual usage. Every member is free to supply as many or few process models in whatever form she chooses to the network. Extensive anonymization mechanisms allow the user complete control over how much information is shared. Extensively utilized process models (e. g. reference models having passed an interorganizational review) are presented in the so-called process gallery, providing new practitioners of process management with a tailored amount of high quality process knowledge to start their endeavors.

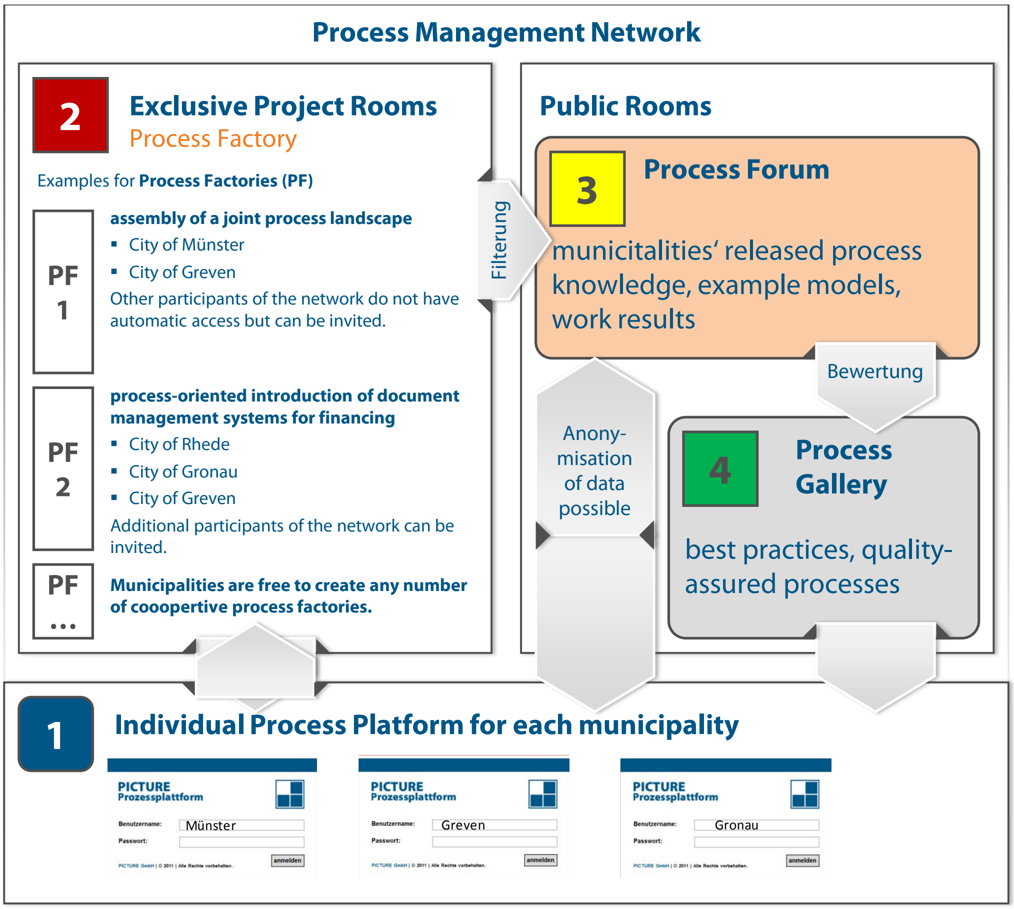

Figure 20: Different scenarios for different forms of cooperation

7.3 The networks capabilities grow together with the members

Like a gym the network is financed by a monthly flat fee, encompassing all services to it's customers. The amount is determined taking into account the size of each individual administration, the number of persons each member organization nominates to be active in the network and the chosen duration of the membership. Members receive immediate and unrestricted access to the process platform as well as the services of the network (training, workshops, etc.) and can utilize the complete stored process knowledge of the network. Just like in a gym the amount of training courses and workshops is determined as a function of the amount of members. The more administrations join, the higher the benefit for everyone. The family of municipalities grows with each member.

By building Germany wide partnerships the network is continuously growing. The PICTURE GmbH is joined by network partners like the the Zweckverband Kommunale Datenverarbeitung Oldenburg (KDO) in Lower Saxony, the Schweriner IT- und Service GmbH (SIS) in Mecklenburg-Western Pomerania and the North Rhine-Westphalian Zweckverband Kommunale ADV Anwendergemeinschaft West (KAAW). These partnerships facilitate a close local cooperation with the network members as well as regular trainings and events in cooperation with the partners in different federal states. As a media partner the Behördenspiegel regularly reports news from the network under the headline of modernization of administration. Partners from research and science institutions further enrich the network. The European Research Center for Information Systems supports the transfer of existing process models to the network. The University of Applied Science Harz actively supports the topic of promotion of trade and industry by providing best practice models.

Interested readers will find more information and an overview of recurring and special events on the website `http://www.prozessnetzwerk.de/`. Additionally a video overview of the different elements of the network provides first glimpses at the process platform using a real life example.

8 A Systematic Approach for the Improvement of Business Processes based on Techniques and Patterns

- **Susanne Leist**, University of Regensburg, Regensburg, Germany, susanne.leist@wiwi.uni-regensburg.de
- **Philipp Griesberger**, University of Regensburg, Regensburg, Germany, philipp.griesberger@wiwi.uni-regensburg.de
- **Florian Johannsen**, University of Regensburg, Regensburg, Germany, florian.johannsen@wiwi.uni-regensburg.de

8.1 Introduction

For more than twenty years, improving business processes has been a top issue for both research and business environment, and has been numbered among “the most important and common titles in both literature and applications” (Coskun, Basligil, & Baracli, 2008). A fundamental contribution in this field was the book “Business Process Improvement” (BPI) written by James H. Harrington in 1991 which focuses on continuous improvement and evolutionary change of the business processes of an organization (Harrington, 1991). Similar approaches in the field of process management have evolved which all have the superior goal of making processes more effective and efficient (Harrington, 1991; Macdonald, 1995). To mention but a few of these approaches there is “Business Process Reengineering” (Hammer & Champy, 1993), “Process Innovation” (Davenport, 1993), “Six Sigma” (Antony, 2006), “Business Restructuring” (Talwar, 1993), or “Core Process Redesign” (Kaplan & Murdock, 1991).

Over the past decades, various methods including techniques and tools were developed that can enable or support the process of improving business processes or parts of them (cf. Doomun & Jungum, 2008; Shin & Jemella, 2002). Even if there are some methods available for improvement itself, it is often stated that none of them adequately support the practitioner through all stages in a BPI project (cf., e.g., Adesola & Baines, 2005). But especially organizations that seek for using a method for improvement need guidelines and advice “to select one methodology from the plethora of available ones (. . .)” (Filipowska, Kaczmarek, Kowalkiewicz, Zhou, & Born, 2009). The same is true of selecting an appropriate technique to make for a beneficial change. Eventually this becomes even more necessary, as various methods often contain the same or at least very similar concepts, techniques and tools, while solely the name of the approach and the angle of promoting the program in an organization are different (Hagemeyer, Gershenson, & Johnson, 2006).

Thus the challenge is to analyze how the act of improving a business process can be supported in a structured, methodological way, which, for instance, techniques may ensure, thus enabling to understand the transformation from the as-is- to the desired to-be-state of a business process.

In the remainder, an overview of existing methods and techniques is therefore given. After the discussion of their contributions, techniques and patterns which support the act of improvement are introduced. Finally conclusions and a short discussion of open tasks are presented.

8.2 Conceptual Basics

8.2.1 Basics

The term business process is defined in different ways in literature, but similarities can be perceived. A process can be seen as a cohesive sequence of activities which add value to input and transform it to output (Harmon, 2007; Harrington & Lomax, 2000). Similarly, a business process also is a sequence of activities, but focuses on fulfilling an organizational task (Davenport & Short, 1990; Harrington, 1991). As a business process is performed by human beings and machines, it can be seen as a socio-technical system (Shaw, Holland, Kawalek, Snowdon, & Warboys, 2007).

At the bottom line, the improvement of business processes results in some kind of change (e.g., Adesola & Baines, 2005; Davenport, 1993; Harrington, 1991) and is aimed at gaining a competitive advantage for its performers by turning a business process into a progressive state (Shahzad & Zdravkovic, 2009) (Vergidis, Tiwari, & Majeed, 2006). This means that the advantage has to be reflected by enhancing the effectiveness and efficiency of the process (Harrington, 1991). To evaluate the success of improvement efforts, there have to be some process-specific measures to evaluate the performance change. Ordinary categories for these performance indicators are time, quality, cost or flexibility which are referred to as the "devil's quadrangle" (Brand & van der Kolk, 1995). The meaning of this, translated into our research, is that, in an ideal situation, an improvement effort ultimately decreases the costs needed for process execution, reduces the time needed for one cycle of a process, increases the quality of the output of a process, and improves the ability for prompt adaptation of a process to react to changing requirements. But, as the name "devil's quadrangle" suggests, this is mostly just wishful thinking, because improving upon one dimension usually has a negative influence upon one or more of the other dimensions. (Brand & van der Kolk, 1995) For example, if the cycle time of a process is reduced because more resources are used, then this probably entails higher costs for one process cycle.

Techniques can be seen as detailed guidelines to create results (e.g., Pacicco, Ravarini, & Pigni, 2010). A technique is "(...) a set of precisely described procedures for achieving a standard task." (Kettinger, Teng, & Guha, 1997) Moreover, a technique can be part of a method (which is used to solve a more individualized problem) and can be supported by tools (especially by IT). In literature, the terms method, technique and tool are often used inconsistently or synonymously (cf. Grünberg, 2003), even though they have different meanings. To avoid the problem of term misinterpretations, we concentrate on techniques according to our definition, regardless of the terms used in literature. The criteria for selecting techniques for our analysis are, on the one hand, the aim of the technique (to improve business processes or elements of it) and, on the other hand, the existence of a procedure to create the desired result(s).

The term pattern was shaped by (Alexander, Ishikawa, & Silverstein, 1977) who recognized that recurring problems in architectural design can be solved by means of a predefined list of reusable patterns. In the mid-nineties, this approach developed high popularity in the area of software engineering. (Gamma, Helm, Johnson, & Vlissides, 1996) e.g. adapted the pattern concept to object-oriented design pattern. They refer to pattern as descriptions of co-operating objects which are customized in order to solve a general design problem in a specific context. According to this, we see patterns as predefined modules which aim for solving a specific problem by applying a predefined measure that has a certain effect.

8.2.2 Methods and techniques of BPI

In literature and in practice alike, several methods and techniques exist which aim to improve business processes. In the following, a short overview of the most well-known methods and techniques is given. The overview does not claim to be complete.

In practice, very often incremental analyses of weak points are used. These analyses are sometimes triggered by weak results of performance measurements or customer complaints and used by practitioners in a very pragmatic way. Unfortunately the success of these analyses is mainly based on the knowledge and experience of the practitioners who apply them. This is due to the fact that the analyses neither offer a systematic procedure nor do they give hints what exactly should be improved.

A more systematic support for improving business processes is provided by Business Process Reengineering (BPR) methods (Davenport & Short, 1990; Hammer, 1990; Hammer & Champy, 1993). The main focus of these works was on supporting enterprises by reengineering critical processes to improve competitiveness and customer satisfaction. All the methods comprise a structured procedure which guides practitioners during their projects. They define roles which fix tasks and responsibilities. In addition, they offer different approaches for the improvement. For example Hammer/Champy suggest to start with a clean sheet of paper to support creativity and find revolutionary solutions (Hammer & Champy, 1993). Davenport defines change levers in different areas (e.g. IT, structure, culture), which support practitioners by identifying enablers to improve processes. These change levers are essentially a list of examples, in which the capabilities and benefits of different kinds of IT use or organizational structures are described. IT has for example the capability to automatize tasks, and therefore can replace or reduce human labor in a process (Davenport, 1993). In a similar way, the different coordination mechanism of Malone can be used to replace existing coordination processes to improve them (Malone, Crowston, Lee, & Pentland, 1993).

Quality Management (QM) methods aim to improve the quality of products and processes and aspire to increase customer satisfaction. They have a broad spectrum to increase the value of companies and their capabilities to compete. In addition, very different methods exist. For example Six Sigma offers practitioners a clear and structured procedure (DMAIC-cycle) which guides a practitioner in a project (cf. (Antony, 2006, pp. 239–241); (Snee & Hoerl, 2003, p. 194)) and defines roles and responsibilities (cf. Hoerls, 2001; Pande, Neuman, & Cavanaugh, 2000, pp. 117–122). Six Sigma supports the identification of causes of “errors”, e.g. by means of data based or process-oriented analyses or by using more subjective tools, such as the Ishikawa diagram (cf., e.g., Ishikawa, 1982; John, Meran, Roenpage, & Staudter, 2008). In addition, it offers creativity techniques to find solutions in order to improve the process (cf. John et al., 2008, pp. 232–240). In contrast Kaizen primarily presents practical guidelines, which help to improve business processes to avoid quality problems (cf. Imai, 1986).

The introduced methods in BPR and QM try to support practitioners with a comprehensive offer of techniques, procedures and roles. They help to set up the project, identify the relevant processes for improvement, support the improvement and the implementation of the improved processes. In addition, some of the methods support the monitoring of the implemented solution, and help to check if the given aims are reached (cf., e.g., John et al., 2008, pp. 272–284). Although all the different steps — that are supported by these methods — are very helpful in a BPI project, we are more interested in their abilities to support the act of improvement. Therefore we take a closer look at techniques which can guide practitioners from the as-is to the desired to-be-state of the process.

We therefore conducted a representative literature review in which techniques regarding their contribution to support the act of improvement were analyzed (cf. Griesberger, Leist, & Zellner, 2011). The analysis covered techniques that are well-known and approved in the broad field of BPI: these two requirements seem to be fulfilled, if a technique appears or is mentioned in several sources which address BPI (e.g., Andersen, 1999; Pande et al., 2000; Rath & Strong, 2002).

Equally, if such techniques are contained in a reference book that deals with a comprehensive overview of techniques in BPI, this would serve as proof of their general awareness (for corresponding reference books see, e.g., Harrington & Lomax, 2000; John et al., 2008; Kanji & Asher, 1996; Kettinger et al., 1997). Besides, most of the selected techniques have been applied in several cases which are documented. The result of the analysis is presented in Section 8.2.3. The following three examples represent literature sources we found during the analysis.

- (Kettinger et al., 1997) present a multi-phase framework for conducting BPR projects where they list 72 techniques that are used in BPR projects, and which they arrange in six phases. They even suggest an approach for the selection of the techniques in a BPR project. But, their context lies in BPR, which focuses on revolutionary changes, and not on continuous improvement like in BPI, although there clearly are techniques that can be used in a BPI as well as in a BPR project. Anyway the work of (Kettinger et al., 1997) does not focus the act of improving business processes.

- The title of the book Business Process Improvement Toolbox by (Andersen, 1999) suggests that it provides support when searching for improvement-precipitating approaches. Indeed, the book may be seen as a beneficial and comprehensive manual that can be used throughout a whole BPI project, from the beginning with understanding the problem and the associated process(es) right through to the end where Andersen concentrates on tools for implementing generated measures. As "tools for improvement" he includes e.g. business process reengineering (BPR) which is, in our understanding, neither a tool nor a technique, but a widespread discipline for radical changes in business processes containing various methods, techniques, and tools. Additionally, through this observation, it becomes apparent that the terms method, technique and tool are not used consistently in literature (Grünberg, 2003). Thus (Andersen, 1999) sets a different approach and does not explicitly focus on techniques in the sense of detailed guidelines that produce a certain output and are designed as measures for improvement.
- (Vergidis et al., 2006) describe a formalized multi-objective approach for improving business processes that is executed by means of a software optimization platform where a process model can be imported and predefined algorithms can be executed which are aimed at either modifying process costs or the cycle time. Although this approach considers measures that precipitate improvement in a business process and thus relate to the act of improvement it is not containing a collection of techniques that can be used for that purpose.

8.2.3 Contributions of methods and techniques

Methods in BPR and QM as well as the techniques support practitioners in improving processes. Their main focus lies especially in

- the identification of the problem (e.g. diagnosis phase by Hammer/Champy; define phase of Six Sigma)
- the search for relevant causes (e.g. analysis phase of Six Sigma, phase "understanding and improving existing processes" by Davenport)
- the measurement of problem solutions (e.g. measure phase of Six Sigma, phase "understanding and improving existing processes" by Davenport)

For the act of improvement, most methods offer creativity techniques or provide examples as best practice.

In particular it can be observed in practice, and especially if resources are limited, that complex methods are rarely applied and, in many cases, that self-developed methods are in use. This observation was supported by an empirical survey in which we asked for the use of BPI methods (cf. Blasini, Leist, & Ritter, 2011). The survey was conducted in German-speaking countries and restricted to banks. Most of the interviewees declared that they used self-developed methods, and about 60 % of the remainder used Kaizen.

Both aspects strengthen the impression that although many methods for BPI exist there is still a lack of support. First, we think providing creativity techniques or best practices is not sufficient. Even if a bright idea can bring about "improvement", its development is not for sure and its contribution can only be evaluated after its implementation. Taking the great innovator Thomas A. Edison as an example, he also stated: "I never did anything worth doing by accident, nor did any of my inventions come by accident; they came by work." (Beals, 1996) Second, we think we can capture the needs of practitioners with techniques or patterns which are able to be integrated in existing approaches.

Therefore our aim is to develop practicable methods supporting the improvement of a process systematically with the help of techniques and patterns.

8.3 A Systematic Way for Improvement: BPI Techniques and Patterns

8.3.1 Contribution of using techniques or patterns to improve business processes

(Vergidis et al., 2006) state that most attempts to optimize a business process are performed manually and do not involve a formal automated method. But the use of techniques and guidelines, like patterns, within improvement efforts is essential in order to enable BPI performers to reorganize their business activities and processes in an organization (Valiris & Glykas, 1999). Therefore techniques and guidelines "play a key role in a company-wide approach to continuous improvement (...)" (McQuater, Scurr, Dale, & Hillman, 1995), which is confirmed by (Coskun et al., 2008) who reveal that "the success of a methodology for BPI is based on the tools and techniques effectiveness that support it." In this sense, the use of techniques is seen as fundamental in order to understand and enable improvement in any process (Bunney & Dale, 1997; McQuater et al., 1995), as they provide working plans to deal with various activities, facilitate motivation and training, accumulate experiences on a variety of aspects, and provide milestones for implementation (Al-Mashari & Zairi, 2000). Hence improving a business process requires a structured and replicable procedure which techniques can offer. As the techniques have to be performed by the people responsible, it is crucial that they are familiar with their special characteristics, because "the results from the application of a particular tool or technique rely heavily on the skill and experience of those implementing it." (Spring, McQuater, Swift, Dale, & Booker, 1998) This means that the success of applying these techniques depends on them being properly handled.

8.3.2 Structured description of relevant techniques

We identified 36 BPI techniques as a result of a representative literature review (cf. Griesberger et al., 2011). It was the aim to explore techniques which support the act of improvement (see Table 4).

After having been identified, the BPI techniques were systematically and consistently described. The results were published in (Griesberger et al., 2011). It was performed as follows: first, the goal and the procedure of a technique as well as the target of its implementation (e.g. reduce costs) were investigated. Next, the elements of a business process were determined that are affected by the application of a technique. The examined elements were: activity (A), organizational unit (OU), resource (RE), input (IP), output (OP), control flow (CF), information flow (IF), organizational assignment (OA), and material flow (MF) (see Section 8.3.3). Thereupon, the success factors were determined by means of which the success of a technique's application can be measured. The success factors under examination were cost, quality, time, flexibility, customer, and staff. This procedure was applied for all of the 36 techniques, and the results were recorded in an evaluation scheme consisting of the above-mentioned parts. In Table 5, we give an example of the evaluation scheme for the technique [22], "Process Cycle Time Reduction". The last section of the evaluation scheme ("Notes") explains how and why the researcher allocated the elements of a business process or success factors to a certain technique so that the selection process is more comprehensive.

No.	Technique	No.	Technique
[1]	Anti-Solution Brainstorming (3)	[19]	Other Points of View (OPV) (2)
[2]	Best-Value Future-State Solution (BVFS) (2)	[20]	Potential problem analysis (PPA) (4; 6)
[3]	Brainstorming (1; 2; 3; 4; 5; 6; 7)	[21]	Problem prevention plan (4; 6)
[4]	Brainwriting (1; 3; 4)	[22]	Process Cycle Time Reduction (1; 2)
[5]	Bureaucracy Elimination (1; 2)	[23]	Process decision program chart (1; 2; 4)
[6]	Cause and effect analysis (1; 2; 3; 4; 5; 6; 7)	[24]	Process Simplification (2)
[7]	Error proofing (pokayoke) (2; 3; 4 ;6)	[25]	Quality function deployment (1; 2; 4; 5; 6)
[8]	Evolutionary operation (EVOP) (4)	[26]	Redundancy Elimination (1)
[9]	Failure mode and effect analysis (2; 3; 4; 6; 7)	[27]	Replenishment Pull System (3)
[10]	Fast Action Solution Technique (FAST) (2)	[28]	Robust design (off-line quality control) (4)
[11]	Generic Pull System (3)	[29]	Setup Time Reduction (3)
[12]	Idealizing (1)	[30]	Should-be Process Map (6)
[13]	Mind mapping (2; 4)	[31]	Snowballing (4)
[14]	Morphological forced connections (4)	[32]	Taguchi methods (4)
[15]	Negative Analysis (2)	[33]	The Importance of Speed (3)
[16]	Nominal group technique (1; 2; 3; 4; 5)	[34]	Theory of Constraint (TOC) (3)
[17]	Objective ranking (4)	[35]	Total productive maintenance (3; 4)
[18]	Opportunity cycle (2)	[36]	Visioning / Imagineering (2; 4; 5; 6)

References: (1) Andersen 1999; (2) Harrington and Lomax 2000; (3) John et al. 2008; (4) Karji and Asher 1996; (5) Kettinger et al. 1997; (6) Pande et al. 2000; (7) Rath and Strong 2002

Table 4: List of BPI techniques

Criteria	Content	References
Goal	"An approach to reduce the time that it takes to move an item through a process."	(Harrington & Lomax, 2000, p. 250)
Procedure	1. Flowchart the process that is being studied. 2. Conduct process walkthrough to understand process and verify flowchart. 3. Collect cycle-time data related to each activity and task (minimum, maximum and average). 4. Collect data that define the quantity flow through each leg of the flow diagram. 5. Construct a simulation model that includes all of the data that have been collected. 6. Perform replication analysis, using the simulation model that includes all of the data that have been collected. 7. Classify each activity or task as real-value added, business-value added or no-value added (eliminate business-value and no-value added activities). 8. Define the average cycle time's critical path through the process, using the simulation model. 9. Using the cycle-time reduction principles, eliminate the critical path. 10. Repeat activities 8 and 9 until the minimum cycle time is obtained. 11. Define worst-case critical path through the process using the simulation model. 12. Using cycle-time reduction principles eliminate the critical path. 13. Repeat steps 11 and 12 until the minimum worst-case cycle time is obtained. 14. Develop a plan to change the process to be in line with the modified simulation model. 15. Pilot the modifications as appropriate. 16. Implement the new process.	(Harrington & Lomax, 2000, p. 254/255)
Result	Reduction of cycle time	(Pande et al., 2000, p. 312)
Mandatory elem. of business proc.	A ✔ · OU ✘ · RE ✘ · IP ✘ · OP ✘ · CF ✔ · IF ✘	OA ✘ · MF ✘
Success factors	Cost ✔ · Quality ✘ · Time ✔ · Flexibility ✘ · Customer ✔ · Staff ✘	
Goal	In step 7 of the procedure each activity or task needs to be classified as real-value added, business-value added or no-value added. Business-value and no-value added activities should be eliminated. Changing the control flow depends on a potential rearrangement of real-value added tasks (Harrington & Lomax, 2000, p. 252). "To date, most of our focus has been on reducing processing time because we see it as added labor cost. (. . .). Long cycle times delay product delivery to our customers and increase storage costs." (Harrington & Lomax, 2000, p. 251) The customer (satisfaction) is affected with this technique, as the cycle time determines how fast the process output can be supplied to the customer. The costs of the new solution are determinant for the evaluation of the solution (Harrington & Lomax, 2000, p. 251).	

Table 5: Evaluation scheme for technique [22] "Process Cycle Time Reduction"

The goal of the technique used as an example is to reduce the time it takes to move an item through a process. To reduce this time, a 16-step-procedure is suggested. The desired result of the technique is the reduction of the cycle time. Concerning the elements of a business process, this technique focuses on both activities and on the control-flow (see check marks at elements “A” and “CF”). This is because the purpose of the technique is to analyze the activities of a process as well as their order (control flow). Regarding the success factors, this technique helps to improve cost, quality and customer satisfaction (see check marks at success factors “Cost”, “Time” and “Customer”). As the name of the technique suggests, time is a success factor that has to be measured when applying the technique. Furthermore, long cycle times are, on the one hand, seen as additional labor cost, while, on the other hand, it is suggested that they have negative effects on customer satisfaction (see field Notes in Table 5).

8.3.3 Comparison of BPI techniques

After the structured description, all 36 techniques were evaluated according to the evaluation scheme illustrated in Table 5. The result of this evaluation is presented in Figure 21, allocating each BPI technique to the business process elements it focuses and to the success factors it supports. For example, in the crossing cell of activity and cost, four different techniques ([5] Bureaucracy Elimination, [22] Process Cycle Time Reduction, [24] Process Simplification and [26] Redundancy Elimination) are listed that focus on improving activities of a business process with respect to cost reduction. In addition to the crossing cells of elements of a business process and of success factors, there are some techniques that only refer to a success factor, without describing which element of a business process has to be changed (last column “no element of a business process affected” in Figure 21). In contrast, there is no technique that helps to improve an element of a business process without having at least one success factor in mind, so the last line (“no success factor affected”) in Figure 21 is empty.

As Figure 21 shows, there are 16 out of 36 BPI techniques (over 44% of the evaluated techniques) that are not included in the matrix, which means that they neither affect elements of a business process nor help to improve any of the success factors, even though they are mentioned as BPI techniques. These techniques do not offer support by referring to an element of a business process or describing how to measure their application. Nevertheless, these techniques can be used to create solutions for improving a business process in general, whereby it has to be determined individually which element of a business process needs to be changed. The 16 techniques are, in most of the cases (e.g. Brainstorming, pokayoke, idealizing), means to support creative thinking, and can be used in every improvement or solution creating situation. So the benefit of most of these techniques is to support the general act of idea generation, but not to improve elements of a business process.

Only the remaining 20 techniques provide hints as to which elements of a business process are affected and/or with the aid of which success factors improvement could be measured when applying these techniques. A first look on the table also shows that a comprehensive technique which completely supports the improvement of all elements of a business process does not exist.

Most of the techniques address activities (16.7%) or resources (16.7%) as the basis of their improvement procedure. The sequence of the activities is determined by the control flow. This element of a process is named four times as the target of different improvement techniques (11.1%). Input, output, information-flow, and organizational assignment are only twice the subject of techniques (5.6%), the organizational unit only once (2.8%). The material-flow is not improved by any of the 36 techniques at all. Likewise, it is notable that there is no technique that focuses on an element of a business process without considering a success factor.

Concerning the dimension success factor of Figure 21, 30.6% of the techniques focus on costs and also 30.6% focus on time as a success factor. 25.0% of the techniques aim to improve parts

		Elements of a business process									
		Activity (A)	Organizational Unit (OU)	(IS-)Resource (RE)	Input (IP)	Output (OP)	Control-Flow (CF)	Information-Flow (IF)	Organizational Assignment (OA)	Material-Flow (MF)	No elemenst affected
Success Factor	Cost	[5]; [22]; [24]; [26]	[26]	[24]; [26]; [27]	[27]	[27]	[22]; [24]	[5]; [26]	[24]; [26]		[2]; [10]; [15]; [18]; [23]; [34]
	Quality	[29]		[29]; [35]			[29]				[11]; [18]; [23]
	Time	[5]; [22]; [24]; [29]; [30]		[24]; [29]; [35]			[22]; [24]; [29]; [30]	[5]	[24]		[2]; [10]; [11]; [23]; [33]
	Flexibility	[29]		[27]; [29]	[27]	[27]	[29]				[11]
	Customer	[22]; [24]; [29]; [30]		[24]; [27]; [29]	[27]	[25]; [27]	[22]; [24]; [29]; [30]		[24]		[9]; [17]; [33]
	Staff			[6]	[6]						
	No success factor affected										

Techniques not included in the matrix : [1], [3], [4], [7], [8], [12], [13], [14], [16], [19], [20], [21], [28], [31], [32], [36]

Figure 21: BPI technique matrix

of the business process to enhance customer satisfaction. Quality is only an important factor for 13.9% of the techniques. Finally, 8.3% of the techniques refer to the flexibility of a process and 2.8% consider staff.

8.4 Derived Patterns

In addition to the matrix as the result of the investigation, 36 techniques referring to the concrete act of improvement were examined as to which fundamental mechanisms (or measures) are mentioned by the techniques to effect improvement. In doing so, 28 elementary mechanisms could be identified (cf. Griesberger, Leist, & Johannsen, 2012) which are presented in Table 6. The advantage of these mechanisms lies in the fact that they can be used as concrete guidelines to improve processes or parts of processes.

Identified measures to improve processes/for process improvement			
accelerated cycle time	eliminate bureaucracy	increase quality	reduce documents
analyze price of output	eliminate critical path	modify activities	reduce handovers
analyze process operation	eliminate data	modify documents	reduce maintenance effort
analyze work equipment	eliminate idle time	parallelize activities	reduce response time
combine activities	eliminate redundancy	redefine responsibilities	relocate capacity
dissolve bottlenecks	eliminate waste	reduce complexity	resequence activities
eliminate activities	increase customer satisfaction	reduce delivery time	train employees

Table 6: BPI patterns (Griesberger et al., 2012)

8.5 Conclusion and Outlook

As BPI seems to be rather an art than science (Davenport, 2005; Hall & Johnson, 2009), research concerning the act of improving a business process is still at its beginning. Creativity is a major part during the process of improvement, but we built on the hypothesis that the more structured the support of the act of improvement, the better the goal oriented and transparent results. Our research is one step in this direction and we achieved the following results:

- Identification and structured description of theoretically existing techniques for the act of improvement
- Support of the selection of the appropriate technique for a problem with the help of the matrix
- Identification of patterns

The further investigation is twofold regarding the techniques and patterns. Obviously not all cells in the matrix are filled, therefore a further investigation aims at completing the BPI techniques. In addition to those cells which offer more than one technique, their characteristics will be analyzed in more detail to help practitioners choose the adequate technique. The patterns are described in narrative text. For their repetitive application a more formulated description would be useful. In addition, we aim to identify parameters to specify their use in different contexts (context-aware patterns). For both techniques and patterns their contributions when applied should be investigated empirically.

9 A Business Process and Data Quality Management Perspective on ERP System Development in the Financial Service Sector

- **Ali Sunyaev**, University of Cologne, Faculty of Management, Economics and Social Sciences, Cologne, Germany, sunyaev@wiso.uni-koeln.de
- **Paul Glowalla**, University of Cologne, Faculty of Management, Economics and Social Sciences, Cologne, Germany, glowalla@wiso.uni-koeln.de

9.1 Introduction

The successful implementation of enterprise resource planning (ERP) systems enables organizations to enhance their efficiency and maintain competitive capability through cross-functional integration across operational activities (Addo-Tenkorang & Helo, 2011; Grabski, Leech, & Schmidt, 2011). Nevertheless, implementation of ERP systems is a risky endeavor since ERP implementation projects are more complex compared to typical software development projects (Hoermann, Kienegger, Langemeier, Mayer, & Krcmar, 2010). Organizations implementing ERP systems are prone to substantial financial risks. These risks, which negatively impact most ERP implementation projects, include exceeding time and budget as well as the abandonment of the implementation and, in some cases, bankruptcy (e.g., Addo-Tenkorang & Helo, 2011; Aloini, Dulmin, & Mininno, 2012; Hoermann et al., 2010; Krigsman, 2008, 2011; Maguire, Ojiako, & Said, 2010). Despite the risks, most organizations across sectors, already rely or implement ERP systems (Botta-Genoulaz & Millet, 2006).

The success of ERP systems is an organizational and technological issue since the implementation involves organizational and business process changes (Addo-Tenkorang & Helo, 2011; Hoermann et al., 2010). With the increasing technological robustness of ERP systems, project success depends even more on organizational and process adaptions (Mohamed & McLaren, 2009). Continuously changing business processes inhibit the timely adaption of IT systems. Currently, two-thirds of business processes are not controlled by the central IT department, but are growing uncontrolled in the operating departments (Software-Initiative Deutschland 2011). In the light of the complexity of ERP systems, this is a serious issue that has to be dealt with. Furthermore, it is a general choice in ERP system implementation to adapt to generic processes or to customize the system (Davenport, 1998; Hoermann et al., 2010). In this context, business process management (BPM) contributes to successful ERP system implementation (Jarrar, Al-Mudimigh, & Zairi, 2000; Žabjek, Kovacic, & Štemberger, 2009).

When examining ERP systems and BPM, data and information quality management (DIQM) should be considered as well. The reason is that ERP systems provide a platform for integrating processes and data (Davenport, 1998; Hoermann et al., 2010). This implicates that both have to be managed to, for instance, have access to timely and consistent information across organizational functions. Furthermore, poor data quality inhibits business process improvements (Forrester Research, 2011).

To address the future issues and implications for ERP systems from a BPM and DIQM perspective, we conducted a qualitative study. Although most organizations across sectors use ERP systems, the benefits within the service sector lag when compared to the industrial sector (Botta-Genoulaz & Millet, 2006). Furthermore, when examining IS activities, the observed sector may play an important role (Chiasson & Davidson, 2005). Only few articles are concerned with “fussy” sectors, such as the healthcare and service sector (cf. Addo-Tenkorang & Helo, 2011; Moon, 2007). Therefore, we address a research gap in ERP system research and conduct our study in the financial service sector.

To identify the future issues and implications for ERP systems from a BPM and DIQM perspective, we conducted 15 semi-structured expert interviews (Flick, von Kardoff, & Steinke, 2009). The contribution of our study is threefold as we consider the current maturity and future issues of ERP systems, BPM and DIQM in the examined organizations. We provide implications for practice and research.

In Section 9.2, we provide related literature and the research gap. This is followed by our research approach in Section 9.3. In Section 9.4, we present the results of our study. This includes market developments and characteristics of the insurance sector and the organizations' maturities regarding ERP systems, BPM, and DIQM. We provide a summary and outlook in Section 9.5.

9.2 Related literature

9.2.1 Managing processes and data

The importance of BPM, not only for ERP systems, is visible in the ongoing research. Several standards and maturity models are the result of decades of still increasing interest (Bandara et al., 2010; Ko et al., 2009; Röglinger, Pöppelbuß, & Becker, 2012). Besides technological issues, BPM considers several organizational aspects. An important aspect of BPM is the continuous improvement of business processes (van der Aalst et al., 2003).

Data is a corporal asset (Khatri & Brown, 2010). Its management is critical for organizational success for several reasons, such as meeting business and compliance requirements and for integrated and automated business processes (Otto, 2011a). Furthermore, increasing data volumes have to be processed (J. Becker, Pöppelbuß, Glörfeld, & Bruhns, 2009; Madnick, Wang, Lee, & Zhu, 2009). Additionally, besides business process integration, increasing and improved analysis possibilities are a driver for DIQM (Capgemini, 2011). Similar to BPM, DIQM has to be considered at an organizational level. In current research, strategic planning and data governance are current issues (cf. Khatri & Brown, 2010; Otto, 2011b).

Data quality is important for process improvement and BPM and DIQM initiatives should be aligned (Forrester Research, 2011). The immediate interdependency between data and processes is visible in process automation "where data quality is a prerequisite for and a benefit of process automation" (Glowalla & Sunyaev, 2012, p. 6). Furthermore, BPM is important to improve data quality in the long-term. Flawed data can be considered a symptom of broken processes which have to be corrected to sustain improvements (English, 1999; Redman, 1996). In contrast, if flawed data are corrected without adjusting the process, the process will continue to produce defective data. Therefore, process-driven approaches seek to assess and improve data quality by redesigning the processes that create or modify data (Batini, Cappiello, Francalanci, & Maurino, 2009). We subsume these approaches under the term process-driven data quality management.

ERP systems are software packages that integrate data and processes across several functions (Davenport, 1998; Haug, Arlbjørn, & Pedersen, 2009; Hoermann et al., 2010). In the case of commercial or standardized software, a ERP system integration imposes generic processes on the enterprise. Since we consider the service sector, where ERP systems lack specific functions (Botta-Genoulaz & Millet, 2006), we consider non-standardized ERP systems as well.

Table 7 provides the mains definitions applied in our study. An according discussion can be found in (Glowalla & Sunyaev, 2012).

BPM	Business process management is concerned with the iterative and incremental optimization of business processes. The optimization of business processes is represented in a continuous lifecycle. The lifecycle encompasses the process analysis or respectively diagnosis, process enactment, and continuous control.
DIQM	Data and information quality describes the information's fitness for their intended use or task by users or user groups. Users can be internal as well as external information consumers. Data quality can be measured by several quality dimensions. The quality is measured with regard to the user requirements and the intended use.
ERP system	An ERP system is an integrated software for supporting main processes and important administrative functions in an organization.

Table 7: BPM/DIQM/ERP system definitions

9.2.2 BPM, DIQM and ERP systems in the financial service sector

Since the sector should be considered within IS research, we provide an overview of the characteristics in financial services. Due to particularity of financial services, we focus on the insurance sector which additionally provides specific characteristics that have to be considered.

Financial services is the most highly regulated industry (Abdullah, Sadiq, & Indulska, 2010) and faces a continuing trend towards increased regulations (J. Becker et al., 2011) and the challenge to provide transparency through reporting (Khatri & Brown, 2010; Otto, 2011a). An example is the current directive “Solvency II”, which demands transparency to ensure organizations with regard to several economic risks (European Commission, 2011).

The need to consider the sector in IS research is corroborated for BPM research, since different sectors are on different maturity levels (J. Becker, Weiß, & Winkelmann, 2010). Regarding DIQM, there is a gap between the ascribed importance to data quality and the already-applied solutions (Capgemini, 2011). This is true for financial services as well. Even organizations with a high propensity for data quality investments show rather low objective investments in data quality projects (J. Becker et al., 2009). However, DIQM has to be considered in the specific context as well, since DIQM is context-dependent and several conceptualizations of data quality exist (e.g., Knight, 2011; Lin, Gao, Koronios, & Chanana, 2007). Furthermore, considering research on ERP systems in financial services, there is a lack of research on ERP systems in financial services (cf. Addo-Tenkorang & Helo, 2011; Moon, 2007).

9.3 Research approach

We conducted 15 semi-structured expert interviews (Flick et al., 2009) to examine ERP systems application from a data and process perspective. The interview guideline aimed at the experts' perspective regarding (1) the developments and IT trends in the organizations and in the service sector in general, (2) the application of ERP systems, and the maturity and application of (3) BPM and (4) DIQM within the examined organizations.

Most of our participants are heads of IT departments or belong to the middle or executive management (Table 8) and are the main drivers for IT innovations (Capgemini, 2011). Overall, 13 of 15 participants are involved in IT-strategy decision making as decision makers or direct advisors. All participants have a minimum job experience in the financial services sector of 11 years and a mean of 19.8 years. The interviews were transcribed and sent them back for communicative validation (Flick et al., 2009). We analyzed the interviews by iterative descriptive and interpretive coding (Myers, 2011). All participants work for insurers or insurance-related organizations. However, for the analysis with regard to the organizations' ERP systems, BPM, and DIQM, we focus on the twelve insurance providing organizations Table 8.

Organizations' premium income in million Euro		Organizations' no. of employees		Participants' position regarding IT-strategic decision making	
< 1000	4	< 1000	4	CIO / Head of IT (national)	5
1000-5000	4	1000-5000	4	directly reporting to CIO / Head of IT (intern.)	3
5001-10000	2	5001-10000	2	directly reporting to CIO / Head of IT (national)	4
> 10000	2	> 10000	2	other executive board members	1
				other participants from insurance sector	2
Total	12		12		12

Table 8: Examined organizations and participants

9.4 Findings

9.4.1 Market and IT developments in the ERP context

Regarding the characteristics of the financial service sector, our study corroborates the *importance of regulations*. 14 of 15 participants address this topic with Solvency II being the main issue affecting the IT landscape and processes. The high priority of fulfilling the requirements, e.g., on reporting, and therefore the need for high data quality, pose a challenge on ERP system implementation. Because of the high uncertainty of future regulation requirements, the sustainability of the ERP systems is questioned. The high priority to adhere to regulations and the changing requirements bring the risk that organizations adopt the data quality perspective of the respective legislative body, instead of considering organizational strategic needs for data quality. Mergers and acquisitions (M&A) impact IT landscapes across organizations. Seven participants address M&A. From an ERP system perspective, standardized ERP systems support consolidation within organizational groups across former legally independent organizations. Specifically in the insurance sector, the longevity of insurance products poses a challenge on DIQM. Many products and their versions have to be managed and impacts of product changes are visible with a high delay. The above-average planning horizon causes uncertainty and the IT systems have to manage new and legacy products with a lifecycle of up to 60 years.

Regarding the IT trends addressed by participants (cf. Figure 22), the *integration of standard and individual software* is the primary topic in the examined organizations. This is intertwined with *system standardization*. There is a strong trend towards standardization, but still a high rate of individual software in financial services. Standardized ERP systems are rather used for administrative functions, whereas individual ERP systems or other systems are used for insurance-specific function. The need for system integration drives the demand for modularized system architectures, respectively *service oriented architecture* (SOA). SOA is referred to in combination with *process automation* and the possibility to define and combine services flexibly. Furthermore, process automation and *data analysis* corroborate the need for high data quality across IT systems. Especially regarding data analysis, there is a need to integrate several, for instance external, data sources to provide high data quality for strategic decision-making.

9.4.2 Maturities

The ERP maturity (cf. Figure 23) is assessed based on the systems' implementation stage. Organizations with low integration are currently integrating different ERP systems across organizational sites due to M&A. In these cases, the maturity is rather an indicator for still-necessary activities on the way to an integrated platform, not as a statement about the actual quality of the

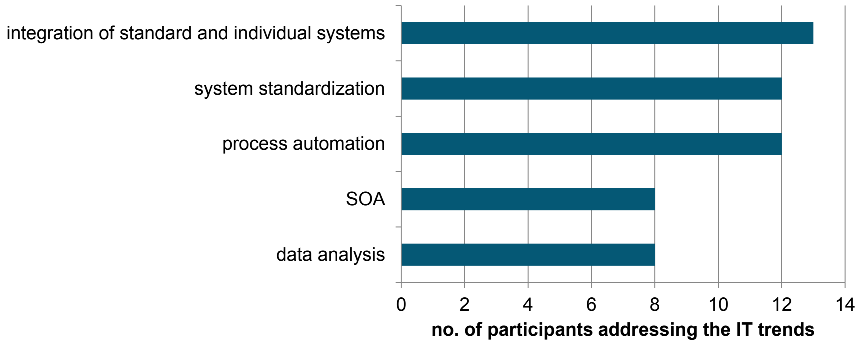

Figure 22: IT trends based on the participants' perspective

different ERP systems. To arrive at an integrated support of administrative (e.g., accounting) and insurance-specific functions (e.g. product development, claims processing), the organizations had to integrate standard ERP systems with other existing systems or customize the ERP system, entailing increased maintenance. With the trend towards standardization, overall, the organizations rely on their standardized ERP systems.

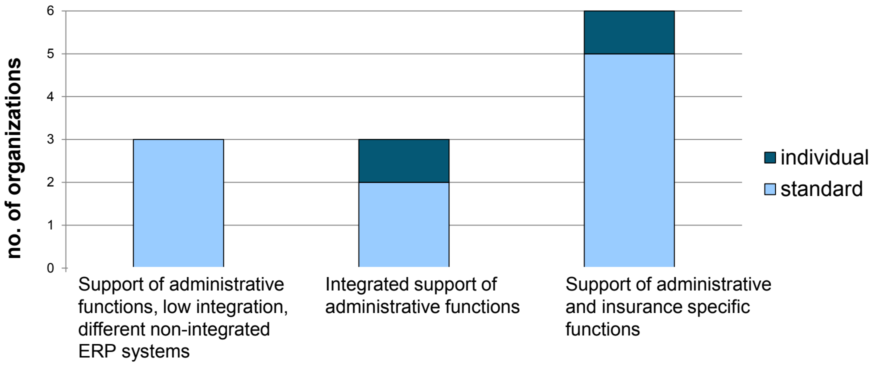

Figure 23: ERP system maturity of insurance providers

For comparability of BPM and DIQM maturity levels (cf. Figure 24) we apply the BPM Maturity Model (BPMMM) (Rosemann, de Bruin, & Power, 2008), which focuses on BPM as a holistic management practice (Röglinger et al., 2012). Furthermore, the maturity stages are similarly applied in DIQM (Aiken, Allen, Parker, & Mattia, 2007; Loshin, 2011).

All organizations are beyond the documentation of first processes. The main difference between organizations at level 3 and higher levels is the derivation of control measures for a continuous improvement of processes. In only one organization, no process-driven improvements are conducted. That is, the improvement of processes is rather driven by IT projects and entailed process changes. Organizations beyond level 3 tend to further refine their BPM approach.

DIQM is at its beginning. That is, occurring problems with data quality are managed ad-hoc. Although data quality is a main topic, extending DIQM in the organizations seems rather not planned. A reason might be the reliance on quality checks that are built into the systems. Organizations at maturity level 2 provide rudimentarily structure approaches to DIQM. DIQM at higher levels include automation of DIQM processes and transfer of established migration practices to continuous operational business.

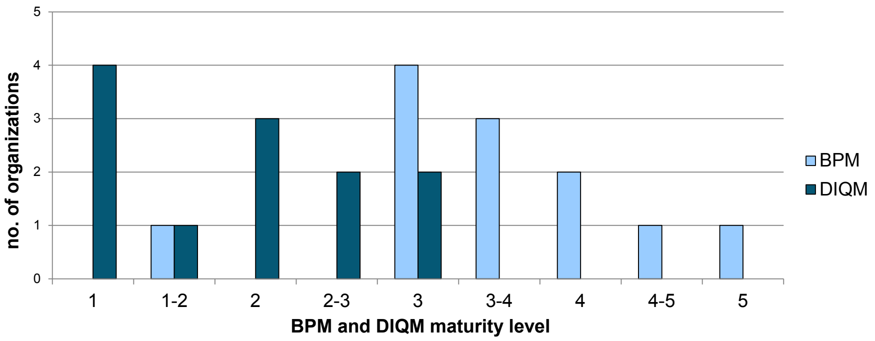

Figure 24: BPM and DIQM maturity of insurance providers

9.5 Summary and outlook

The use of standard ERP systems is increasing in financial services. However, due to the still high rate of individual software for insurance-specific function, integration of ERP systems into the existing landscape is a major topic. It is necessary to manage ERP systems with regard to other IT systems. Although this might sound obvious, a main issue from a data and process perspective is that the participants have an application-oriented view on data and processes. Especially regarding data quality, they consider data that is processed in specific IT systems. A reason might be the continuous need to conform to regulations. Such an approach to DIQM and moreover BPM inhibits the integrated management of data and processes. From a technical perspective, with the technical robustness of ERP systems (Mohamed & McLaren, 2009), the modularization of ERP systems is necessary to increase flexibility. Besides the insurance organizations, vendors of ERP systems should engage in SOA as this might draw the distinction between ERP systems as competitive necessity in financial services and ERP systems providing further benefits through integration across service-specific functions. Overall, the importance of organizational issues in ERP system implementation and use increases. Therefore, we further consider the main issues with respect to BPM and DIQM.

Both BPM and DIQM should be considered as *IT-independent* approaches. That is, data and processes have to be aligned to organizational needs, allowing continuous adaption of requirement to changing IT-landscapes. Therefore, IT governance has to be considered a related topic supporting the fulfillment of strategic organizational requirements on BPM and DIQM. Such an IT-independent approach considers the management of data and processes that are not yet supported by IT as well and avoids suboptimal improvement of single systems. *BPM and DIQM should be aligned* at a strategic and operative level. The need to align BPM and DIQM initiatives is necessary to improve maturity of both management approaches. Regarding the need to consider organizational issues, BPM might support the understanding and application of DIQM as a management approach. At the operative level, process automation drives the need to manage processes and data continuously. Furthermore, for a long-term improvement of data quality, *process-driven data quality management* is necessary. Regarding the increasing M&A, organization should engage in process-driven data quality management to keep up improvements to data quality, for instance after system migrations. The need to *engage in SOA* is important to consider the IT trend towards integration of standard and individual software. The modularization simplifies integration of IT systems and supports reduction of individual systems to organization-specific core services. Furthermore, engaging in SOA in conjunction with BPM in the service sector and for process automation supports arriving at a high process quality (Beimborn & Joachim, 2011; Brahe, 2007). Specifically for DIQM at its low maturity, we see the need *to guide existing and future data quality measures by a data quality framework* and distinguish DIQM from IT management (cf. Khatri & Brown, 2010; Otto, 2011b). With the context-dependency of data quality, a framework for financial services would support the management of data quality with regard to regulative and organizational requirements. Existing measures to fulfill regulative requirements, such as collecting new data or updating data models, should be conducted with regard to organizational requirements as well. Additionally, to solve data quality problems, stakeholders need to understand what data quality is (Helfert & Hossain, 2010) and the data's usage context (Y. W. Lee & Strong, 2003). In this context, a governance framework supports communication of DIQM.

Further research needs to generalize our results, since we examined are rather small number of organizations and participants in financial services and specifically the insurance sector. However, we provide an understanding for current issues in financial services from the participants' perspective. Furthermore, sector-specific data governance approaches should examine DIQM in highly regulated industries in more detail. In this context, synergies between BPM and DIQM should be examined to improve alignment and consider DIQM as a managerial approach.

10 The Aspect Based Analyses of Process Modeling Techniques

■ **Igor Fiodorov**, Moscow State University of Economics, Statistics and Inforamtics (MESI), Moscow, Russian Federation, igor.fiodorov@bpexpert.ru

Abstract

There is no single and common definition what is a business process model. Different categories of users apply this term for dissimilar things. In order to identify all components of the process model we discuss its perspectives and aspects. We use this approach to compare modeling techniques. Not all modeling techniques equally capture these perspectives and aspects, some omit important details of the process' behavior.

10.1 Introduction

Yet there is no single and common definition what is a business process model (Kindler, 2004). Different categories of users apply this term for dissimilar things like VISIO flowcharts, EPC and BPMN diagrams, even BPEL programs, despite their differences (Axenath, Kindler, & Rubin, 2005). Some of models used for business analyses give only a very general representation of use case, another, used for automation, include all possible paths of process execution. A number of models have low level of detail and show only main functions, others go deep to the level of elementary actions. The absence of unified understanding provokes a conflict when user gets a model that doesn't meet his expectations. So it is very important to define all ingredients of the process model.

Different researchers consider a process model consist of a number of perspectives. A CIMOSA model have four perspectives (Vernadat, 1996) while Zachman name six well known layers (Zachman, 2003) ARIS integrated model mention three main perspectives while fourth depend on the goal of modeling (Scheer, 1992). In this work we will follow Curtis who considers a process model as integrated representation that unites four perspectives (Curtis, Kellner, & Over, 1992):

- Behavioral: describe the dynamics of process execution;
- Informational: describe the business entities subject area;
- Organizational: describe the distribution of work between the performers;
- Functional: describe the structural decomposition of work.

In our understanding each perspective consists of layers, we will call them aspects. In this paper we will investigate the aspects of four process perspectives.

10.2 The aspects of the behavioral perspective

The Behavioral perspective describes system in dynamics. It answers a question "How the work has to be done?". Let split the question How in to three sub questions:

- In which order the operations are executed?

- At what time are the operations started, how long do they last?
- Why are the operations executed in a particular order?

The answer to the first question is business logic, which is a procedural description of the order of process execution. The second question is answered by the timetable which adds temporal relations between operations. Finally the answer to the third question is business rules that explain the reasons of the decision. In this way we have divide the behavioral perspective in to three aspects. Each of these aspects should be reflected in a model. Let us examine these aspects in details.

10.2.1 Business logic

Usually the business logic is modeled with a help of a workflow diagrams where a node represent an operation, while an arc indicate an order of execution. Some of operations transform the input data flow into the output, while others do not change flow but route it. For example, logical operator that branches the process flow do not modify the data and routes it in accordance with the specified condition. Thus logical operators are elements of the business logic, while a criterion of routing is the business rule. Usually the business logic includes explicit information about the route required, but excludes criteria for making a decision.

The diagrams that describe the business logic visually seem simple and understandable, since they does not include full set of business rules, time schedule, control actions taken when the process parameters go beyond the threshold, so many analysts use them to align with the business. However, the simplicity is deceptive, IT developers have to re-collect the missing information and their understanding of the process may differ significantly from those of the analyst. There is a dangerous situation: the model does not fully describe the process, details are not explicitly recorded and exist in a minds of programmers, which is one of the reasons why the model of the process on paper does not match the logic of the IT system.

10.2.2 Business rules

A business rule is a statement that defines or constrains some aspect of the business. In contrast to procedural descriptions, rules posit the limitations on the execution of the process, but do not specify how to achieve the expected result. As shown above, the logical operator represents a work and belongs to the business logic, while the condition of the routing is the business rule. Similar routing criteria may be found in some other operations, for example in an event it can keep a rule of a time, etc. R. Ross proposes the following classification of business rules (Ross, 2009):

- Behavioral Rule: a rule that there is an obligation concerning conduct, action, practice, or procedure. Behavioral rules are about what people must or must not do.
- Definitional Rule: a rule that is intended as a definitional criterion giving a necessity about the meaning of some concept. They do so in two basic ways:
  - Computation rules provide decision logic needed to perform calculations.
  - Classification rules provide decision logic needed to determine whether or not something is true.

As we see above, the process branching is based on the behavioral or routing criteria that take the values of true or of false. What is true and what is false is determined by the classification rule.

In turn, the latter should receive an input value, obtained using the computation rule. Consider an example: calculate a discount as a function of a current order size (computation rule), classify a value of the discount: large, medium, low (classification rule) and finally send the transaction for an approval by the supervisor with an appropriate authority (behavioral rule).

However, a common practice of process modeling is to fix the behavioral criteria forgetting the definitional one. The absence of some business rules on the process model makes the diagram incomplete. Another mistake is to combine all rules in the routing element on the process diagram, which makes more difficult modify a decision. A similar suggestion to separate decisions and rules, take apart a gateway and a rule task belongs to B. Silver (Silver, 2010). It comes from following practical advice - analyst should clearly highlight all types of rules on the process diagram, placing them in a separate model elements. This will help the analyst to clearly locate the appropriate logic.

10.2.3 The schedule of the process execution

In the field of material production a Gantt chart is used to calculate the time required to manufacture the product and in this way determines a production time table. For business processes the time table is more complex, since each operation can be performed in time, while the whole process delays due to returns backward to reprocess.

The ontology of time used to describe the temporal relations between the operations that make up the process uses two basic concepts: *time instant* and *time interval*. *Time instant* is the main primitive element and it provides the means for identifying a point on a timeline that has no duration. *Time interval* is defined by means of start and end *instants* and has therefore an associated duration which can be calculated by subtracting the limiting *instants* (Pedrinaci, Domingue, & de Medeiros, 2008). In the business process modeling the *time instant* is associated with an *event*. *The event* is used to coordinate the execution of various processes or different branches of a single process. A *time interval* is associated with a timer that limits the execution or the waiting time.

Some modeling methodologies consider that the *event* is capturing the fact that information object has changed (Software AG, 2012) and thus they mix the *Event* with a *State* of the object. The first one can be associated with a *time instant* while the second can't. Let's be careful to distinguish the *event* as change of the *state* and as a means of coordination. Some modeling techniques don't support time intervals.

10.2.4 The level of detail of the process logic

To answer the question "How?" the process diagram should contain a detailed description of operations that form a process. But many analysts itemize operations, without specifying details of their execution. This approach assumes that the performer knows how to do the operation. However, an employee tends to perform his work based on an individual experience gained in a company with a different organizational structure or corporate culture, which leads to variability of the execution.

The business process may consist of nested reusable components called sub-processes. No need to assume that each sub-process is a new level of decomposition and thus limit the depth of breakdown as it is recommended by SADT (Marca & McGowan, 1988). An analyst should proceed with decomposition until he reaches a necessary level of details.

International standard encourages distinguishing an *operation* and a *task* (*ISO/IEC*, 2009). The *operation* results in a change of a state of information object being acted upon while the task outcomes in the change of an attribute of the same object (Aitken, Stephenson, & Brinkworth, 2010). Let's try to clarify this definition for a case of process modeling. Work done in the process is recorded in the information object that can be associated with a process state variable, which can take qualitative and quantitative states (Samek, 2009). The *task* is a unit of work performed by a participant on the information object that quantitatively modifies that object, but not leading to a qualitative change of its state. For example, a participant has introduced new data, but this does not mean the end of the document processing. The *operation* is called a set of tasks that changes a qualitative state of that information object. While in the analytical modeling the level of operations would be quite sufficient, in the executable process modeling we must strive for the task level of detail (Telnov & Fiodorov, 2012).

10.2.5 The degree of business process logic completeness

Note that the majority of workflow diagrams present a limited number of execution scenarios, specifying only the most obvious routes by which the major number of process instances are executed, forgetting that in reality there are many other alternative scenarios of execution: backward transitions for re-processing that slow down the execution; transitions forward, bypassing some operations that speeds it up; the exceptional situations, such as client's denial from his order, unavailability of required information or technical resource.

The process diagram that presents use case has a right to exist when we plan to develop a functional information system, where a human determines the order of execution. But if we are developing a process-oriented system, where the order of operations is determined by the system, the model should cover all possible scenarios; otherwise the operation would become impossible (Fiodorov, 2011).

10.3 The aspects of the organizational (resource) perspective

Organizational perspective describes the dynamics of the enterprise, in contrast to the organizational structure, which shows the static distribution of a workforce between business units. The organizational perspective includes four aspects that are important for the business process execution:

1. How to select candidates for the execution of each operation?
2. Which of candidates should be appointed as an executor?
3. What are the privileges of the executor, appointed to the task?
4. In what order the executor can performs tasks assigned to him?

10.3.1 The aspect of grouping

The selection of candidates for the operation was traditionally carried out using a role model. However, due to the difficulties with the mapping of roles on the organizational chart, there is a trend to omit the role model and perform the direct assignment of employees to each operation. Such an approach can't be considered satisfactory, since it represents a clear retreat from the model-oriented design to programming. Problems with mapping of the role model on to the organizational structure stems from the fact, that the process-oriented model of the work is mapped on the functionally-oriented organizational structure. There is a contradiction between the process organization of labor and functional organizational structure. Instead of the role the analysts use a job position or an organization unit. As a result the actor becomes bound to the organizational structure of a specific company. That does not meet the original purpose of the role model.

The essence of the role should be viewed from the two points of view: the business modeling and access rights. In a business modeling the role means a group of actors who can be assigned to the specific operation. In the IT the role means the group of the participants who have similar rights to access the objects of an IT system (Awad, Grosskopf, Meyer, & Weske, 2009). Those definitions do not contradict each other. In the first case IT object is seen as the operation of the process. In the second, IT objects can be considered as: the operation, process instance, process template and information object. Logical people grouping is important for both roles and access rights, unfortunately analysts sometime forgetting about the access rights as a result the participants can gain an access to the process instances created by other user in the same role.

Let's consider the grouping from the perspective of management theory. H.Minzberg (Mintzberg, 1983) proposes to define the organization structure as the way in which the labor process is first divided into individual work tasks and then is coordinated. He uses the grouping by the following criteria: (a) processes; (b) work tasks (functions); (c) qualification and skills; (d) the time of work (shift); (e) the product of the process; (f) the clients of the organization; (h) the place of work.

Let's use his criteria for a logical people grouping. The grouping by a process allows selection of all actors involved in this process. The confusion arises from the grouping by the functions. In the functionally-oriented company a grouping by the functions is used to structure organizational units. This gives a cause to analysts to bind a function to the organizational unit or to treat it as a job position. However, in the process oriented company the process is cross-functional, it intersects the boundaries of units and positions. For example, an employee and his manager can perform the same operation, respectively they are located in the same role, while working in different positions. Therefore, the grouping by functions should be seen as a first step of grouping actors who are assigned on the specific operation. To distinguish between employee and his manager we should use the additional criteria of grouping.

As mentioned above, it could happen that two participants in one role should not see the work of each other. For example, sellers in different territorial units can't see the process instances of each other. In this case, the grouping by the place of work helps to clarify the grouping by function and thus extend the definition of the actor's access right. Similarly, one can use other kinds of grouping and thus precise the participant's access rights. Thus, the procedure for selecting candidates which would perform the operation narrows to finding the participants, who belong to the respective groups at the same time. In mathematical terms, this means the need to find the intersection of several sets, each of which describes the appropriate group. At the same it is necessary to provide the situation when the resulting subset is empty. In last case, for example, the appropriate manager can manually assign an actor.

10.3.2 The aspect of assignment of the actor

Once candidates are selected, one of them should be assigned at run time into a physical actor appointed to perform a task. The following strategies are available (Stroppi, Chiotti, & Villarreal, 2011):

1. Task is given to all of selected candidates and one will select himself;
2. The actor is manually nominated by the manager;
3. Actor is selected based on performance indicators of the process instance

- Given the execution time of the process (shortest process time, shortest rest-processing time, earliest due date)
- Given the history of execution (to one who has already participated, to one who has not yet participated).

4. Actor is selected based on performance indicators of the process participants (according to the current workload or his overall production for the period).

While selecting the executor we should consider the situation when the selected actor will be absent from work for a long time, so someone should be appointed temporarily to perform his duties.

10.3.3 The priviledges of actor appointed to the task

Finally, the privileges of the actor determine his right to refuse to perform the operation or to pass it to another actor (e.g., vertical escalation), ask help or consultancy from colleagues (horizontal escalation) (Mullins, 2005). A common mistake is to associate these privileges with an organizational position only, while in a process-oriented company they can be based on temporary workgroup etc. The logical people grouping can help to resolve the necessary organizational hierarchy.

10.3.4 The aspect of execution order

The last aspect specifies the order in which the executor will select his tasks from the task list. Typically, the user selects a first item from his task list located in workspace. By default, the task list is sorted in a way that process instance that came first is at the top of the list and the last one appears at the end. However, the order can be changed by manipulating the priority of the process instance. Thus, instances that are late can receive a higher priority and will appear at the top of the task list so they will be selected for execution first. Alternatively a user can have a right to select any task from his list despite the order. In the first case a system is responsible for the scheduling of tasks, in the second the scheduling is done by the user.

10.4 The aspects of the informational perspective

Information model is often expected to describe only a structure of documents involved in the process, whereas actually it has four aspects.

The structural aspect defines the relationships between documents and between data objects. Documents of the process can be divided into structured and unstructured. The last are stored as an image and are enclosed with a context the meta-information. Different structured documents can contain common information so that data entered in one document could be available in the other. To describe the structural aspect we use an object hierarchical data model. This model does not describe the database schema, but shows conceptual relationships between the individual objects, their elements and methods of work with the data.

The aspect of static integrity determines the permissible range of the data values, i.e., the maximum and minimum value of a parameter. Some developers place a check of the input data to an appropriate screen forms. It turns out that one check method can be repeated several times in many forms. To avoid multiplication the single method of data integrity must be stored centrally in the object data model (Goedertier, Haesen, & Vanthienen, 2007).

The aspect of dynamic integrity appoints the right to see and modify the data objects at different process steps. For example, while entering the order you can update and modify the information about the customer, but on the next steps the changes are not possible. Centrally storing the methods of dynamic integrity simplifies maintenance and modification of the process screen forms.

Information flow, that accompanies the execution of the process, is formed by the set of information objects that are passed between steps of the process. Among them is the main information object that captures the execution result of current operation, a process stage or an entire process and thus connects inputs and outputs. We already associated this object with a state variable that determines the status of the system at any given time. The BPMN 2.0. specification uses the concept of *sequence flows*, but does not define it explicitly. For ease of reading it introduces a *token* that traverse the sequence flows. The *token* is defined as a “theoretical concept” and is used to determine the behavior of the executable process (Object Management Group (OMG), 2011), unfortunately it not clearly explained. Now we can interpret the token as the state variable that is moving along the process and in this way determines the temporal order of the process execution.

10.5 Functional perspective

A functional perspective is a strong tool to analyze a process, it shows the system in statics, answers the question “what should be done to achieve a goal?” It is believed that by having a full set of functions one can build a system using reusable components. A functional model is built by functional decomposition, as this is the most natural way to analyze the system (Marca & McGowan, 1988). The model can be seen as a work breakdown structure that list all units of work but doesn’t indicate a temporal order of the execution. It has multilayered structure, defines a hierarchy of components that allowed to select appropriate level of detail. The strength and benefit of functional perspective is because it is produced top down.

Modern tools for business process modeling are quite wrong to ignore this perspective. If an analyst need to add the activity in the workflow diagram, he must first find a place for this unit of work on a functional decomposition. This will help to avoid duplicated and skipped functions. Identifying missing or duplicated function in the workflow diagram is much more laborious because two operations that correspond to these functions can be located far from each other.

10.6 Aspect based analyses of EPC diagrams

In this research we propose to consider a multi-layer and multi-level model of the process. This approach allows us comparing the process modeling notations in a new fashion. Let’s consider the EPC notation, a member of ARIS integrated architecture (Software AG, 2012).

The EPC notation is intended to describe the business logic, but restricts the model to the level of operations. Generally it does not show all paths of process execution but shows only the separate use cases. EPC does not allow to describe the temporal characteristics of the execution, does not clearly specify business rules. Instead of the object domain model ARIS describes the ER storage model, where the dynamic and static data integrity is not modeled at all. The flow objects in the ARIS methodology are not defined. The organizational structure is modeled without roles, participants are bind directly to positions or to organizational units. Selection of the actor, his privileges and order of tasks are not considered.

Deficiencies are often a continuation of our virtues. The problem of ARIS is related to an attempt to adapt this tool to address a very wide range of tasks, but without explaining the rules of a particular case. As a result, many analysts use the notation intuitively. Sometimes we can understand their idea from the context of the model, but it can't be assumed that the machine will automatically analyze the context when translating EPC in the executable format.

10.7 Conclusion

The goal of this research is to show that the process model consists of few perspectives of several separate aspects each. Not all modeling techniques equally capture these perspectives and aspects, some omit important details of the behavior.

It can be noted that some of the models that are used in the practice of reengineering, do depict the process behavior thus could not be called a process model. Let us think, Hammer and Chumpy encourage us to replace the functional management with the process one, and we, in order to implement their call, use functional modeling. The one question that naturally arises: Can we move on to the process management through functional modeling, is not there a contradiction? Perhaps there lies the reason of the failure of some reengineering projects .

11 Event-driven Application Systems in Justice, Economy and Governance

- **Erich Ortner**, Steinbeis-Transferzentrum TECHNUM, Konstanz, Germany, e.ortner@technum.biz
- **Marco Link**, Darmstadt Technical University, Darmstadt, Germany, link@winf.tu-darmstadt.de

11.1 Introduction

Event-driven application systems can be compared to the conventional, referring to the user or to IT (Information Technology) itself merely data-driven application systems. Both types can nowadays be developed and arranged dynamically and extensively fail-safe (resilient). Data represent a medium which is also used in event-driven application systems. Events are on the other hand elusive (singular) objects from the real world of the IT users, which must be captured as well as managed indelible in application systems merely on schema level with regards to data. This primarily takes place when on this basis an occurrence shall as exactly as possible and without faults be ahead determined (planned) both with regards to the straightened flow (regulation event) and to the work that has to be done (execution event).

The construction of such systems in justice, economy and governance therefore in a primarily not technological, but primarily sociologically-ethical area holds a special responsibility into itself. Also the developers of event-driven application systems are now — together with the users — responsible for the “social contents”. In this context and in economic practice the so-called “business logic” and its “compliance” are often mentioned. And in application development we speak of correctness in respect of content, but also of ethically and morally justified “expert design” or the socially tolerated “(expert) semantic” of the linguistic expressions in the described domain. Those are for example, because of the IT use, the share of responsibility of the developers for

- the socially correct flow of a court procedure,
- the fault-free and economically correct preparation of balance sheets,
- the tax return observing truthful and all legal regulations of enterprises or of citizens,
- the responsible planning of and compliance with the budget framework of a state,
- the lawful project planning and execution of building projects,
- etc.

Also politically-ethical (cultural) interests play now an outstanding role besides the logical and technological aspects with regard to a for this way possibly nascent “fault-free society” in the global context.

A system type opens up with event-driven, resilient application systems, which could help mankind to survive borderline-situations as e.g. overspill population, climate change, resources lack, financial and debit crisis etc. in a reasonable and ideology free way.

11.2 The Event Model

Since the emergence of Workflow Management Systems in the 1990s, it is good practice in Applied Computer Science, to establish the use of IT in organizations also process-centric (real world) and not only data-centric (virtual world). Amazingly, until the doctoral thesis of Matthias Fischer (M. Fischer, 2012), it did not succeed in all the years to develop a similar model for the field of real-world processes on a purely logical basis, similar to the relational model by Ted Codd (1923-2003) in the field of data. These processes can be organized into a directed flow of elusive events.

A process is according to a definition of Martin Carrier and Reiner Wimmer (Mittelstraß, 1995), "the directed flow of an occurrence" and be composed of events. Figure 25 represents the principle of the event based regulation and execution of processes. Regulation events could roughly be divided up into the two groups of initial and observing events. On the other hand, execution events could be suitable subdivided according to the degree of their interference or predetermination (modeling), for example. The solar flares can probably be predetermined still less exactly today as for example the meticulous planning and carrying out of an airport or a railroad station.

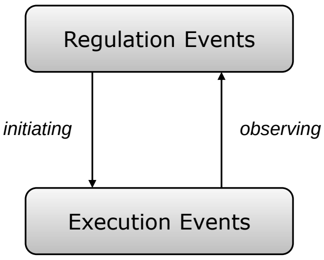

Figure 25: Principle of an event-driven application system

The event schema, with which a kind of logical window is opened to the real world (universe), defines Fischer as follows:

$$\mathfrak{S}(\overline{\mathfrak{A}}) = \{\mathbb{A}, \mathbb{Z}, \mathbb{E}, \mathbb{B}\}$$

$\mathfrak{S}(\overline{\mathfrak{A}})$: event schema
$\mathfrak{A}$: instances (extension)
$\mathbb{A}$: set of preconditions
$\mathbb{Z}$: set of postconditions
$\mathbb{E}$: set of properties and invariants
$\mathbb{B}$: set of relations (outward intension)

At first Fischer reconstructs language-critically resp. rational-grammatically a general "frame" (schema) for events. We could describe this strikingly as a kind of "logical wormhole" since it still fits in with the logical space- and timelessly as a pure abstraction. The "event-window" is then established model-likely in space and time by the further explanations' established location and temporal perspective, using relevant concepts of space and time. That means the frame gets step-by-step filled with relevant concepts of a universal event description. Via the actor perspective it then also turns out well, to equip the event before it really takes place systematically with the substantial concepts (schema pieces) for actors and (work-)means. This intellectual procedure (method) is used continuously in accordance with Figure 25 both on the regulation and on the execution layer of our universal application system architecture (Ortner, 2010).

The constructive and language critical reference of the approach can be expressed as follows by analogy with (Kamlah & Lorenzen, 1996):

> "By an elusive, singular event being brought about to a (language logical) schema agreed on, it is available (e.g. for the renewed execution of such events) like a (re-)usable equipment."

Often one thinks of a soccer match as an example, the events were brought about by modeling to a language schema during the action (e.g. ball assumptions, referee's decisions at "bugs" etc.)

and now arbitrary — almost identical or by optimization by the modeler with less “bugs” — can take place so. The skills (the ability) of the actors (players, etc.) to follow the prescribed minutely schemas are mostly only relevant to the success of the “moves”. The theory of “schema and instances” was delivered to in (Wedekind, Ortner, & Inhetveen, 2004).

Because processes can be “broken” in a very high number of very small events and described in great detail before their execution, the advantages of Fischer’s language-based event model compared to previous approaches of process modeling and process regulation are obvious. In addition to a logic-based process modeling (coupled with the extensive capabilities of the automated quality control and generation of precisely matching event patterns), the planned events can be very accurately, both in terms of execution and in terms of regulation in the relevant field (e.g. business, justice and governance) determined in advance. We can consequently expect a nearly flawless occurrence while meeting all of our requirements considered in the model taking place in a by planning and modeling well “prepared” application or event domain.

11.3 The Development Methodology

Such event schemata, as mentioned in Section 11.2, are used for describing work and preparing working systems. MTM (methods time measurement) describes such a process language for certain domains. MTM is a method for industrial and administrative process modeling. It is an approved worldwide standard used in many industries such as car manufacturing, aircraft manufacturing, also health insurances and finance sector (N.N., 2010). MTM uses so called MTM-Process Building Blocks to model basic work operations. Every building block represents a work standard and contains micro processes with defined starting and ending point, e.g. ’walking one meter’ or ’get and place’ an object. All elements are titled with a specific code (e.g. 3000KA. . . 5 for ’walking one meter’) that is identical worldwide. Therefore, verbal description can be reduced to a minimum. This is a reason why MTM is also called a “process language” (H. Fischer, Britzke, & Busenbach, 2010).

According to defined influencing factors like object weight and size or distance to object, the user chooses a process building block out of a catalogue suitable to the operation he wants to model. There are different catalogues for a variety of application fields: industrial processes (mostly manual assembly), logistic processes, administrative processes for office work, etc. For industrial processes, there are also different catalogues for mass, serial or one of a kind respectively small batch production. A unique attribute of all MTM-Process Building Blocks is the time standard. Every building block is related to an approved time value that represents the required time to complete the operation (e.g. 0.9 s to walk one meter). The time value depends on influencing factors as well as catalogues and is a statistical value for an average trained and average aged person (Bokranz & Landau, 2006). There is no time standard for creative mental activities like developing a new product or having a conversation (Busenbach, Link, Füssel, & Ortner, 2011).

Those MTM process building blocks can by interpreted as standardized types of event schemata. Those standards lead to the ability to design workflows in a primarily bottom-up manner. On the other side the top-down analysis methods, which comes out of the BPM (business process management) discipline, are necessary to fulfill strategic, legal or customer requirements (Link & Ortner, 2010). Finally MTM and BPM deliver complementary bricks to a holistic system approach. Figure 26 shows the corresponding lifecycle for the development of process-centric and event driven application systems.

In this area, BPMN (business process model and notation) is an actual method for describing and control processes by IT-systems (Stiehl, 2012).

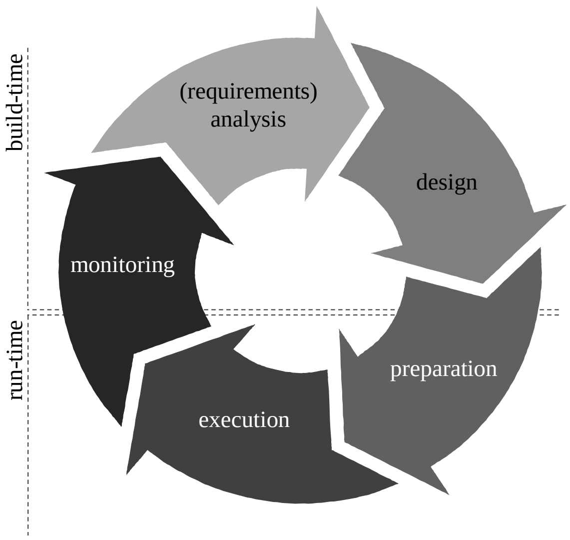

Figure 26: ProCEM lifecycle (Link & Ortner, 2010)

11.4 The Prototype: Basic Systems and Application Domains

Event technology, in which people are much more integrated “interactive” as in — taken in for itself — already outmoded information technology, is the future. Pure information systems are out, application systems, especially as event-driven, resilient interaction applications are in.

The ProCEM Software Suite (Process-Centric Enterprise Modeling and Management) was developed to provide several functions to support enterprises by getting resilient. As underlying basis, a modular and extendable architecture was chosen for this system.

The system is characterized by three layers and one orthogonal group of modules. On the top an interaction layer is placed, which is, according to the lifecycle in Figure 26, separated into build- and run-time. This layer controls the interaction with human beings and IT systems. As system core, the schema equipped basic systems are responsible for the main business and process logic. Concerning the data persistence, on the system bottom, different databases are connected. Due to compliance and governance reasons, a flexible rights- and user-management system was established as a layer overlapping module.

Concrete fields of applications, such as Government & Administration, Justice and other Businesses are shown in Figure 27.

11.5 Conclusion

Event-driven application systems represent a new paradigm in the 70-year history (Denning & Metcalfe, 1997) of commercial use of ICT (Information and Communication Technology) in organizations. Their outstanding characteristics are:

- Continuous reconstruction of the concepts for things and occurrences in the application areas of ICT.
- First model (expert design), then implement (use of ICT).

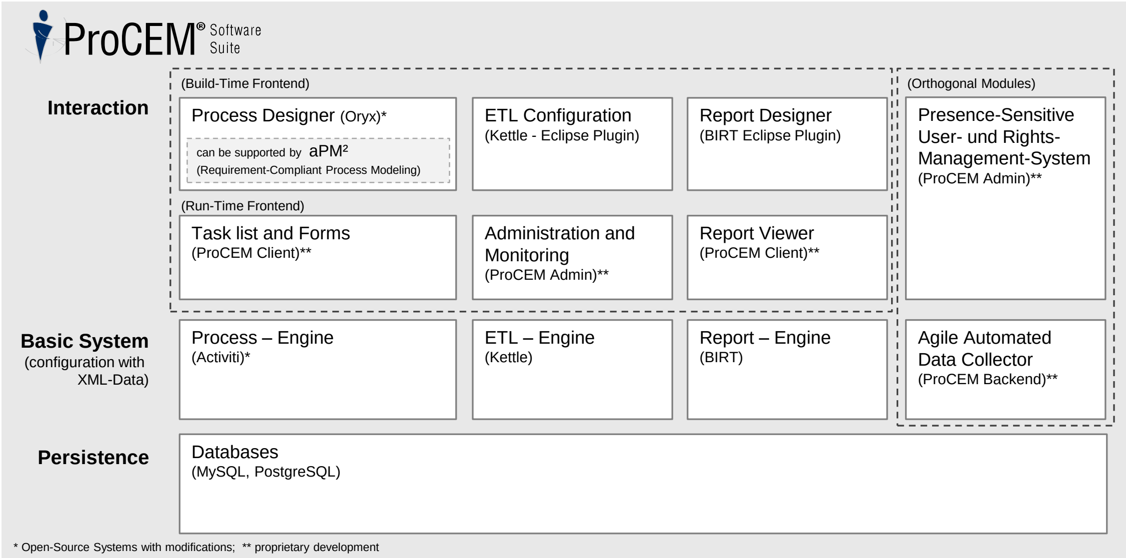

Figure 27: ProCEM software suite architecture (M. Fischer, Link, & Zeise, 2011)

- Anchoring of ICT occurrences (e.g. transaction processing of the basic and application software) in the real world of each user (real-world/media-world-interaction).

In the years to come a huge amount of event-driven application systems, many of them based on the pattern of vehicle navigation systems, but touching the socio-ethical and practical range will conquer markets. We probably can expect navigation systems for the public sector like justice, economy, administration, but also for the private sector like navigation systems for shopping or perhaps even for happiness. *The times, they are a-changing*.

12 How to Identify and Design Successful Business Process Models: An Inductive Method

- **Jürgen Walter**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, juergen.walter@iwi.dfki.de
- **Peter Fettke**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, peter.fettke@iwi.dfki.de
- **Peter Loos**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, peter.loos@iwi.dfki.de

Abstract

Although a variety of enterprise models has been documented in model databases, many of the known reference models were developed based on individual enterprise models. The predominant method for developing reference models is based on a deductive development strategy. In contrast, in this paper an inductive method for reference modelling is presented. The main idea of this method consists of seven phases and uses a graph-based approach for identifying structurally analogous parts of models within a repository of individual enterprise models. Furthermore, an illustration of a corresponding software tool and a sample application scenario is presented.

12.1 Introduction

The usage of reference models offers many advantages for the development of individual enterprise models in practice as well as in science (Fettke & Loos, 2004; Frank, 2008). The realisation of these advantages requires the availability of reference models. Thus, methods for a systematic development of high potential reference models are of high relevance. Basically, two ways of gathering knowledge within reference modelling for the development of reference models are known: a deductive and an inductive strategy (J. Becker & Schütte, 1997; vom Brocke, 2003):

- *Deductive strategy:* Common principles and theories are the basics for the development of a reference model. The reference model will be refined and be made more concrete during the development phase.
- *Inductive strategy:* On the basis of individual enterprise models, a reference model is developed by the identification of commonalities of the individual models and by the abstraction of particularities. An increasing abstraction from specifics of individual enterprise models is one characteristic of this development process.

Even though both strategies are scholarly known, a deeper analysis of the current state-of-the-art shows a significant gap. Most methods follow the deductive strategy while the inductive strategy is supported only a few times. Thus, the potential of the inductive strategy for the development of reference models remains unused. At the same time it is obvious that, with increasing use of enterprise modelling, the amount of individual enterprise models, target models and reference models increases steadily. Consequently, innovative methods are needed to extract the available knowledge from model databases for the use in reference model development. Against this background, it is the central goal of this paper to introduce a method for the inductive development of reference models (cf. Figure 28).

This article is divided into 5 sections. After this introduction Section 12.2 gives an overview on the state-of-the-art. The main part of this article is Section 12.3, where a method for the inductive

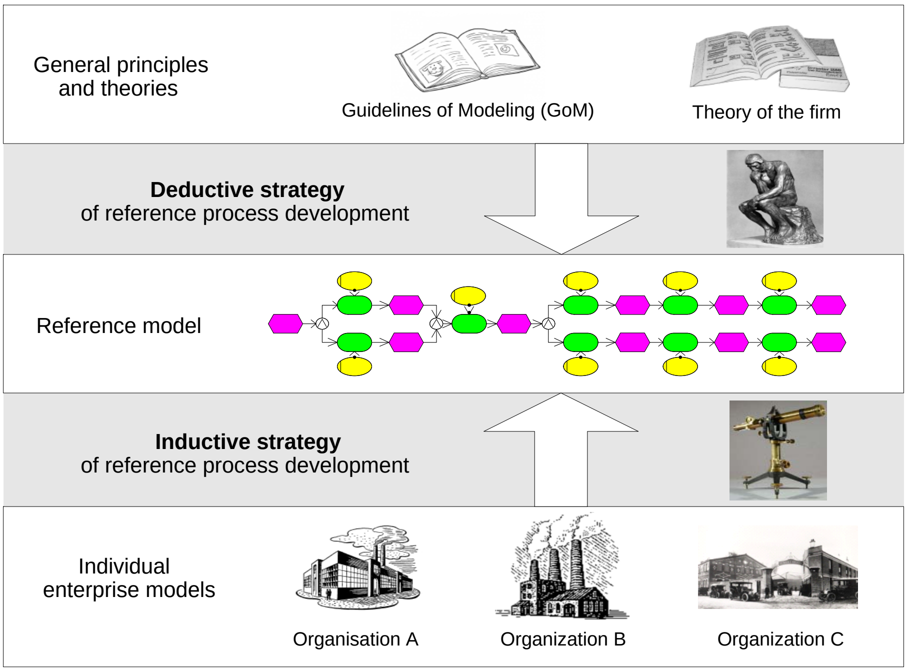

Figure 28: Strategies for identifying and designing reference process models

development of reference models is presented. In Section 12.4, the application scenario and tool support for the proposed method is outlined. Finally, the article is closed with a short conclusion and an outlook on future research.

12.2 Related work

A detailed analysis of scholarly known methods for the development of reference models which is here only presented in results (cf. Figure 29), shows, that the inductive strategy of reference modelling plays no prominent role. Typically, starting from a general definition of the problem, a reference model is derived by a stepwise refinement and concretisation. In contrast, activities such as the creation of individual enterprise models or the abstraction of enterprise-specific features, that would be expected for the inductive strategy, are not listed at the top level of the life cycle models. None of the known methods explicitly argue against the inductive strategy. On the contrary: Some even noted that existing individual enterprise models and other knowledge sources should be identified and taken into account as part of the reference model development (J. Becker, Delfmann, Knackstedt, & Kuropka, 2002; Schwegmann, 1999; Thomas, 2006). Nevertheless, besides the programmatic call to consider existing individual enterprise models, only few concrete suggestions exist for a systematic derivation of reference models from these models.

However, the question remains open, what can be done if appropriate individual enterprise models are neither available nor can be identified ahead of the reference model development. Must the development of individual enterprise models for reference modelling be abandoned in this case? Or is it possible that reference model development benefits from the developments of individual enterprise models whereas in a second step a reference model is derived in an inductive manner?

Besides the known methods, some authors (Gottschalk, van der Aalst, & Jansen-Vullers, 2008; Li, Reichert, & Wombacher, 2010) present first ideas for an inductive strategy for reference modelling. However, these works do not provide general inductive methods for the development of reference models, which would be comparable to the aforementioned deductive methods. Instead, reference

Fetke et al. 2004	Schlagheck 2000	Becker et al. 2002	Schütte 1998	vom Brocke 2003	Ahlemann et al. 2007	Delfmann 2006	Thomas 2006	Schwegmann 1999	This work
Problem definition	Problem definition	Definition of the project goal	Problem definition	Planning und testing of the construction	Problem identification	Definition of the project goal	Reference model requirements	Specification of the reference model requirements	Reference model Requirements engineering
Construction in the strict sense	Analysis and decomposition of the problem-domain	Definition of the reference modelling technique	Construction of the reference model framework	Construction of the reference model framework	Planning	Definition of the reference modelling technique	Identification of adequate knowledge sources	Identification of information sources	Initial development of individual enterprise models
Assessment	Iterative and incremental construction of a reference model	Creation of the reference model	Construction of the reference model structure	Construction of the reference model structure	Model construction	Implmention the refrence modelling technique	Modelling method, modelling language and modelling tool	Scoping and Decomposition of the problem domain	Refinement of the individual enterprise models
Maintenance	Evaluation and evolution	Testing of the reference model	Completion	Completion of the reference model	Validation	Creation of the reference model	Reference model creation	Mapping of structural model and behavioural models	Initial development of the reference model
		Commercialisation of the reference model	Appplication	Supply the construction technique	Practical testing	Evaluation of the reference model	Reference model evaluation	Variant mapping of structural and behavioural models	Refinement of the reference model
					Documentation	Commercialisation of the reference model	Reference model release	Classification of partial models	Evaluation of the reference model
								Quality assessment and quality control	Maintenance and enhancements
Four phases models		Five phases model			Six phases models			Seven phases models	

Figure 29: Live cycle models for reference modelling

modelling is purely seen as an algorithmic problem.

The inductive strategy does not seem to be very widespread. In light of the following facts this finding is even more surprising:

1. A lot of reference models have been constructed inductively (see: attribute "construction method" in the reference model catalogue at `http://rmk.iwi.uni-sb.de`).

2. Both development strategies can be combined without problems: A deductively developed reference model can be used, together with individual reference models, as a basis for further development of reference models.

3. Business process modelling has gained more importance for organizational practice (Scheer & Brabänder, 2010), thus, more individual enterprise models, target models and reference models are available, which can be used for inductive reference modelling.

In addition to the work, which is specific for the development of reference models, there are various approaches that have a certain similarity to the inductive development of reference models; e.g. approaches for model comparison (Dijkman, Dumas, van Dongen, Kaarik, & Mendling, 2011) or for the integration of enterprise models (Rahm & Bernstein, 2001). These approaches are very interesting but the presented concepts have not been applied for reference modelling so far.

In conclusion, it can be stated that the deductive strategy significantly dominates the previous methods for reference model development. The inductive strategy and its fundamental ideas are basically known. Nevertheless, there is a lack of general methods for the inductive construction of reference models. In order to close this gap, in the following section, an inductive strategy is proposed.

12.3 Methods for inductive reference modelling

12.3.1 General requirements

The following requirements must be met by a method of inductive reference model development:

- *Inductive development:* The method is intended to support a modeller in that way that a reference model can be derived out of individual enterprise models systematically.

- *Identification of commonalities:* The derived reference model should contain similarities of the individual enterprise models.

- *Abstraction:* The derived reference model should be more abstract than the individual enterprise models.

- *Generativity:* It should be possible to derive the individual enterprise models out of the inductively generated reference model.

- *Properties of natural languages:* Natural languages are a common part of enterprise models, whereas known phenomena as homonymy, synonymy and linguistic fuzziness are typical. A method must take into account these aspects.

12.3.2 Seven phase model for inductive reference modelling

In this subsection, the proposed seven phases live cycle model for inductive reference modelling will now be introduced in more detail (cf. Figure 29 and Figure 30).

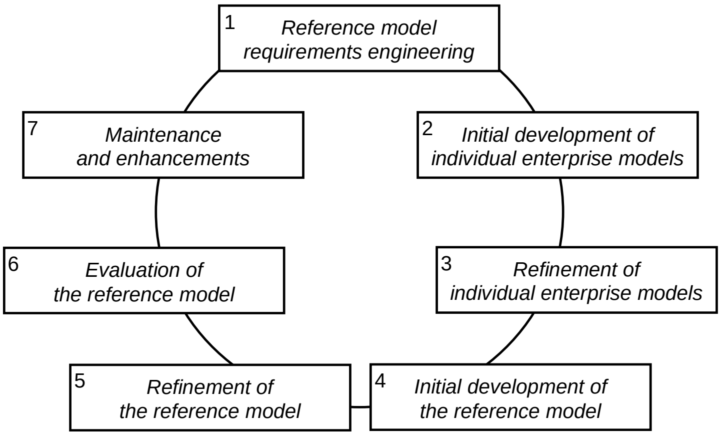

Figure 30: Seven phases live cycle model for inductive reference modelling

Reference model requirements engineering: Goal of the first step is to identify the requirements that a derived reference model must fulfil. To determine the requirements, the following alternatives are available: *Interviews* with domain experts or potential model users can give guidance concerning the question, which requirements a reference model must fulfil. A *literature review* of relevant literature provides an insight into aspects that must be met by a derived reference model. An *analysis of existing reference models* provides an overview of the requirements which are already fulfilled by other reference models.

Initial development of individual process models: Goal of the phase is to collect individual enterprise models that are used for the inductive development of reference models. To reach this goal, several things have to be done: A *class definition* is used to determine the class of enterprises the reference model should be developed for. In an *enterprise selection* step, some enterprises of the previously defined class have been selected for the later collection of individual enterprise models. To reduce the effort of later analysis, different modelling conventions must be harmonised into *unified modelling conventions*. Then, the enterprise models of the selected enterprises have to be developed. Here, the known methods for business modelling can be used.

Refinement of individual process models: Goal of this phase is the harmonization and preprocessing of individual enterprise models. For this purpose, the unified modelling conventions have to be applied to the individual enterprise models in order to harmonise them. The *generation of model synsets* can be build in order to prepare an appropriate grouping of the models in next step. A model synset is defined based on the concept of a linguistic synsets, which designates a set of interchangeable words in certain contexts (Miller, 1998).

Initial development of the reference model: Goal of this phase is to generate a reference model out of the homogenized individual enterprise models. Here, different individual models can be *clustered* with the help of the previously calculated model synset. Then, models belonging to one cluster are similar and models of different clusters are different. For grouping, also the known similarity measures for enterprise models (Dijkman et al., 2011) can be used. In a next sub-step, the *reference model* can be derived. For this derivation process, the identification of similarities between individual sub-models provides great potential. It is assumed that some parts of different enterprise models are very similar which could be summarized in a reference model: A model can be interpreted as a graph, so that identification of isomorphic subgraphs can be used to find such similar parts within a single model or different models (Walter, Fettke, & Loos, 2012).

Refinement of the reference model: Goal of the fifth phase is the post-processing of the derived reference model: Here, the *concatenation of model fragments*, which reflect interesting relationships between parts of the raw reference model and the *integration of deductively developed reference model fragments*, which are fragments of a reference model that cannot be derived inductively and the creation of *manually extensions*, which cannot be derived full automatically, are of interest.

Evaluation of the reference model: Goal of this phase is the evaluation of the developed reference model. Within a discourse between the model developers, users and evaluators, the different possible perspectives and criteria for the evaluation process must be negotiated because they cannot be defined a priori. Typical perspectives are the *assessment against the requirements* that have been defined in phase 1, the *assessment against individual enterprise models* that should be derivable from the reference model and the *assessment on the basis of an existing framework* in literature, where several criteria are mentioned, e.g., by (Frank, 2007), the guidelines of modelling (J. Becker, Rosemann, & Schütte, 1995) or ontological quality criteria (Fettke, 2006).

Maintenance and enhancements: Goal of the seventh phase is to maintain and improve the reference model after the initial construction. This includes corrections of the reference model as well as necessary additions. Important considerations here are stability of the reference model, the planned development costs and complexity of necessary changes.

12.4 Tool support and application scenario

12.4.1 Tool support

In support of the proposed method, a corresponding software tool was created. The goal of the tool development was not to support a fully automated development of a reference model. Rather, the tool supports a developer to create a reference model in an inductive manner.

In order to achieve platform independence, JAVA was used as programming language. The architecture of the tool consists of three layers that are shown in Figure 31. At the lowest layer, functionalities for loading and storing of model data are available. Two file formats are supported, the ARIS Markup Language (AML) and EPC Markup Language (EPML). The second layer contains concepts and algorithms which support the analysis of individual enterprise models and the derivation of a reference model. The top layer contains functions for model representation and browsing of repositories and functions to explain the derivation process.

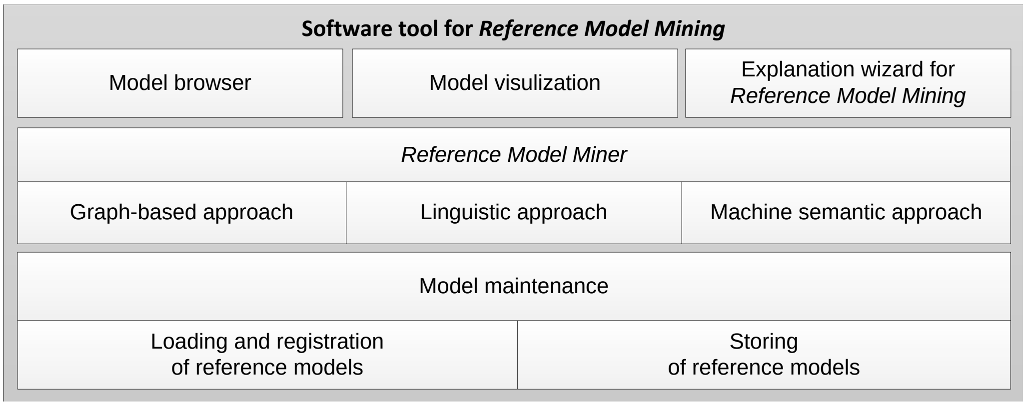

Figure 31: Architecture of the Reference Model Miner

12.4.2 Application scenario

The application of the presented method is demonstrated below with an example. Since the development of a reference model remains a complex task, which may be seen as an independent research result, the following application scenario is primarily intended to be an illustration of the method.

One of the main problems in reference modelling is the identification of elements that describe same activities. But if neither a definition of similarity of activities exists nor similar activities can be identified, it is almost impossible to calculate the similarity of processes. By the comparison of structural aspects, it allows to get rid of vocabulary problems and to concentrate on structural analogies between models. A graph-based measure was introduced which is independent of equality definitions for elements (Walter et al., 2012). Hereby, (subgraph) isomorphisms are used to determine structural analogy of two EPCs (cf. Figure 32). The advantage of this technique is that information can be extracted without previous knowledge about the equality of elements. Obviously, both EPCs are complete *structural analog* although they describe different processes. This characteristic can be used for reference modelling.

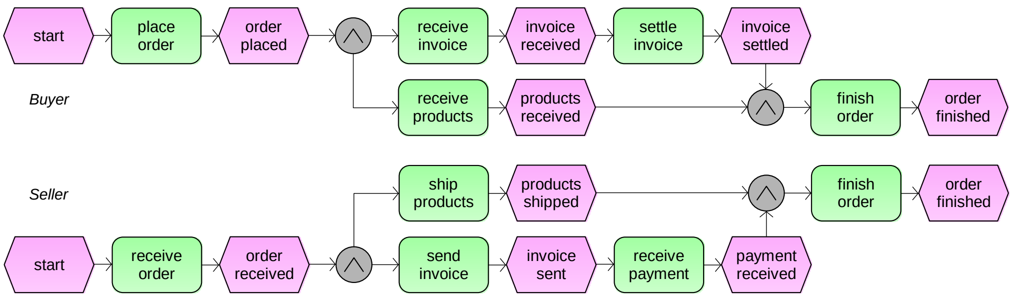

Figure 32: Structural analog process chains

12.5 Conclusion and future work

Reference modelling offers several advantages for the practice of enterprise modelling. However, these benefits can only be used if well-performing reference models are available. While the predominant methods are almost exclusively based on deductive approaches, our work presents an inductive approach. Although this method does not support a pure algorithmic approach, it can still significantly support the modeller in the reference model development. This potential support of reference modelling is particularly attractive, since neither a deductive nor an inductive strategy has clear advantages. Consequently, in practice of reference modelling, it is suitable to combine both strategies. For future work the following interesting starting points can be mentioned:

- development of performance concepts for an inductive reference modelling,
- wide application of the method to gain more experience in terms of performance and
- application of the inductive method to develop new reference models.

13 BPM in the IT factory – Challenges for the Future

Holger Schrödl, Otto-von-Guericke University Magdeburg, Chair of Business Informatics, Magdeburg Research and Competence Cluster VLBA, Magdeburg, Germany, holger.schroedl@ovgu.de

13.1 BPM in the Context of current Data Center Management

In the early 80s, the American and European automotive industry were characterized by a high proportion of self-manufacturing. Nearly 40 percent of production takes place in the manufacturers themselves. Suppliers have played a much smaller role than today. Then, the Western automotive industry has been challenged by the unexpected competition from Japan. The local auto manufacturers were able to produce quality vehicles at relatively low cost. Their benefits were primarily, that their production and work organization was more effective than their Western competitors and that parts of them were outsourced to production to subcontractors (Lean Production). The basis for such cooperation was essentially the standardization of processes and components. Similar problems as the automotive industry in the 80s today is IT: It is faced with global competition in the operation of application systems, servers, networks, etc. Emerging markets in India and China are leading induced by increasing the comparability of services to users of IT services and putting costs pressure on their services. At the same time, the management of the CIOs expect that the price reduction is reflected in the IT service costs and either the total IT budget decreases or increase quality and value proposition of IT significantly.

The use of such economies of scale is a professional management of IT, regardless whether it is the IT service provider or the CIO organization. It can be established concepts and methods from the industrial production of goods and services from the management transferred to IT. For example, an end-to-end application of the Six Sigma concept may lead to significant successes, who rated the IT service processes from the user to the IT service provider in this manner, can significantly increase the quality of service. The well-known methods from the industrial business process of cost accounting lead to more transparency. Production planning systems (PPS) guarantee higher utilization rates and will lead to more efficient IT operations. Especially in industrial goods production in the last century a new phenomenon was observed: there Industrialization led to large productivity gains. Increasingly, external and internal IT service providers are trying to reproduce this development. This development has significant implications on future business process management for IT service providers.

13.1.1 Approach to an aligned BPM for future Data Centers

To elaborate on this phenomenon, a structured approach in conducted to investigate the concepts and opportunities of industrialization on IT service providers. This is done by taking the concept of supply chain management as research framework. Supply chains are networks which organize manufactures, service providers and distribution sites that supply raw material, perform a transformation of raw material into both intermediate and finished products and distribute them to the customers (H. L. Lee & Billington, 1992). Supply chain management (SCM) denotes all task related to manage the supply chain like planning and control, organizational structuring, product and information flow facility structure, management methods and risk and reward structure (Cooper, Lambert, & Pagh, 1997). With regards to a short term perspective, supply chain management is primarily to increase productivity, reduce inventory and inventory cycle times. On a long term perspective, supply chain management should lead to increasing market share, customer satisfaction and increasing profits for all participants in the supply chain (Tan, Kannan, & Handfield, 1998). Therefore, this concept might be useful to examine the first preliminary ideas.

13.1.2 BPM in SAP UCC Magdeburg Data Center Management

SAP UCC Magdeburg is a university data center, which offers worldwide IT and support services. Mainly, this includes IT and support services for the design and provision of learning environments for SAP products. These learning environments, which consist essentially of a script learning (curriculum) and a customized SAP installation, will be made worldwide from a central data center for universities and educational facilities. IT services range from the simple provision of an already existing learning environment that can be accessed by external educational institutions on demand to the redesign of learning environments, which is a project in the classical sense. The whole service provisioning is divided into a service team, all working at one location and perform the various task areas. Overall, the data center goes away as modern IT-Factory with the aim of creating an optimal performance over a diverse catalog of offerings.

13.2 Transition of Data Center Management

First efforts have shown, that it might be appropriate to transfer concepts and models from the traditional industrial environment to the context of IT service providing. To elaborate on this issue in a structured approach, a conceptual model of IT service providing in an industrial environment is proposed.

13.2.1 IT Factory

This model was build first on the four industrial principles standardization and automation, modularization, continuous improvement processes and focusing on core competencies. Second, a core concept of ITIL was taken. Following this aspect, there is a direct link from business services, which represent the customers' aim, to the required IT resources by linking them together through IT services. These IT services are linked to the business services through a business service catalogue and are linked to the IT resources through a technical services catalogue. Third, the core concept of SCOR was taken to achieve a holistic approach to IT service providing. The result of combining these three concepts to one conceptual model is displayed in Figure 33.

13.2.2 SCOR Alignment

The growing market acceptance and the first successful demonstration projects show, that industry aspects in IT service providing have a growing influence on the design of IT services itself and IT resources used to provide these services. Now companies are raising the question of how to achieve this issue to achieve sustainable competitive advantages. For this purpose, the five key processes of the SCOR model in the context of the proposed conceptual model are considered separately. The framework chosen for such a holistic approach is the SCOR model (Supply Chain Operations Reference-model) (Poluha, 2005). This model was designed by the Supply Chain Council as a reference model for describing business processes in the Supply Chain (Supply Chain Council, 2008). It draws on both corporate as well as enterprise-wide business processes described. SCOR has established itself as a model for the market, especially shown by the fact that more than 1000 companies worldwide have joined the Supply Chain Council. The active development of the model currently in Version 10.0 highlights the efforts to establish the SCOR model as a standard in a growing market. It is not only relevant to look at complex supply chains, but it also offers the opportunity to improve basic requirements, which contributes significantly to the acceptance of the model. The SCOR model includes five key supply chain operations Plan,

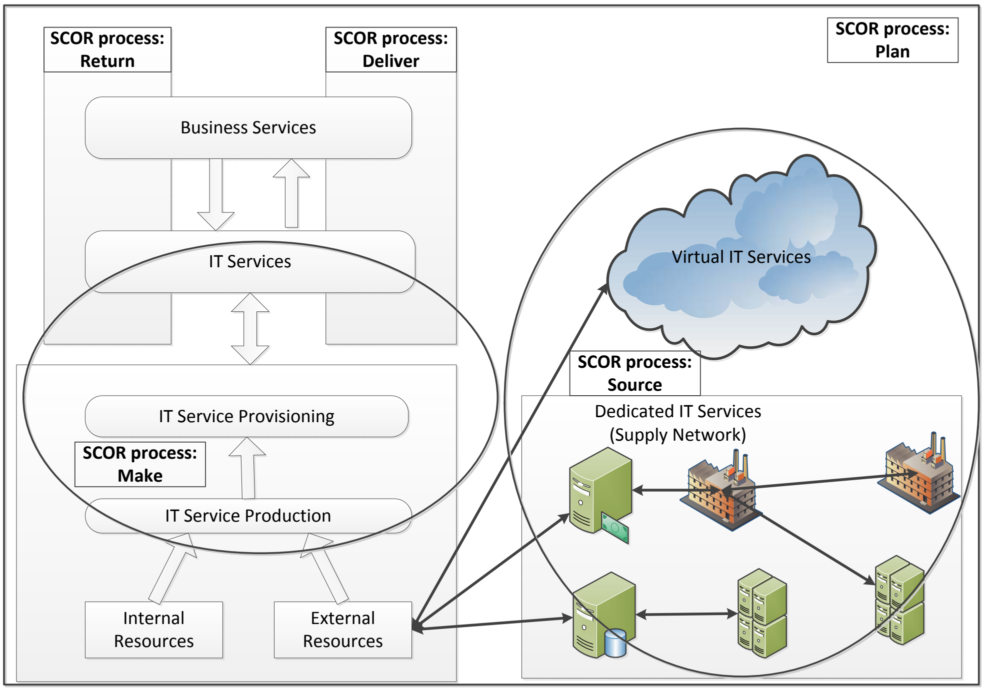

Figure 33: Conceptual model of an IT factory

Source, Make, Deliver and Return and is organized into four levels of observation: process level, configuration level, process element level, and implementation level.

13.2.3 Industrialization of IT Services

Some year ago, the first discussions about the industrialization of IT service providing were started in practice as well as in the scientific community (Brenner, Ebert, Hochstein, & Übernickel, 2007; Lamberti, 2004; Mertens, 2006). The base of these discussions was the enormous success of industrialization achievement in traditional industry sectors. According to Brenner et al. (Brenner et al., 2007) there are four principles, which are responsible for the success of industrialization in traditional industry sectors:

- *Standardization and automation:* Production costs of products may be decreased significantly through increasing the proportion of standards in products as well as in business processes. Central factors of the production processes are division of labour and assembly line production.
- *Modularization:* Dividing products in modules and components enable a customization of a product although production process are highly standardized. This leads to a customer-oriented production with low production costs.
- *Continuous Improvement Processes:* By means of various quality concepts like Kaizen, TQM or Six Sigma companies tried to improve their production processes. Furthermore, companies used these quality concepts to enable the measurement of the quality improvement.
- *Concentration on core competencies:* During the last decade, companies have decreased their vertical range of manufacturing. Inefficient production steps have been outsourced to other providers with a higher potential for specialization and scale effects.

Looking at these four principles from an IT service perspective, one can see, that in the IT industry, there are already several concepts, which might be appropriate to serve as an enabler for the accordant industry principle cf. Table 9:

Industry principle	IT concepts
Standardization and automation	Cloud Computing, IaaS, PaaS, SaaS, CMMI, ITIL, COBIT
Modularization	Virtualization, Grid-Computing, Blade-Computing, Utility-Computing, SOA
Coninuous Improvement Process	SLA, OLA, CIO, Sig Sigma
Concentration on core competencies	IT-Outsourcing

Table 9: IT concepts aligned to industry principles according to (Brenner et al., 2007)

Mertens (Mertens, 2006) has provided a first structural model of an IT service provider as a so-called "IT-factory". For this structural model, relevant processes were identified and put in the context of a production environment of IT services (see Figure 34). This model shows a first idea about how to develop a holistic concept for the production of IT service processes in an industrial way. Reflecting these first results it seems, that the adoption of industrial principles to the IT service industry is fairly straight forward. But, on the other hand, there are some differences and restrictions. From the perspective of generating IT services, there are differences in the development processes and production processes for material goods and products which have an intangible outcome like IT services (Böhmann & Krcmar, 2007). Intangible goods are simply to re-produce with no or small production costs (Picot, Reichwald, & Wigand, 2010), they are in general not stockable (Engelhardt, Kleinaltenkamp, & Reckenfelderbäumer, 1993).

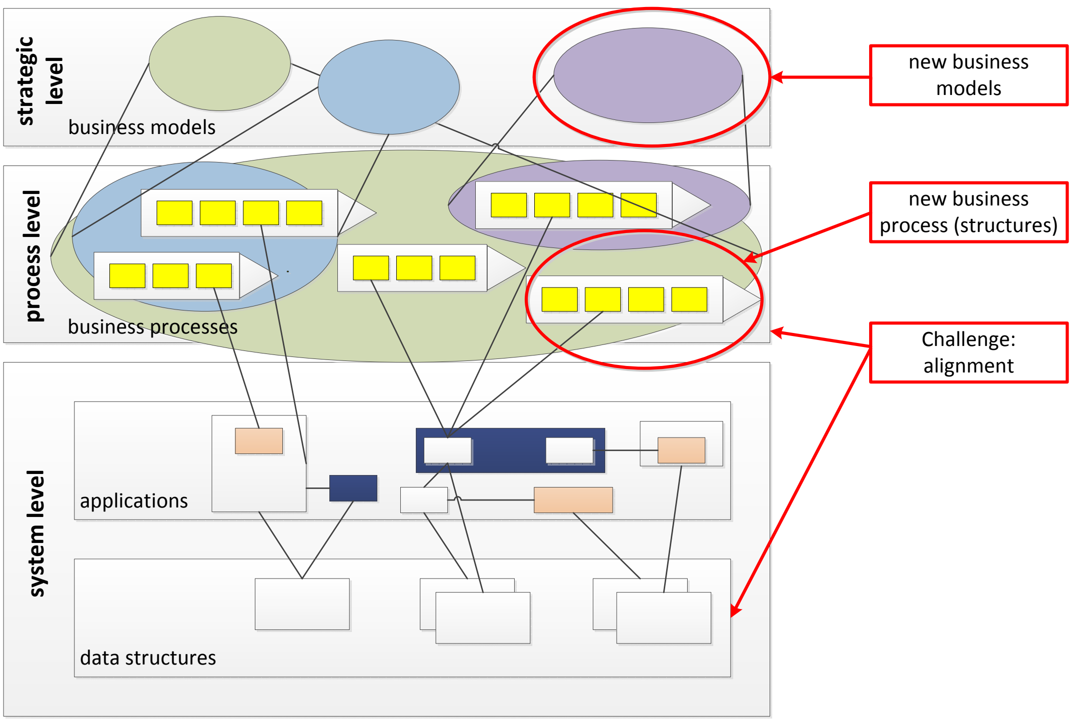

Figure 34: UCC learning aligned to (Österle & Winter, 2003)

13.3 Learnings from BPM in SAP UCC Magdeburg

From the insights of the UCC, several implications and issues can be observed. It can be stated, that in a data center environment, new business models occur. These business models consist of fragmented service providers, providing one ore multiple IT services. New business processes with complex structures, e.g. federated business processes with divergent ownership, are fundamental for these new business models. Current data centers are usually ITIL aligned to ensure the proper process management. But even in a mature alignment of data centers related business process to ITIL, challenges occur, e.g.:

- Manual transition of decisions in business processes to technical execution (this is not a "tools" question, rather a modeling question)
- How to distribute new and existing SAP instances?
- When to scale out for new infrastructure?
- How to implement new business models efficient?

From these general learnings, several specific questions arise. Two of the will be discussed in the following section.

13.3.1 Challenge 1: Stock Management

A first example for the paradigm shift of traditional business processes towards an IT factory is the example of stock management. In classic industries, stock management is used to guarantee the proper fulfillment of customer requests for certain products. But also in the IT industry, is it necessary to fulfill the customer requests for certain products in the required time frame. To illustrate this, the example of "Storage-as-a-service" as IT serviced provided from a data center is used. Data centers providing storage to their customers are trying to optimize between having enough storage in place for the current demand and the expected demand in the near future without having too much storage available due to occurring costs and technological developments. From a classic point of view, this is stock management for the product "storage-as-a-service". Coming from a classical perspective, several questions would arise:

- What is "stock" for this product?
  - Hard disks in the cellar?
  - Free disk space?
- How to get insights in the future demand?
  - Planning process for future demand?
  - MRP (material resource planning)?
- How is the economic situation?
  - Make or Buy strategy available?
  - Scale out dimensions?
  - Business model?
  - Calculation dimensions?

Changing the product to "ERP-as-a-Service": what does stock management mean in this context? And how have business processes and business process management have to be adopted to these needs?

13.4 Challenge 2: Service Return

The orchestration of application modules is a promising method to obtain highly dynamic, purpose-oriented business applications (Buyya, Yeo, & Venugopal, 2008). But cloud providers are not really prepared to extract data in a way, that the data can be used seamlessly by another application (Böhm, Leimeister, Riedl, & Krcmar, 2009). Furthermore, Business applications are highly stateful (Walker, 2007) and concerning the time aspect of transition from one provider to another, the states of the business processes have to be considered to ensure proper condition in the target system In short: what does “returning a service” mean in the context of business applications? The return processes include the return and the withdrawal of unwanted or no longer needed goods. Return in IT industrialization means ending of services, service level agreements and similar concepts. It also means to get data back and business process components to build a similar service in another environment. In IT industrialization, the topic of return is not discussed at all at the moment. Due to the absence of substantial concepts, this will be part of future research.

13.5 Implications / Issues

From the reflections on the paradigm shift in data center management and the observations of the UCC Magdeburg, several implications arise. They can be summarized as follows and should be addressed in future research on business process management in the context of data center management:

- Enhancement of “planning constructs” in BPM for data centers
  - Best practices model constructs for data center BPM?
- In general: developing new constructs for transferring concepts from the production industry into the context of service providing / IT factory
  - How to identify successful concepts in the context of service providing?
- Tighter integration between people processes and “machine” processes
  - data and process standards?
- Improvement of decision modeling and decision execution
  - Decision modeling in a technical context?
- Common agreed semantics data models for people-technology integration
  - How to model data and processes for stock management for IT service products?

14 How to implement BPM using SAP Process Integration and SAP Business ByDesign

- **Holger Wittges**, Technische Universität München, Munich, Germany, holger.wittges@in.tum.de
- **Harald Kienegger**, Technische Universität München, Munich, Germany, harald.kienegger@in.tum.de
- **Helmut Krcmar**, Technische Universität München, Munich, Germany, helmut.krcmar@in.tum.de

14.1 Motivation

The basic goal of this paper presented in the PropelleR Workshop Modeling Breakout Session is to start a discussion with lecturers at German and Russian universities how to integrate practical aspects of Business Process Management (BPM) into curricula at university level. On the one hand there is a lot of research on BPM but only few researches on how to apply this knowledge for hands-on teaching with real enterprise systems. Therefore in this paper we'll have a look at the "implementation" phase of the PropelleR framework (cf. Figure 35) and present some ideas how SAP© solutions addressing the BPM topic and how lecturers may integrate them in university curricula.

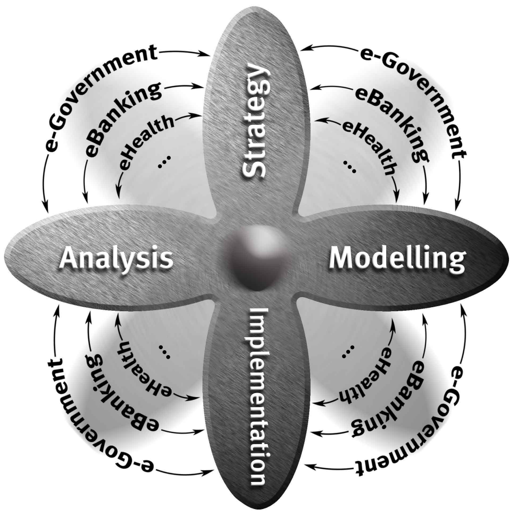

Figure 35: PropelleR framework (Source: PropelleR Workshop Handout)

There are a lot of challenges in BPM implementations like:

1. How to transform an informal, semi-formal or formal BP-Model to an executable model?
2. What are appropriate tools?
3. How to set-up a BPM implementation infrastructure for research and teaching?

On the first challenge you find some ideas in (Wittges, 2005). Here we want to focus on the second topic "tools" and make some comments on the third "setup".

14.2 BPM tools

There are lots of “BPM tools” on the market with very different support-focus, usability, stability and practical relevance. SAP AG offers various solutions in this context. You can distinguish SAP solutions in two categories “On Demand” and “On Premise” solutions (cf. Figure 36).

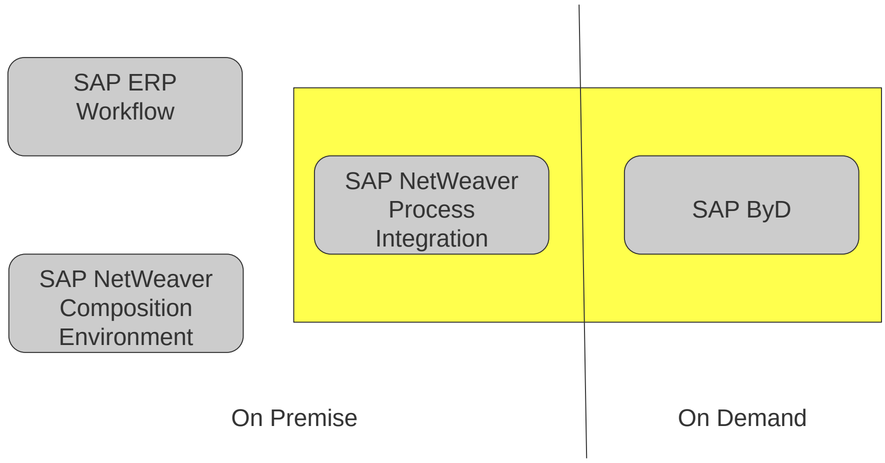

Figure 36: Important SAP© BPM related tools available within the SAP University Alliances Program

As the authors work within the SAP University Alliances Program (UA Program) and have some experiences with SAP related BPM tools they presented one “On Premise” and one “On Demand” BPM related SAP solution. The SAP ERP workflow is part of the SAP ERP [8] and covers a Workflow Management System (WMS) integrated within the core of SAP ERP. It is a very stable system but does not reflect the state of art you would expect, especially for workflow design and workflow integration using XML and Web-Services. The SAP NetWeaver Composition Environment is a quite new solution and part of the SAP NetWeaver stack. It allows you to integrate SAP functions into the SAP Portal Environment. We focus here on the SAP NetWeaver Process Integration, as this is a proven and compliant tool supporting many standards (such as XML, SOAP, UDDI) and provides many technical aspects of BPM implementation. On the other hand we'll have a look at SAP Business ByDesign, as this latest ERP system development from SAP especially supports the configuration and functional implementation of BPM, based on a very flexible adaptable ERP On Demand solution.

14.2.1 SAP NetWeaver Process Integration (PI)

SAP PI offers a set of tools which support BPM in implementing business processes. An overview of the SAP PI architecture is presented in Figure 37. The core component is the Integration Server which is responsible for processing (for example XML-coded) messages from different sources at runtime. The Enterprise Services Builder (ESB) is used to define (simple) services that are put together in the Integration Builder to implement more complex business processes.

A comprehensive description on SAP Netweaver PI can be found at (SAP AG, 2012b). Special teaching materials can be found within the SAP University Alliances Portal see: `http://scn.sap.com/community/uac` or in (Nicolescu et al., 2010).

The available material can be used to show students how for example an Event-driven Process Chain (EPC) representing a sales business process can be (mostly manually) implemented using

[8] The latest version of SAP ERP is called SAP ERP 6 EhP 6 also known as SAP Business Suite 7 (May 2012).

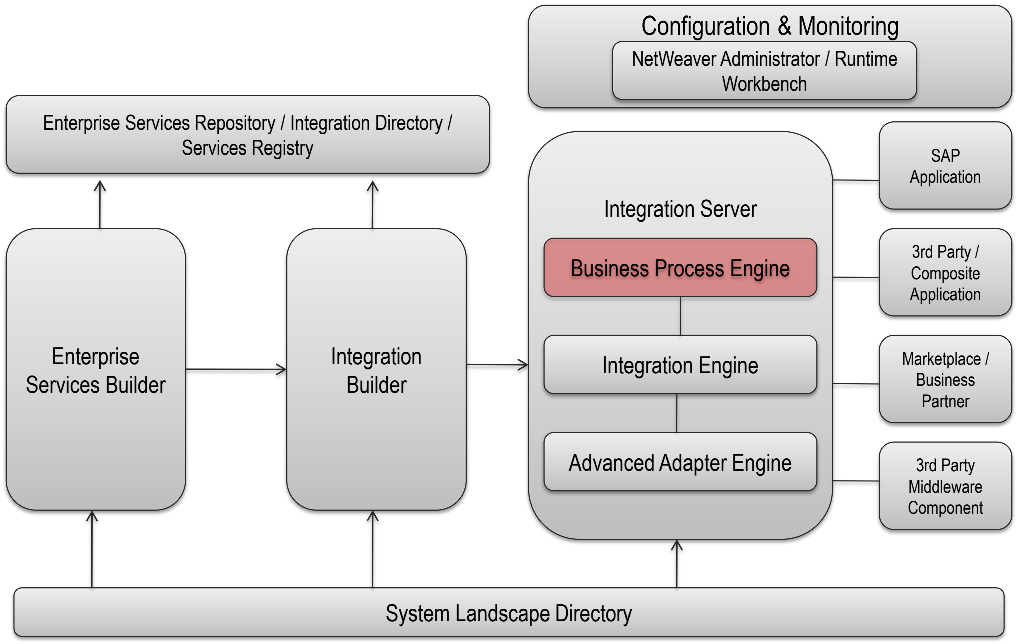

Figure 37: SAP NetWeaver process integration architecture (Nicolescu et al., 2010)

SAP PI. In order to use this solution in teaching fundamental JAVA and/or ABAP programming skills are required.

In general, there are four main challenges related to the integration processes:

1. Application-to-Application (A2A) processes
2. Business-to-Business (B2B) processes
3. Business Process Management (BPM)
4. Enterprise Services

Here, we are focusing on the BPM part using SAP NetWeaver PI to model, configure, execute and monitor processes. In complex system processes, stateless message processing on the Integration Server is not always sufficient. At design time, developers implement so called integration processes in the Enterprise Services Repository (ESR) to correlate messages and handle more complex processes using loops. At configuration time, the modeled processes are imported into the Integration Directory (ID) and adapted to the specific system landscape. At runtime, the Integration Server executes these processes on the Business Process Engine (BPE) and stores information about already started and ongoing processes. The implemented processes are usually based on the message processing of the different applications in the system landscape (Nicolescu et al., 2010).

The ccBPM (cross-component Business Process Management) is responsible for integrating processes that can be implemented within one company or across several different companies. For that purpose, the BPE is used to merge individual transformations that were implemented using the Adapter Engine and the Integration Engine to a business process. The Business Process Execution Language (BPEL) is used to describe the business processes. As shown in Figure 38 the process models are created via a graphical editor.

In contrast to the SAP Business Workflow, the BPE communicates with application on backend

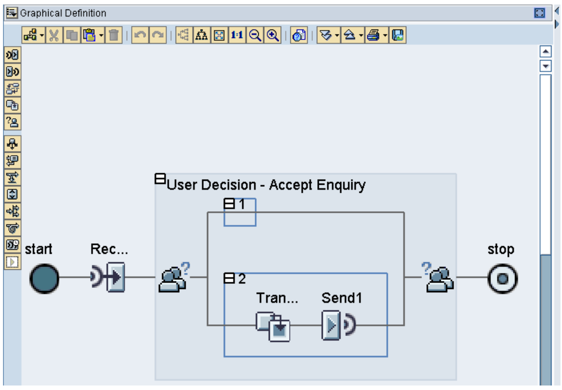

Figure 38: Graphical definition of processes during design time

systems exclusively using messages [9]. It has no access to processes, the user or organizational management within the application system. However, the BPE is closely connected to the workflow engine of SAP systems (such as ERP systems). At runtime, workflows are automatically generated from integration processes that are running on the affected application systems (e.g. SAP ERP). An integration process may send messages to the workflow engine; it can also process messages from the workflow engine.

14.2.2 SAP Business ByDesign

SAP Business ByDesign is an On Demand ERP solution. It covers the most common ERP processes (like procurement and sales) and is accessible by a modern, easy to use Web User Interface. The core functions are presented in Figure 39.

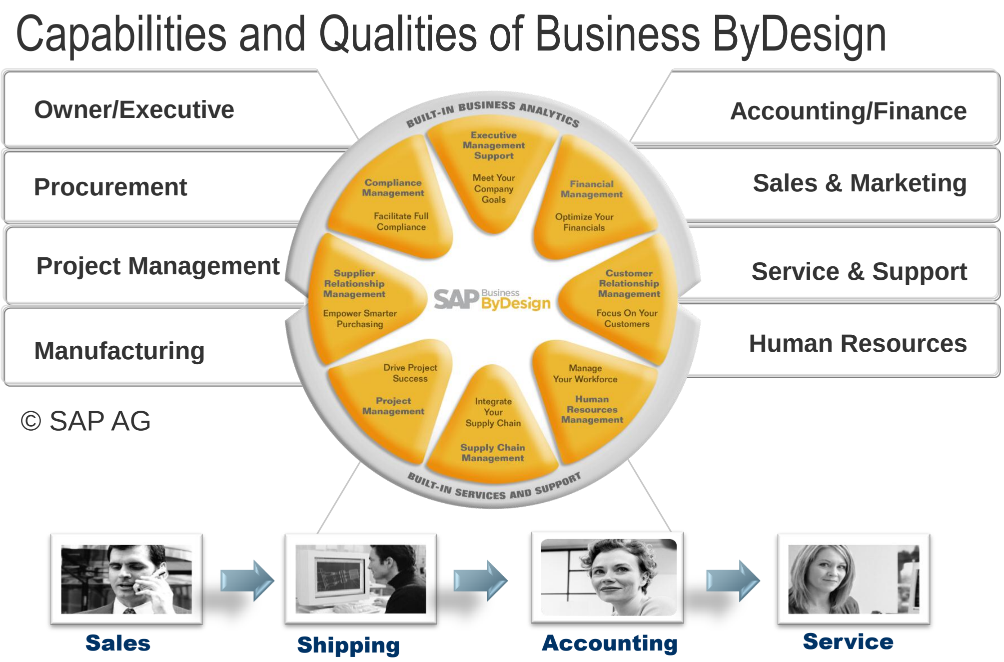

Figure 39: Core functions within SAP Business ByDesign©

[9]More information about this topic can be found in the SAP Help Portal (`http://www.help.sap.com`).

The most comprehensive online documentation of SAP Business ByDesign is accessible from the ByDesign Web Interface. A short overview is online available at (SAP AG, 2012a). Special teaching material can be found within the SAP University Alliances Portal see: `http://scn.sap.com/community/uac` or in (Konstantinidis, Kienegger, Flormann, Wittges, & Krcmar, 2012).

When teaching BPM implementation SAP Business ByDesign can be of interest, if you want to show how business processes can be implemented by customizing predefined content within the SAP ByDesign implementation process called "scoping". Based on this scoping the appearance of the Web-Interface, Workcenter, Workflow, Embedded Analytics and available Collaboration tools will be defined. This can be done without detailed programming skills, but a very good understanding of the business process itself and the functionality of SAP Business ByDesign.

Following, we're focusing on the implementation of business processes within the SAP Business ByDesign system. As already mentioned, with SAP Business ByDesign SAP offers a cloud based ERP solution for small and medium sized enterprises. The SAP Business ByDesign Go-Live Methodology is designed to simplify the process of implementing and going live with the Business ByDesign solution. The methodology contains project phases, workshops, accelerators, acceptance checkpoints, streams and project tasks. The SAP Business ByDesign Go-Live Methodology consists out of four project phases (Prepare, Fine-Tune and Integrate & Extend, Test and Go-Live). The most innovative part of the implementation of the Business ByDesign solution is the system inherent steps which guides the users through the implementation directly in the system (so called Business Configuration). At the beginning, during the so called "Scoping phase" the functionalities of the system are defined. Here, customers can decide whether they want to implement a specific functionality (e.g. Financial Accounting, Workforce Administration etc.) or not (cf. Figure 40). The system automatically checks the validity of the selected functions and helps users by auto-selecting other, depended functions to ensure a correct implementation.

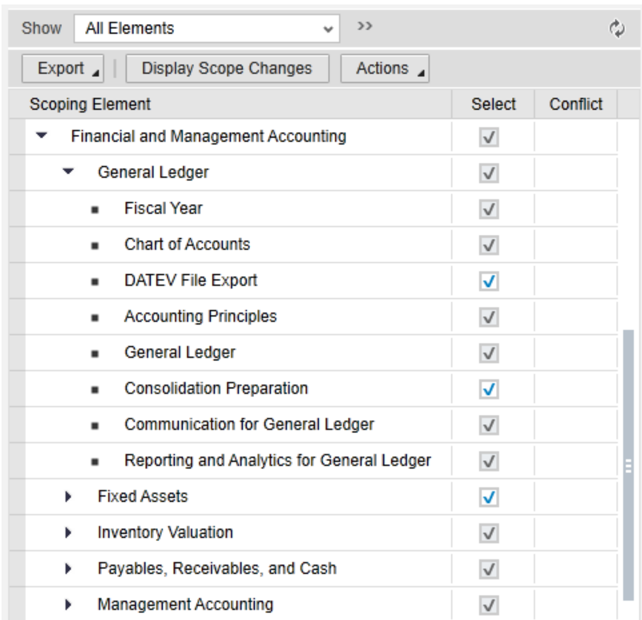

Figure 40: Define scope of the Business ByDesign solution

Based on best practices, business processes are implemented for the selected functions. In the following steps, the responsible users are able to specify or adapt the business processes for the organization's purposes. Exemplified on the Financial Accounting part, if the general ledger function was selected, the system asks you in the following step for the accounting standards the organization is working with. After this, the system creates automatically a pre-configured chart of account. During the phase of Fine-Tuning, this chart of account may be adapted (extended) for specific business needs. During the Fine-Tuning phase the pre-configured scope of the solution can be adapted more precisely. The Fine-Tune aspect focuses on the system related activities. The organization structure is established and all system settings are completed. During this phase, all mandatory configuration activities are organized in a logical sequence. It allows the user to tailor the solution to the specific need of the organization. The Integrate & Extend aspect targets the custom content development (if applicable) and the data migration tasks.

14.3 Infrastructure Setup

If someone is interested in using mentioned SAP solutions in research and teaching they can get in contact with the global SAP University Alliances Program headed in Walldorf [10]. In order to reduce the hosting and support complexity for you SAP works globally together with five SAP University Competence Center in Brisbane, Chico, Magdeburg, Milwaukee and Munich. The idea behind this cooperation is described as an “Adaptive Infrastructure” for Education Service Providing (Mohr, Simon, & Krcmar, 2005).

In 2012, there are more than 1,000 educational institutions [11] using SAP solutions in research and teaching, so that it is most likely, that you’ll find peers to exchange with.

A good starting point to figure out, what is going on is: `http://www.sap-uac.com`.

[10]See: `http://www.sap-uac.com` (last access June, 16th 2012).
[11]See: `http://uaaroundtheworld.informatik.tu-muenchen.de/overview(bD1lbiZjPTEwMQ==)/start.htm` (last access June, 16th 2012)

15 Agile Social Business Process Management using Sensor Technologies and Web 2.0

- **Constantin Houy**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, constantin.houy@iwi.dfki.de
- **Markus Reiter**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, markus.reiter@iwi.dfki.de
- **Peter Fettke**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, peter.fettke@iwi.dfki.de
- **Peter Loos**, Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI) and Saarland University, Saarbrücken, Germany, peter.loos@iwi.dfki.de

Abstract

Business Process Management (BPM) has become an intensely investigated field of research in recent years and, furthermore, BPM methods and techniques have gained more and more importance for organizational practice. However, even if common BPM methods and techniques have reached a certain state of maturity, there still exist a number of shortcomings concerning exception handling, a cross-organizational management of business processes and continuous process improvement issues. This article presents a selection of results of the recently finished consortium research project PROWIT funded by the German Federal Ministry of Education and Research (BMBF). To contribute to the betterment of the mentioned shortcoming, the PROWIT prototype integrates BPM techniques with synchronous and asynchronous telecommunication technologies, Web 2.0 functionalities as well as heterogeneous sensor technologies in order to support a more agile management of business processes.

15.1 Introduction

The methods and techniques of Business Process Management (BPM) have been intensely investigated in the Information Systems (IS) discipline in recent years and have, furthermore, gained more and more importance for organizational practice (Scheer & Brabänder, 2010). These methods and techniques as well as adequate BPM software tools are supposed to support organizations in sustaining their competitive advantage (Hung, 2006) while focusing on the design, enactment, control and analysis of business processes in order to facilitate an optimized value creation (van der Aalst et al., 2003). However, even if common BPM techniques have reached a certain state of maturity and their usage supports a better efficiency and effectiveness of business processes, there still exist a number of shortcomings concerning exception handling (*ad-hoc processes*), the support of agile communication and collaboration in processes as well as communication-related issues regarding continuous process improvement. An important reason for these shortcomings can be found in the fact that many BPM systems (BPMS) do so far not integrate and support process-related communication functionalities. This is remarkable as the execution of business processes is significantly bound to a target-oriented information exchange between all stakeholders, which is also the reason why the exchange of information is regarded as one of the three major types of interactions in organizations, besides the exchange of products and services and monetary assets (Scheer, 1999).

In the following, a selection of major outcomes and results of the recently finished consortium research project *Process-oriented Web-2.0-based Integrated Telecommunication Service* (PROWIT) which has been funded by the German Federal Ministry of Education and Research (BMBF) [12]

[12]Process-oriented Web-2.0-based Integrated Telecommunication Service (PROWIT), support code FKZ 01BS0833. The PROWIT consortium consists of Software AG (project leader), IMC AG, KAESER KOMPRESSOREN GmbH, KOM

are presented. In this research project, the mentioned shortcomings of common BPM methods, techniques and tools resulting from a missing integration of adequate process-oriented communication functionalities have been addressed based on a design-oriented research approach (Hevner, March, Park, & Ram, 2004; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007). The PROWIT software prototype integrates common BPM techniques with synchronous and asynchronous telecommunication technologies, like IP telephony, and Web 2.0 applications, like Wikis, Blogs or Social Tagging, in order to support a more agile and flexible management of business processes which can be supported by a whole community of people involved in a business process. The identification of persons in a process community, which are able to help if handling exceptions in a business process is necessary, as well as the identification of a situation-adequate means to contact these persons are supported by situation-aware context data gathered from heterogeneous soft- and hardware sensors. The evaluation of the developed PROWIT platform has been performed together with application partners from practice.

The remainder of our article is as follows: after this introduction, relevant conceptual foundations of BPM, telecommunication, context and sensors technologies are introduced in Section 15.2 before Section 15.3 presents the PROWIT idea, application scenarios, the system architecture and the prototype's user interface. Section 15.4 concludes the article.

15.2 Conceptual Foundations

15.2.1 Business Process Management and Communication

Business Process Management comprises methods, techniques and tools supporting the design, execution, control and analysis of business processes with the goal to improve value creation in organizations (van der Aalst et al., 2003). Business processes can be defined as sequences of executions in a business context based on the purpose of creating goods and services (Scheer, 1999). In contrast to the earlier approach of Business Process Reengineering (BPR) describing a radical redesign of business processes as a singular transformation (Hammer & Champy, 1993), today, BPM is commonly understood as an evolutionary improvement process (J. Becker et al., 2011). Figure 41 visualizes such a business process lifecycle.

Although communication is an essential activity in every phase of the business process lifecycle for all the persons involved in a process, e.g., process designers, executors, controllers etc. (*the process community*), today's Business Process Management Systems and organization's telecommunication systems are seldom coupled. In the context of BPM, different types of communication techniques are relevant. In order to be able to quickly communicate about and to handle exceptions occurring in a business process or in the context of cross-organizational collaboration, synchronous communication techniques like phones, mobile phones as well as some asynchronous communication techniques like instant messaging services can support a quick exchange of messages. Furthermore, in the context of continuous process improvement or the long-term coordination of cross-organizational collaboration processes, it is important to have adequate means to communicate process-related topics with many different members of a process community and to persistently document this communication. In this context, so-called Web 2.0 communication techniques, like Wikis, process-related Blogs or Twitter messages, social networking functionalities for the process community, social tagging of process models for suggesting possible improvement etc. can offer significant potential for BPM (Houy, Fettke, & Loos, 2010a). BPM can especially profit from the *collective intelligence* existing in such self-organizing process communities (Vanderhaeghen, Fettke, & Loos, 2010). There are first approaches for integrating the latter techniques into BPMS, which are commonly subsumed under the term *BPM 2.0* or *So-*

– Multimedia Communications Lab at Technical University of Darmstadt and the Institute for Information Systems (IWi) at the German Research Center for Artificial Intelligence (DFKI). Further information on the project can be found at `http://www.prowit-projekt.de/`. The software prototype can be accessed at `http://prowit-demo.de/`.

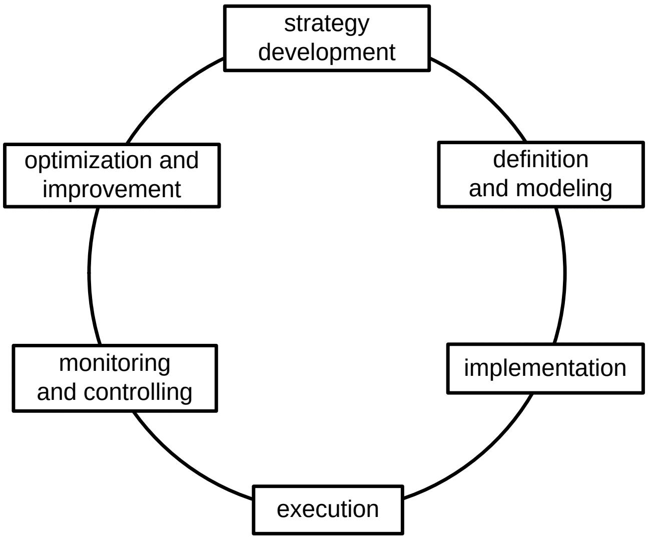

Figure 41: Business process lifecycle, according to (Houy, Fettke, & Loos, 2010b)

cial BPM (Kurz, 2011). However, it is often still up to each member of the process community to align the use of communication technology with the current process-related activity. In order to tap their full potential, the two worlds of BPM and modern telecommunication technologies have to be further integrated.

15.2.2 Context and Sensor Technologies

In order to increase the effectiveness of communication in general and to offer new services as well as new possibilities of communication, current communication technology is more and more taking the communication context of individual persons into account, e.g., the location of a person which is used for location-based services, the person's current task or the social relationship towards a communication partner (Reinhardt et al., 2010) which also offers considerable potential for agile and flexible BPM (Houy, Reiter, Fettke, & Loos, 2010).

The concept of *context* is object of investigation in a variety of scientific disciplines, such as mobile application research (Kofod-Petersen & Mikalsen, 2005) or artificial intelligence (Brézillon & Brézillon, 2008). Context has been defined as information describing the situation of entities such as persons, places or objects, which are considered relevant for users, applications or the interaction between users and applications (Dey, Abowd, & Salber, 1999). Context can be decomposed into several dimensions, like task context, social context, personal context, spatio-temporal context or environmental context (Kofod-Petersen & Mikalsen, 2005). In the range of BPM, the context of a business process or a person involved in a business process is important for achieving a better process execution quality as well as a better execution flexibility (de la Vara, Ali, Dalpiaz, Sánchez, & Giorgini, 2010; Rosemann, Recker, & Flender, 2008). In order to automatically identify the context of an entity like a person or a business process, sensor technology can be used. A sensor can detect a physical attribute which is provided as the result of a quantitative measurement (Schmidt, 2002). Two kinds of sensors can be distinguished: software sensors and hardware sensors (Schmidt, Beigl, & Gellersen, 1998). In order to identify the context of persons for BPM purposes, it is favourable to use existing infrastructure as data sources for sensors. As an example, the keystrokes on a keyboard or a moving computer mouse at a desktop PC can deliver information about the current location of the person who is logged in and working at this PC (Johnson, Carmichael, Kay, Kummerfeld, & Hexel, 2004). Such information can, furthermore, be used to recommend an adequate possibility of contacting a person in cases where a fast re-action on problems occurring in a business process is needed and the person has to be quickly contacted. Future communication systems with integrated sensors could, thus, not only be able to identify the context of members of a process community but also be able to use this context in order to recommend the best communication medium (mobile phone, fixed line, email or others) or automatically forward calls to other members of the process community with the same role in a business process, if a desired communication partner is currently not available. In the following section the basic idea of PROWIT, application scenarios, the system architecture as well as the user interface of the PROWIT prototype are presented.

15.3 Agile Business Process Management with PROWIT

The basic idea of the PROWIT software prototype is to integrate BPM methods and techniques with different internet-based communication techniques and, furthermore, using heterogeneous sensors for context determination (Reinhardt, Schmitt, Steinmetz, Walter, & Schwantzer, 2011). In order to create a software prototype which shows the potential and also the relevance of the combination of BPMS, modern communication and sensor technologies for agile BPM in practice, the project consortium identified and specified practical application scenarios as a basis for the PROWIT prototype development (cf. Figure 42). Thereby, it was important to consider the support of business processes with defined as well as undefined schemata (*ad-hoc processes*), the support of routine processes with and without exceptions as well as the support of unique business processes. In this context four relevant application scenarios in practice representing all these requirements have been identified: knowledge management in IT services, vendor managed inventory processes, the process of coordinating OEM projects and the maintenance or reparation of complex machines. These four scenarios have been condensed into one complex application scenario combining all requirements and treating customer service processes concerning complex product-service-bundles which should be supported by the PROWIT prototype.

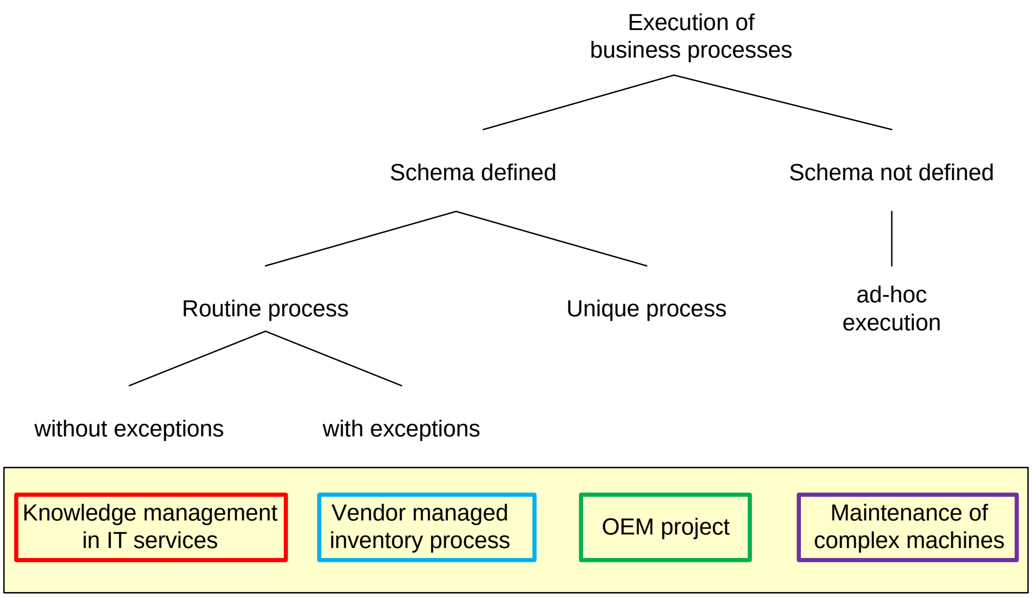

Figure 42: PROWIT application scenarios

In order to develop a flexible software prototype which can also be extended by further sensors, new BPM functionalities or new communication techniques, the PROWIT prototype has been developed based on a service-oriented architecture (SOA) using the Liferay Enterprise Portal Server (`http://www.liferay.com/`). The different functionalities for BPM, for communication and collaboration have been implemented as so-called Portlets which are loosely coupled services put together on the Liferay Enterprise Portal Server which serves as a so-called Portlet Container. This architecture also allows for integrating external BPM services, communication and collaboration services into the platform. This principle of service-oriented architectures for BPM software systems is visualized in Figure 43.

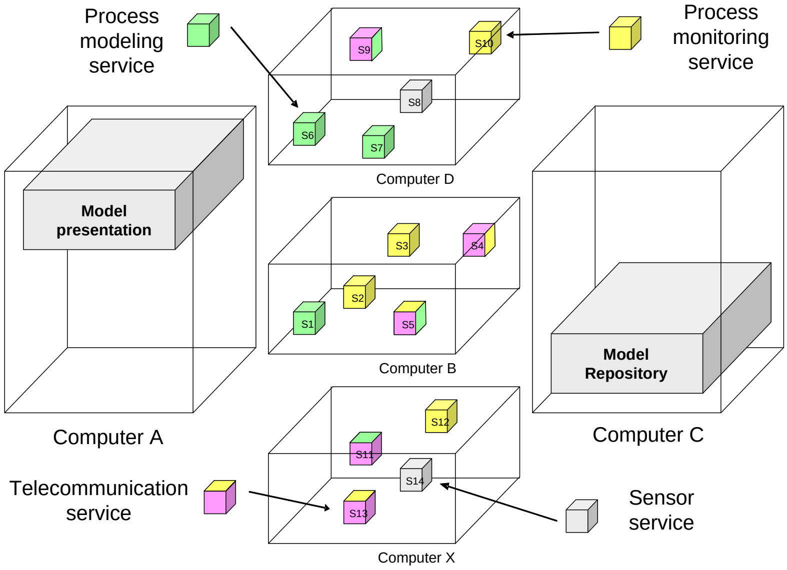

Figure 43: Service-oriented architecture for BPM software systems (Houy, Reiter, Fettke, & Loos, 2010)

The following Figure 44 presents a more detailed view on the functional systems architecture of the PROWIT prototype describing the different system layers (application, middleware, network) and the different integrated functionalities regarding the management of sensors, business logics, communication and collaboration. The application layer and communication middleware are structured in a way that different heterogeneous sensors can to a certain extent be flexibly registered at the platform during run time (Reinhardt et al., 2010).

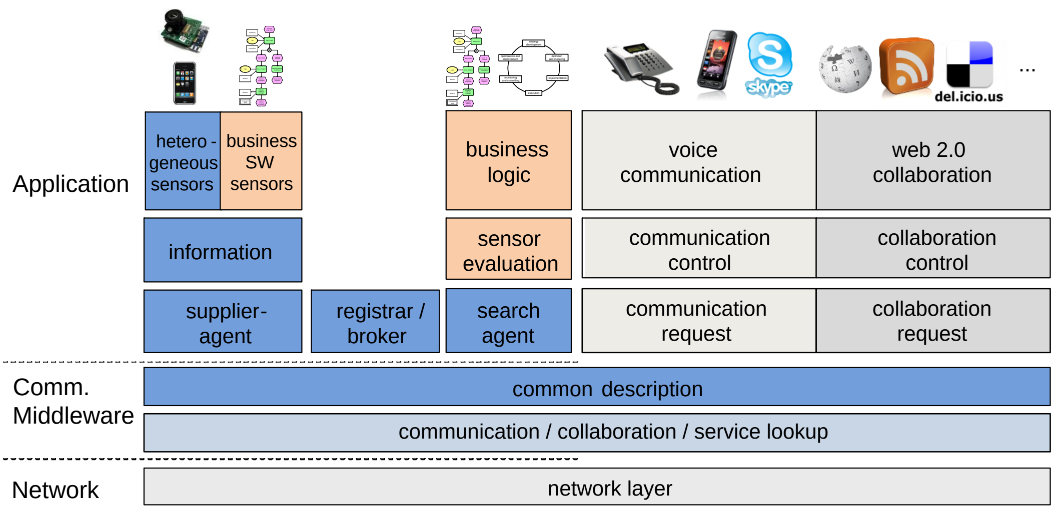

Figure 44: PROWIT architecture, based on (Hollick, Rensing, Schmitt, & Reinhardt, 2009)

Besides the seamless integration of different heterogeneous sensors it is also possible to flexibly extend the BPM, communication and collaboration functionalities of the PROWIT system by means of new portlets containing new services. Figure 45 visualizes the user interface of the

PROWIT prototype addressing our customer service application scenario. In this screenshot, portlets with related functionalities are marked in the same colour. The upper left portlet and the upper portlet in the middle (*orange*) provide workflow functionality for the automation of the process model shown on the lower left side (*red*). This process model represents a part of the customer service application scenario. In the process model the actual process step is also marked by a rectangle and relevant context information concerning this process step are given in the upper middle portlet. The lower middle and the lower right portlet (*green*) provide context information related to the marked process step of the currently executed process instance. Furthermore, they offer a contextual dynamic help system based on Wiki functionalities, e.g., concerning documented and commonly occurring problems with a complex machine of the currently served customer. The portlet in the upper right corner (*blue*) supports contacting members of the process community and provides information on their current state of availability (available, on holidays etc.). Available means of communication for contacting a member of the process community are recommended based on collected sensor data about the current context of each person. The PROWIT system allows for directly calling a person on her or his phone or mobile phone using IP telephony as well as easily contacting a person via other communication means, like instant messaging, e-Mail etc. only by clicking on a symbol representing an available means of communication in this portlet.

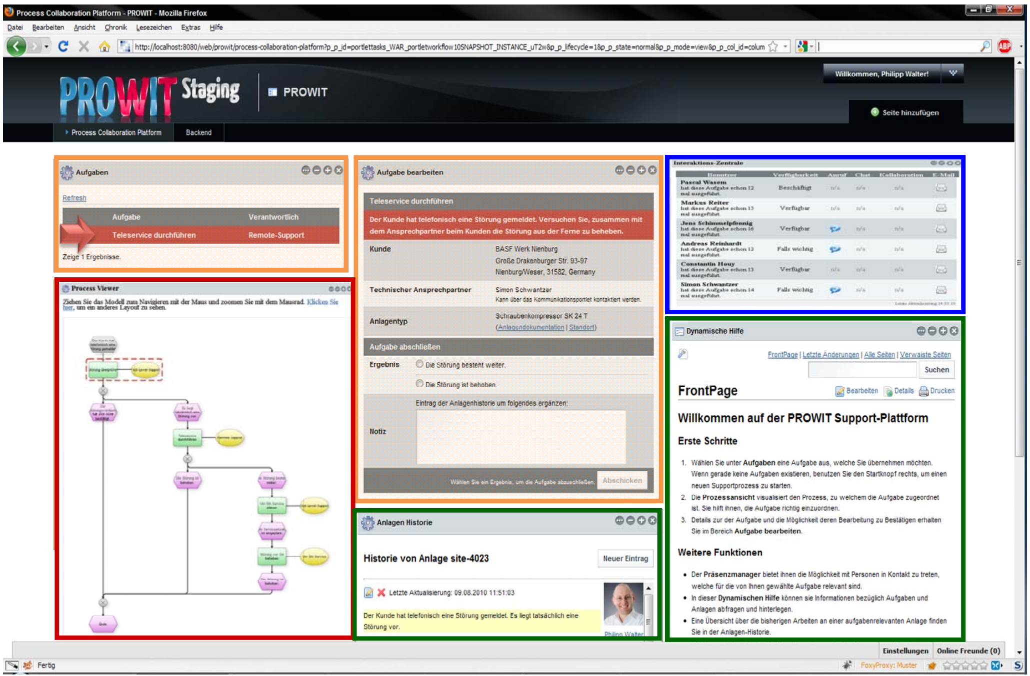

Figure 45: Screenshot of the PROWIT System

The PROWIT prototype has been tested and evaluated focussing on the implemented customer service scenario. In this context, interviews with several domain experts of the application partner showed that especially the integration of BPM, context-aware communication and collaboration were found to be very useful as a lot of highly relevant information for task fulfilment are gathered on one screen and are, thus, very easily accessible. Moreover, the web-based user interface which has also been adapted for mobile devices in order to support on-site service technicians was found to be easy to use and was in most cases found to be easily understandable without further explanation.

15.4 Conclusion

In this article we have presented a selection of results of the consortium research project PROWIT. The developed prototype integrates common BPM techniques with synchronous and asynchronous communication technologies in order to support a more agile social BPM. The identification of persons' process-related context as well as the identification of a situation-adequate means to contact persons belonging to a process community is supported by situation-aware context data gathered from heterogeneous soft- and hardware sensors. Future research has to further investigate the possibilities of combining BPM methods and techniques with modern communication and collaboration technologies in order to tap their full potential.

Acknowledgement

The research described in this paper was supported by a grant from the German Federal Ministry of Education and Research (BMBF), project name: "Process-oriented Web-2.0-based Integrated Telecommunication Service" (PROWIT), support code FKZ 01BS0833. The authors of this article would also like to thank all the project partners for the fruitful and successful collaboration in the project.

16 Business Process Management in Education – The BPM Academic Initiative

Mathias Weske, Hasso Plattner Institute for Software Systems Engineering, University of Potsdam, Potsdam, Germany, mathias.weske@hpi.uni-potsdam.de

This section introduces the BPM Academic Initiative, which fosters research and education in business process management by providing a professional process modeling and analysis tool free of charge for lecturers and students. The initiative also provides free teaching material, which is quality checked by the BPM Academic Initiative core team.

16.1 Background

Business process management (Weske, 2012; van der Aalst, 2011; J. Becker et al., 2011) plays a key role in today's university education in several disciplines. In economics and business administration, the identification and proper representation of working procedures from a business and an organizational perspective is an important topic, while information systems curricula investigate the operations of enterprises, their interplay and optimization potentials. Computer science students and software engineers aim at deriving from business process models process implementations using IT infrastructures, for instance, enterprise information systems and service oriented architectures. Process modeling is the basis in each of these scenarios, so that high-quality, practical education in process modeling plays a major role in these university programs.

Behind this background, the BPM Academic Initiative provides a professional process modeling and analysis tool free of charge for lecturers and students in academia, accompanied by a comprehensive set of teaching exercises. The teaching exercises are available under a Creative Commons license, which allows lecturers both to use the material as-is and to tailor it according to their education needs Figure 46.

The Initiative is run by business process experts from academia and from a software vendor, namely Wil van der Aalst (TU Eindhoven, The Netherlands), Gero Decker (Signavio GmbH, Germany), Frank Leymann (U Stuttgart, Germany), Jan Mendling (WU Vienna, Austria), Michael Rosemann and Jan Recker (QUT Brisbane, Australia) and Michael zur Mühlen (Stevens Institute of Technology, USA). The core team is led by Mathias Weske (HPI, U Potsdam, Germany). Since its start in autumn 2009, the initiative has been enjoying significant success. As of this writing in 2012, there are more than ten thousand users registered at the platform, and more than eighty thousand process models have been developed by lecturers and students worldwide.

16.2 Using the Platform

The process modeling and analysis tool is provided by Signavio, a software vendor based in Berlin, Germany. The Signavio Process Editor is provided as a service, i.e., it runs in standard web browsers. This means that no software needs to be installed at the client side, neither by lecturers nor by students.

To use the platform, lecturers register at http://academic.signavio.com to receive their access information. They are provided with a registration link, which they can send to their students. Students use that link to register in the work space of their respective lecturer.

This simple registration procedure suffices to invite all students to the workspace of a lecture. Re-

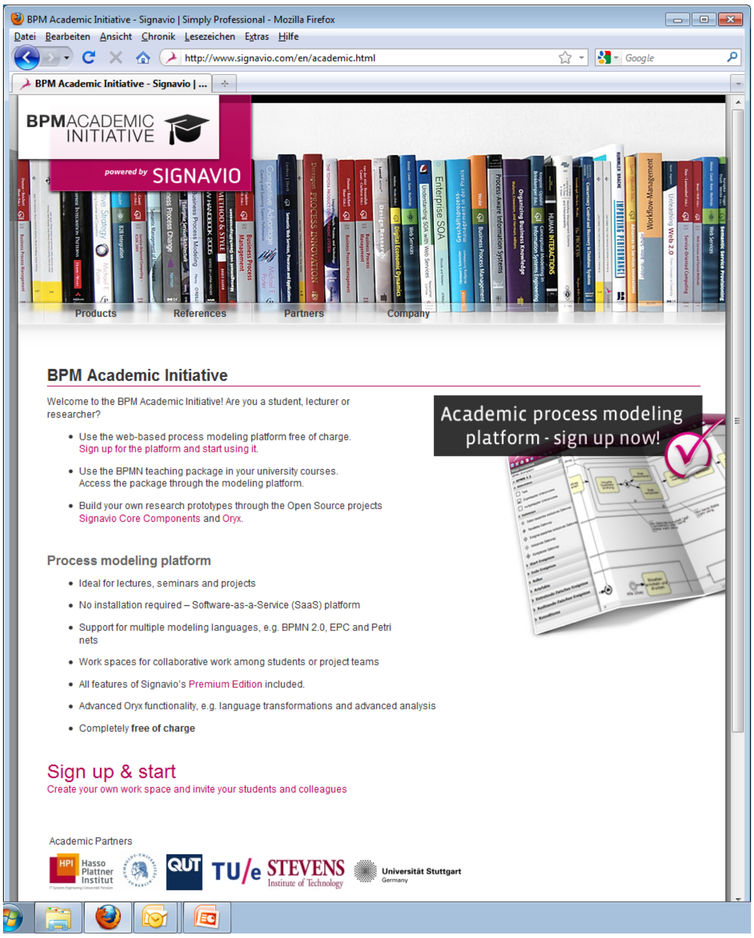

Figure 46: BPM Academic Initiative web site

questing licensing keys or installing software is not required – the current version of the software is loaded to the web browser, so that updates are instantly available to all users of the platform.

The software supports a wide set of different modeling notations. In addition to BPMN (Business Process Model and Notation) as the de facto standard in process modeling (Berliner BPM Offensive, n.d.), EPC (Event Driven Process Chains) are available. For curricula interested in formal aspects of business processes, Petri nets are supported as well. For software engineers, there are also options to model executable processes: Processes to be executed in the Activiti open source process engine or in the JBoss application server. The relationships between different business processes can be expressed in process landscapes. The system is not restricted to modeling processes: it can also be used to model use case diagrams and class diagrams that we know from the UML.

We invite members of the Propeller consortium to get involved, to register at `http://academic.signavio.com` and use the system and the teaching material provided. Especially colleagues from Russia are invited to join. The references contain a list of text books that cover different aspects of business process management and also a link to a set of BPMN posters — including a Russian version — that highlight the elements of that process modeling language.

17 Outlook: Future Research Endeavors

■ **Armin Stein**, University of Muenster, European Research Center for Information Systems, Muenster, Germany armin.stein@ercis.uni-muenster.de

On the last day of the workshop, the participants worked together on a concrete idea for project proposals. The discussion was performed under the light of the breakout sessions' findings and moderated by Dr. Armin Stein. It was stimulated by the presentation of the former PropelleR proposal handed in to the EU FP7 Theme Activities of International Cooperation under the Specific Programme Capacities in 2011.

The initial idea of the proposal was the building of a BPM center of excellence in Moscow, Russia, serving as focal area for European-Russian BPM research. By increasing the transparency of cross-national processes and making the complexity of these processes manageable, BPM not only enhances the processes effectiveness and efficiency but is also capable of strengthening the overall relationship between the EU and Russia.

Until now, the BPM stream in Russia had slightly unofficial character and was seen as something applicable only for foreign practice. Even up to 2005 e-Government as an allegory for openness and transparency of governmental business processes did not have a high reputation in Russia. However, the president of Russia just recently highlighted that the Russian economy suffers from extreme inefficiency of business processes. Competition and rapidly changing IT options are forcing both companies and governmental institutions to realise the potential benefits of BPM practice in reality.

The growing complexity needs to be addressed with a holistic approach. The PropelleR project's idea was to take the major lifecycle phases and capability areas of BPM into account:

- The overall *strategy* of any organisation, be it a single private company, a single governmental institution, or a network spanning an organisation, including both private companies and governmental institutions, has to be the main driver for the underlying business processes. Along with the strategy come the governance, the consideration of people involved as well as the organisational culture, all influencing the success of any BPM project.
- *Modelling* spans the methods required for the definition of processes, including tools and techniques. On a conceptual level, models enable the stakeholders to generate a common understanding of the "as-is" scenario or case and to build a basis for the derivation of the expected to-be realisation.
- Once conceptually designed and transferred to a desired to-be-state, business processes have to be made executable and *implemented* into IT systems, supporting the stakeholders and leading to a more consistent, efficient and transparent workflow and clarifying communication among the participants.
- Permanent improvement can be guaranteed by aligning the strategy of the organisation with the results of BP *analysis*, and passing them on to the modelling and implementation area.

Researchers from 12 different EU member states and associated countries were to be involved in the Russian competence centre building the project consortium. They were distinguished into four core and ten cluster partners. Each of the core BPM areas, such as strategy, modelling, implementation, and analysis, was to managed by one of four core partners, who are the most renowned BPM researchers in Europe. Every cluster partner was affiliated to one or more BPM core areas and was assigned to at least one of the core partners.

Not only the most important fields of application such as e-Government were to be addressed by BPM, but also related areas, such as e-Banking, e-Health, or e-Finance.

The proposal was formally rated eligible for being funded by the EU, but did not rank among th five highest rated ones and therefore was rejected. The participants supported the initial idea and agreed on continuing the efforts. According to the Strategy Session, the outcomes of the project should, however, be more in the style of a European BPM expert panel rather than a hub and spokes structured research project. The task of this panel should be the definition of a general research and education agenda for BPM scholars and practitioners in Europe.

The University of Münster as driver of the initial proposal offered to stay connected with representatives of the EU and push the efforts, involving those of the attendees agreeing to participate. The next call for proposal of the EU should be awaited and suiting funding schemes should be selected.

Additionally, the participants agreed to check funding sources for diverse project endeavors and suggest it to the community. Finally, it was agreed to initiate a shared web space for documents required for future collaboration and set up a mailing list to speed up communication.

References

Abdullah, N. S., Sadiq, S., & Indulska, M. (2010). Emerging challenges in information systems research for regulatory compliance management. In B. Pernici (Ed.), *Lecture Notes in Computer Science: Vol. 6051. Advanced Information Systems Engineering* (pp. 251–265). Berlin, Germany: Springer. doi: 10.1007/978-3-642-13094-6_21

Addo-Tenkorang, R., & Helo, P. (2011). Enterprise resource planning (ERP): A review literature report. In *Proceedings of the World Congress on Engineering and Computer Science (WCESC 2011)* (Vol. 2). San Francisco, CA.

Adesola, S., & Baines, T. (2005). Developing and evaluating a methodology for business process improvement. *Business Process Management Journal*, *11*(1), 37–46. doi: 10.1108/14637150510578719

AHConferences. (2012). *VIII BPM Forum (Business Process Management).* Retrieved from `http://www.ahconferences.com/conferences/?conf=713`

Aiken, P., Allen, M. D., Parker, B., & Mattia, A. (2007). Measuring data management practice maturity: A community's self-assessment. *Computer*, *40*(4), 42–50. doi: 10.1109/MC.2007.139

Aitken, C., Stephenson, C., & Brinkworth, R. (2010). Process classification frameworks. In J. vom Brocke & M. Rosemann (Eds.), *Handbook on business process management 2* (pp. 73–92). Berlin, Germany: Springer. doi: 10.1007/978-3-642-01982-1_4

Alexander, C., Ishikawa, S., & Silverstein, M. (1977). *A pattern language: Towns, buildings, construction.* New York City, NY: Oxford University Press.

Al-Mashari, M., & Zairi, M. (2000). Revisiting BPR: A holistic review of practice and development. *Business Process Management Journal*, *6*(1), 10–42. doi: 10.1108/14637150010283045

Aloini, D., Dulmin, R., & Mininno, V. (2012). Risk assessment in ERP projects. *Information Systems*, *37*(3), 183–199. doi: 10.1016/j.is.2011.10.001

Andersen, B. (1999). *Business process improvement toolbox* (2nd ed.). Milwaukee, WI: American Society for Quality.

Antony, J. (2006). Six sigma for service processes. *Business Process Management Journal*, *12*(2), 234–248. doi: 10.1108/14637150610657558

Ashurst, C., Doherty, N., & Peppard, J. (2008). Improving the impact of IT development projects: the benefits realization capability model. *European Journal of Information Systems*, *17*(4), 352–370. doi: 10.1057/ejis.2008.33

Awad, A., Grosskopf, A., Meyer, A., & Weske, M. (2009). *Enabling resource assignment constraints in BPMN* (BPT Technical Report No. 04-2009). Potsdam, Germany: Hasso Plattner Institute.

Axenath, B., Kindler, E., & Rubin, V. (2005). *The aspects of business processes: An open and formalism independent ontology* (Tech. Rep. No. tr-ri-05-256). Paderborn, Germany: Computer Science Department of the Unversity of Paderborn.

Bandara, W., Chand, D., Chircu, A. M., Hintringer, S., Karagiannis, D., Recker, J. C., ... Welke, R. J. (2010). Business process management education in academia: Status, challenges, and recommendations. *Communications of the Association for Information Systems*, *27*(1), 743–776.

Batini, C., Cappiello, C., Francalanci, C., & Maurino, A. (2009). Methodologies for data quality assessment and improvement. *ACM Computing Surveys*, *41*(3), 16:1–16:52. doi: 10.1145/1541880.1541883

Batini, C., Lenzerini, M., & Navathe, S. (1986). A comparative analysis of methodologies for database schema integration. *ACM Computing Surveys*, *18*(4), 323–364. doi: 10.1145/27633.27634

Beals, G. (1996). *Thomas Edison "Quotes".* Retrieved from `http://www.thomasedison.com/quotes.html`

Becker, J., Algermissen, L., & Falk, T. (2012). *Modernizing processes in public administrations.* Berlin, Germany: Springer.

Becker, J., Delfmann, P., Knackstedt, R., & Kuropka, D. (2002). Konfigurative Referenzmodellierung. In J. Becker & R. Knackstedt (Eds.), *Wissensmanagement mit Referenzmodellen.*

Konzepte für die Anwendungssystem- und Organisationsgestaltung (pp. 25–144). Berlin, Germany: Springer.
Becker, J., Kugeler, M., & Rosemann, M. (Eds.). (2011). *Process management: A guide for the design of business processes* (2nd ed.). Berlin, Germany: Springer.
Becker, J., Pöppelbuß, J., Glörfeld, F., & Bruhns, P. (2009). The impact of data quality on value based management of financial institutions. In *Proceedings of the 15th Americas Conference on Information Systems (AMCIS 2009).* San Francisco, CA.
Becker, J., Rosemann, M., & Schütte, R. (1995). Grundsätze ordnungsmäßiger Modellierung. *Wirtschaftsinformatik*, *37*(5), 435–445.
Becker, J., Rosemann, M., & von Uthmann, C. (2000). Guidelines of business process modeling. In W. M. P. van der Aalst, J. Desel, & A. Oberweis (Eds.), *Lecture Notes in Computer Science: Vol. 1806. Business Process Management: Models, Techniques, and Empirical Studies* (pp. 30–49). Berlin: Springer, Germany.
Becker, J., & Schütte, R. (1997). Referenz-Informationsmodelle für den Handel: Begriff, Nutzen und Empfehlungen für die Gestaltung und unternehmensspezifische Adaption von Referenzmodellen. In H. Krallmann (Ed.), *Wirtschaftsinformatik '97 – Internationale Geschäftstätigkeit auf der Basis flexibler Organisationsstrukturen und leistungsfähiger Informationssysteme* (pp. 427–448). Heidelberg, Germany: Physica.
Becker, J., & Schütte, R. (2004). *Handelsinformationssysteme. Domänenorientierte Einführung in die Wirtschaftsinformatik* (2nd ed.). Frankfurt am Main, Germany: Redline Wirtschaft.
Becker, J., Taratoukhine, V., Vilkov, L., & Rieke, T. (2006). Process driven value assessment of ERP solutions: An overview of the extended SAP methodology. In B. Unhelkar & Y.-C. Lan (Eds.), *Proceedings of the 2nd international conference on information management and business (IMB2006)* (pp. 225–235). Sydney, Australia.
Becker, J., Vilkov, L., Taratoukhine, V., Kugeler, M., & Rosemann, M. (2007). *Process management.* Moscow, Russian Federation: Eksmo.
Becker, J., Vilkov, L., Taratoukhine, V., & Rosemann, M. (Eds.). (2008). *Process management.* Moscow, Russian Federation: Eksmo.
Becker, J., Weiß, B., & Winkelmann, A. (2010). A multi-perspective approach to business process management in the financial sector. In R. Sabherwal & M. Sumner (Eds.), *Proceedings of the International Conference on Information Systems (ICIS 2010).* Saint Louis, MI.
Becker, W., & Dietz, J. (2004). R&D cooperation and innovation activities of firms: Evidence for the German manufacturing industry. *Research Policy*, *33*(2), 209–223. doi: 10.1016/j.respol.2003.07.003
Beimborn, D., & Joachim, N. (2011). The joint impact of service-oriented architectures and business process management on business process quality: An empirical evaluation and comparison. *Information Systems and e-Business Management*, *9*(3), 333–362. doi: 10.1007/s10257-010-0129-1
Berliner BPM Offensive. (n.d.). *BPMN Poster.* Retrieved from http://www.bpmb.de/index.php/BPMNPoster
Blasini, J., Leist, S., & Ritter, C. (2011). Successful application of PPM: An analysis of the German-speaking banking industry. In *Proceedings of the 19th European Conference on Information Systems (ECIS 2011).* Helsinki, Finland.
Böhm, M., Leimeister, S., Riedl, C., & Krcmar, H. (2009). Cloud Computing: Outsourcing 2.0 oder ein neues Geschäftsmodell zur Bereitstellung von IT-Ressourcen? *Information Management & Consulting*, *24*(2), 6–14.
Böhmann, T., & Krcmar, H. (2007). Hybride Produkte: Merkmale und Herausforderungen. In M. Bruhn & B. Strauss (Eds.), *Wertschöpfungsprozesse bei Dienstleistungen* (pp. 239–255). Wiesbaden, Germany: Gabler.
Bokranz, R., & Landau, K. (2006). *Produktivitätsmanagement von Arbeitssystemen: MTM-Handbuch.* Stuttgart, Germany: Schäffer-Poeschel.
Borisova, M. (2009). *ProveIT project: Russia and Germany exchanged their experiences.* DW. Retrieved from http://dw.de/p/HFYT
Botta-Genoulaz, V., & Millet, P. A. (2006). An investigation into the use of ERP systems in the service sector. *International Journal of Production Economics*, *99*(1), 202–221. doi: 10.1016/j.ijpe.2004.12.015

Brahe, S. (2007). BPM on top of SOA: Experiences from the financial industry. In G. Alonso, P. Dadam, & M. Rosemann (Eds.), *Lecture Notes in Computer Science: Vol. 4714. Business Process Management, 5th International Conference* (pp. 96–111). Berlin, Germany: Springer. doi: 10.1007/978-3-540-75183-0_8

Brand, N., & van der Kolk, H. (1995). *Workflow analysis and design*. Deventer: Kluwer Bedrijfswetenschappen.

Brenner, W., Ebert, N., Hochstein, A., & Übernickel, F. (2007). *IT-Industrialisierung: Was ist das?* Retrieved from http://www.computerwoche.de/management/it-strategie/592035/index.html

Breuker, D., Pfeiffer, D., & Becker, J. (2009). Reducing the variations in intra- and interorganizational business process modeling – an empirical evaluation. In *Proceedings of the Internationale Tagung Wirtschaftsinformatik.* Vienna, Austria.

Brézillon, P., & Brézillon, J. (2008). Context-sensitive decision support systems in road safety. In F. Burstein & C. W. Holsapple (Eds.), *Handbook on Decision Support Systems 2: Variations* (pp. 107–123). Berlin, Germany: Springer. doi: 10.1007/978-3-540-48716-6_6

Bunney, H. S., & Dale, B. G. (1997). The implementation of quality management tools and techniques: A study. *The TQM Magazine*, *9*(3), 183–189. doi: 10.1108/09544789710168966

Busenbach, M., Link, M., Füssel, U., & Ortner, E. (2011). BPM and MTM: Concept for continuous process management to increase productivity. In G. Lee (Ed.), *Proceedings of the 2011 International Conference on Mechanical Engineering and Technology.* New York City, NY.

Buyya, R., Yeo, C. S., & Venugopal, S. (2008). Market-oriented cloud computing: Vision, hype, and reality for delivering it services as computing utilities. In *Proceedings of the 10th IEEE International Conference on High Performance Computing and Communications (HPCC'08)* (pp. 5–13). Dalian, China. doi: 10.1109/HPCC.2008.172

Capgemini. (2011). *Studie IT-Trends 2011: Unternehmen fordern wieder Innovation.* Retrieved from http://www.de.capgemini.com/insights/publikationen/it-trends-2011/

Chan, L. K., & Wu, M. L. (2005). A systematic approach to quality function deployment with a full illustrative example. *Omega*, *33*(2), 119–139. doi: 10.1016/j.omega.2004.03.010

Chiasson, M. W., & Davidson, E. (2005). Taking industry seriously in information systems research. *MIS Quarterly*, *29*(4), 591–605.

Cnews. (2012a). *BPM in Russia: More than half of companies have already described the key processes (in russian).* Retrieved from http://www.cnews.ru/news/line/index.shtml?2012/03/27/483075

Cnews. (2012b). *Business process management: shift in focus?* Retrieved from http://www.cnews.ru/reviews/index.shtml?2012/04/02/483995

Cooper, M. C., Lambert, D., & Pagh, J. D. (1997). Supply chain management: More than a new name for logistics. *The International Journal of Logistics Management*, *8*(1), 1–14. doi: 10.1108/09574099710805556

Coskun, S., Basligil, H., & Baracli, H. (2008). A weakness determination and analysis model for business process improvement. *Business Process Management Journal*, *14*(2), 243–261. doi: 10.1108/14637150810864961

Curtis, B., Kellner, M., & Over, J. (1992). Process modeling. *Communications of the ACM*, *35*(9), 75–90. doi: 10.1145/130994.130998

Dahalin, Z. M., Razak, R. A., Ibrahim, H., Yusop, N. I., & Kasiran, M. K. (2010). An enterprise architecture methodology for business-IT alignment: Adopter and developer perspectives. *Communications of the IBIMA*, *2010*, 1–14. doi: 10.5171/2011.222028

Damanpour, F., & Wischnevsky, J. D. (2006). Research on innovation in organizations: Distinguishing innovation-generating from innovation-adopting organizations. *Journal of Engineering and Technology Management*, *23*(4), 269–291. doi: 10.1016/j.jengtecman.2006.08.002

Davenport, T. H. (1993). *Process innovation: Reengineering work through information technology*. Boston, MA: Harvard Business Press.

Davenport, T. H. (1998). Putting the enterprise into the enterprise system. *Harvard Business Review*, *76*(4), 121–131.

Davenport, T. H. (2005). *Thinking for a living: How to get better performance and results from knowledge workers*. Boston, MA: Harvard Business Press.

Davenport, T. H., & Short, J. E. (1990). The new industrial engineering: Information technology and business process redesign. *Sloan Management Review*, *31*(4), 11–27.

de la Vara, J., Ali, R., Dalpiaz, F., Sánchez, J., & Giorgini, P. (2010). Business Processes Contextualisation via Context Analysis. In J. Parsons, M. Saeki, P. Shoval, C. Woo, & Y. Wand (Eds.), *Lecture Notes in Computer Science: Vol. 6412. Conceptual Modeling – ER 2010* (pp. 471–476). Berlin, Germany: Springer. doi: 10.1007/978-3-642-16373-9_37

Delfmann, P., Herwig, S., & Lis, L. (2009a). Konfliktäre Bezeichnungen in Ereignisgesteuerten Prozessketten – Linguistische Analyse und Vorschlag eines Lösungsansatzes. In *Proceedings of the 8th GI-Workshop EPK 2009: Geschäftsprozessmanagement mit Ereignisgesteuerten Prozessketten.* Berlin, Germany.

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

Denning, P. J., & Metcalfe, R. M. (1997). *Beyond calculation: The next fifty years of computing*. New York City, NY: Copernicus.

Dey, A., Abowd, G., & Salber, D. (1999). A context-based infrastructure for smart environments. In P. Nixon, G. Lacey, & S. Dobson (Eds.), *Proceedings of the 1st International Workshop on Managing Interactions in Smart Environments* (pp. 114–128). Dublin, Ireland.

Dijkman, R., Dumas, M., van Dongen, B., Kaarik, R., & Mendling, J. (2011). Similarity of business process models: Metrics and evaluation. *Information Systems*, *36*(2), 498–516. doi: 10.1016/j.is.2010.09.006

Doomun, R., & Jungum, N. V. (2008). Business process modelling, simulation and reengineering: Call centres. *Business Process Management Journal*, *14*(6), 838–848. doi: 10.1108/14637150810916017

Edwards, W., & Barron, F. H. (1994). SMARTS and SMARTER: Improved simple methods for multiattribute utility measurement. *Organizational Behavior and Human Decision Processes*, *60*(3), 306–325. doi: 10.1006/obhd.1994.1087

Engelhardt, W., Kleinaltenkamp, M., & Reckenfelderbäumer, M. (1993). Leistungsbündel als Absatzobjekte: Ein Ansatz zur Überwindung der Dichotomie von Sach- und Dienstleistungen. *Zeitschrift für betriebswirtschaftliche Forschung*, *45*(5), 395–426.

English, L. P. (1999). *Improving data warehouse and business information quality: Methods for reducing costs and increasing profits*. New York City, NY: John Wiley & Sons.

European Commission. (2011). *Solvency II.* Retrieved from `http://ec.europa.eu/internal_market/insurance/solvency/`

Fettke, P. (2006). *Wirtschaftsinformatik – Theorie und Anwendung: Vol. 5. Referenzmodellevaluation. Konzeption der strukuralistischen Referenzmodellierung und Entfaltung ontologischer Gütekriterien* (Vol. 5). Berlin, Germany: Logos.

Fettke, P., & Loos, P. (2004). Referenzmodellierungsforschung. *Wirtschaftsinformatik*, *46*, 331–340.

Filipowska, A., Kaczmarek, M., Kowalkiewicz, M., Zhou, X., & Born, M. (2009). Procedure and guidelines for evaluation of BPM methodologies. *Business Process Management Journal*, *15*(3), 336–357. doi: 10.1108/14637150910960594

Fiodorov, I. (2011). A comparative analysis of the business process modeling notations (in russian). *Open Systems Journal*, *19*(8), 28–32.

Fischer, H., Britzke, B., & Busenbach, M. (2010). MTM – Prozesssprache und Bausteinsystem. In B. Britzke (Ed.), *MTM in einer globalisierten Wirtschaft: Arbeitsprozesse systematisch gestalten und optimieren* (pp. 15–27). Munich, Germany: mi-Wirtschaftsbuch. FinanzBuch-Verl.

Fischer, M. (2012). *Logikbasierte Prozessmodellierung: Ein ereignisorientierter Ansatz zur kontinuerlichen Modellierung und Qualitätssicherung von Geschäftsprozessen*. Dissertation, Technische Universität Darmstadt, Darmstadt, Germany.

Fischer, M., Link, M., & Zeise, N. (2011). ProCEM® – Integriertes Softwaregestütztes Prozessmanagement. In N. Zeise, M. Fischer, & M. Link (Eds.), *Anwendungsorientierte Organisationsgestaltung: Prozessmanagement – Systementwicklung – Modellierung* (pp. 311–329). Hamburg, Germany: baar.

Flick, U., von Kardoff, E., & Steinke, I. (2009). *An introduction to qualitative research* (4th ed.). Thousand Oaks, CA: Sage Publications.

Forrester Research. (2011). *Trends in data quality and business process alignment.* Retrieved from http://www.trilliumsoftware.com/success/_landing_pages/Forrester-TAP-2012/Forrester-TAP.pdf

Frank, U. (2007). Evaluation of reference models. In P. Fettke & P. Loos (Eds.), *Reference modeling for business systems analysis* (pp. 118–140). Hershey, London: Idea Group Inc.

Frank, U. (2008). Reflexionen zur sprachlichen Konstruktion von Informationssystemen. In E. Heinemann (Ed.), *Anwendungsinformatik. Die Zukunft des Enterprise Engineering. Festschrift für Erich Ortner zum 60. Geburtstag* (pp. 37–49). Baden-Baden, Germany: Nomos.

Galoppin, L., & Caems, S. (2007). *Managing organizational change during SAP implementation*. Bonn, Germany: SAP Press.

Gamma, E., Helm, R., Johnson, R., & Vlissides, J. (1996). *Entwurfsmuster: Elemente wiederverwendbarer objektorientierter Software* (1st ed.). Munich, Germany: Addison-Wesley.

Global CIO. (2011). *Analytical research: Russian business process management (BPM) market.* Retrieved from http://www.globalcio.ru/workshops/46/

Glowalla, P., & Sunyaev, A. (2012). Process-driven data and information quality management in the financial service sector. In L. Jessup & J. Valacich (Eds.), *Proceedings of the 18th Americas Conference on Information Systems (AMCIS 2012).* Seattle, WA. (forthcoming)

Goedertier, S., Haesen, R., & Vanthienen, J. (2007). *EM-BrA2CE v0.1: A vocabulary and execution model for declarative business process modeling* (FETEW Research Report KBI No. 728). Leuven, Belgium: Department of Decision Sciences and Information Management. Katholieke Universiteit Leuven.

Gopalakrishnan, S., & Damanpour, F. (1994). Patterns of generation and adoption of innovation in organizations: Contingency models of innovation attributes. *Journal of Engineering and Technology Management*, *11*(2), 95–116. doi: 10.1016/0923-4748(94)90001-9

Gottschalk, F., van der Aalst, W. M. P., & Jansen-Vullers, M. H. (2008). Mining reference process models and their configurations. In R. Meersman, Z. Tari, & P. Herrero (Eds.), *Lecture Notes in Computer Science: Vol. 5333. On the Move to Meaningful Internet Systems: OTM 2008 Workshops* (pp. 263–272). Berlin, Germany: Springer. doi: 10.1007/978-3-540-88875-8_47

Gou, H., Huang, B., Liu, W., & Li, X. (2003). A framework for virtual enterprise operation management. *Computers in Industry*, *50*(3), 333–352. doi: 10.1016/S0166-3615

Grabski, S. V., Leech, S. A., & Schmidt, P. J. (2011). A review of ERP research: A future agenda for accounting information systems. *Journal of Information Systems*, *25*(1), 37–78. doi: 10.2308/jis.2011.25.1.37

Griesberger, P., Leist, S., & Johannsen, F. (2012). *Context-aware patterns for improving business processes* (Working Paper). Regensburg, Germany: University of Regensburg.

Griesberger, P., Leist, S., & Zellner, G. (2011). Analysis of techniques for business process improvement. In *Proceedings of the 19th European Conference on Information Systems (ECIS 2011).* Helsinki, Finland.

Grünberg, T. (2003). A review of improvement methods in manufacturing operations. *Work study*, *52*(2), 89–93. doi: 10.1108/00438020310462890

Gunasekaran, A. (1999). Agile manufacturing: A framework for research and development. *International Journal of Production Economics*, *62*(1-2), 87–105. doi: 10.1016/S0925-5273(98)00222-9

Hadar, I., & Soffer, P. (2006). Variations in conceptual modeling: Classification and ontological analysis. *Journal of AIS*, *7*(8), 568–592.

Hagemeyer, C., Gershenson, J. K., & Johnson, D. M. (2006). Classification and application of problem solving quality tools: A manufacturing case study. *The TQM Magazine*, *18*(5), 455–483. doi: 10.1108/09544780610685458

Hagen, C. R.-v., & Stucky, W. (2004). *Business-Process- und Workflow-Management*. Wiesbaden, Germany: Teubner.

Hall, J. M., & Johnson, D. M. (2009). When should a process be art, not science? *Harvard Business Review*, *87*(3), 58–65.

Hammer, M. (1990). Reengineering work: Don't automate, obliterate. *Harvard Business Review*, *68*(4), 104–112.
Hammer, M., & Champy, J. (1993). *Reengineering the corporation: A manifesto for business revolution*. New York City, NY: Harper Business.
Harmon, P. (2007). *Business process change: A guide for business managers and BPM and Six Sigma professionals* (2nd ed. ed.). Burlington, MA, USA: Morgan Kaufmann.
Harrington, H. J. (1991). *Business process improvement: The breakthrough strategy for total quality, productivity, and competitiveness*. New York City, NY: McGraw-Hill Professional.
Harrington, H. J., & Lomax, K. C. (2000). *Performance improvement methods: Fighting the war on waste*. New York City, NY: McGraw-Hill Professional.
Haug, A., Arlbjørn, J. S., & Pedersen, A. (2009). A classification model of ERP system data quality. *Industrial Management & Data Systems*, *109*(8), 1053–1068. doi: 10.1108/02635570910991292
Hauser, J. R., & Clausing, D. (1988, May-June). The house of quality. *Harvard Business Review*, 63–73.
Helfert, M., & Hossain, F. M. Z. (2010). An approach to monitor data quality: Product oriented approach. In J. N. Luftman & A. S. Vinze (Eds.), *Proceedings of the 16th Americas Conference on Information Systems (AMCIS 2010).* Lima, Peru.
Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75–105.
Hoerls, R. (2001). Six sigma black belts: What do they need to know? In *45th Annual Fall Technical Conference of the Chemical and Process Industries Division and Statistics Division of the American Society of Quality* (pp. 391–406). Toronto, Canada.
Hoermann, s., Kienegger, H., Langemeier, M., Mayer, M., & Krcmar, H. (2010). Comparing risk and success factors in ERP projects: A literature review. In J. N. Luftman & A. S. Vinze (Eds.), *Proceedings of the 16th Americas Conference on Information Systems (AMCIS 2010).* Lima, Peru.
Hollick, M., Rensing, C., Schmitt, J., & Reinhardt, A. (2009). *The PROWIT architecture (unpublished project documentation)* (Tech. Rep.).
Houy, C., Fettke, P., & Loos, P. (2010a). *Einsatzpotentiale von Enterprise-2.0-Anwendungen - Darstellung des State-of-the-Art auf der Basis eines Literaturreviews.* (Veröffentlichungen des Instituts für Wirtschaftsinformatik No. 192). Saarbrücken, Germany: Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI).
Houy, C., Fettke, P., & Loos, P. (2010b). Empirical research in business process management: Analysis of an emerging field of research. *Business Process Management Journal*, *16*(4), 619–661. doi: 10.1108/14637151011065946
Houy, C., Reiter, M., Fettke, P., & Loos, P. (2010). Potentiale serviceorientierter Architekturen für Software-Werkzeuge des Geschäftsprozessmanagements. In W. Esswein, K. Turowski, & M. Juhrisch (Eds.), *Lecture Notes in Informatics: Vol. P-171. MobIS 2010. Modellierung betrieblicher Informationssysteme* (pp. 211–227). Bonn, Germany: Gesellschaft für Informatik.
Hung, R. Y.-Y. (2006). Business process management as competitive advantage: A review and empirical study. *Total Quality Management*, *17*(1), 21–40. doi: 10.1080/14783360500249836
IEEE Task Force on Process Mining. (2011). Process mining manifesto. In *Lecture Notes in Business Information Processing: Vol. 99. Business Process Management Workshops. Part 2* (pp. 169–194). Berlin, Germany: Springer. doi: 10.1007/978-3-642-28108-2_19
Imai, M. (1986). *The key to japan's competitive success*. New York City, NY: McGraw–Hill.
Ishikawa, K. (1982). *Guide to quality control*. Hong Kong: Asian Productivity Organization.
ISO/IEC. (2009). ITU-T Rec. X.906–ISO/IEC 19793: Information technology – Open distributed processing – Use of UML for ODP system specifications.
Jarrar, Y., Al-Mudimigh, A., & Zairi, M. (2000). ERP implementation critical success factors: The role and impact of business process management. In *Proceedings of the IEEE International Conference on Management of Innovation and Technology (ICMIT 2000)* (Vol. 1, pp. 122–127). Singapore. doi: 10.1109/ICMIT.2000.917299
Jiménez-Jiménez, D., & Sanz-Valle, R. (2011). Innovation, organizational learning, and perfor-

mance. *Journal of Business Research*, *64*(4), 408–417. doi: 10.1016/j.jbusres.2010.09.010

John, A., Meran, R., Roenpage, O., & Staudter, C. (2008). *Six Sigma+ Lean Toolset*. Berlin, Germany: Springer.

Johnson, C. W., Carmichael, D., Kay, J., Kummerfeld, B., & Hexel, R. (2004). Context evidence and location authority: The disciplined management of sensor data into context models. In *Proceedings of the 1st International Workshop on Context Modelling, Reasoning and Management at UbiComp 2004* (pp. 74–79).

Kamlah, W., & Lorenzen, P. (1996). *Logische Propädeutik: Vorschule des vernünftigen Redens* (3rd ed.). Stuttgart, Germany: BI-Wiss.-Verl.

Kanji, G. K., & Asher, M. (1996). *100 methods for total quality management*. London, England: Sage Publications.

Kaplan, R. B., & Murdock, L. (1991). Core process redesign. *McKinsey Quarterly*(2), 27–43.

Kettinger, W. J., Teng, J. T. C., & Guha, S. (1997). Business process change: A study of methodologies, techniques, and tools. *MIS Quarterly*, *21*(1), 55–80.

Khatri, V., & Brown, C. V. (2010). Designing data governance. *Communications of the ACM*, *53*(1), 148–152. doi: 10.1145/1629175.1629210

Kindler, E. (2004). Using the Petri net markup language for exchanging business processes? potential and limitations. In M. Nüttgens & J. Mendling (Eds.), *Proceedings of the 1st GI Workshop XML4BPM – XML Interchange Formats for business process management at 7th GI conference* (pp. 43–60). Marburg, Germany.

Knight, S. (2011). The combined conceptual life-cycle model of information quality: part 1, an investigative framework. *International Journal of Information Quality*, *2*(3), 205–230. doi: 10.1504/IJIQ.2011.040669

Ko, R. K. L., Lee, S. S. G., & Lee, E. W. (2009). Business process management (BPM) standards: A survey. *Business Process Management Journal*, *15*(5), 744–791. doi: 10.1108/14637150910987937

Kofod-Petersen, A., & Mikalsen, M. (2005). Context: Representation and reasoning about context in a mobile environment. *Revue d'Intelligence Artificielle*, *19*(3), 479–498.

Konstantinidis, C., Kienegger, H., Flormann, L., Wittges, H., & Krcmar, H. (2012). *SAP Business ByDesign: Anpassung und Integration*. Bonn, Germany: SAP Press.

Krigsman, M. (2008). *Levi strauss: SAP rollout 'substantially' hurt quarter.* Retrieved from http://www.zdnet.com/blog/projectfailures/levi-strauss-sap-rollout-substantially-hurt-quarter/917

Krigsman, M. (2011). *ERP survey: New IT failure research and statistics.* Retrieved from http://www.zdnet.com/blog/projectfailures/2011-erp-survey-new-it-failure-research-and-statistics/12486

Kupriyanov, Y., & Taratoukhine, V. (2011). Principles of managing organizational change (in Russian). *Information Technology (Информационные технологии)*(6), 66–71.

Kurz, M. (2011). BPM 2.0: Selbstorganisation im Geschäftsprozessmanagement. In E. J. Sinz, D. Bartmann, F. Bodendorf, & O. K. Ferstl (Eds.), *Schriften aus der Fakultät Wirtschaftsinformatik und Angewandte Informatik der Otto-Friedrich-Universität Bamberg: Vol. 9. Dienstorientierte IT-Systeme für hochflexible Geschäftsprozesse.* (pp. 193–216). Bamberg, Germany: University of Bamberg Press.

Lamberti, H.-J. (2004). *Industrialisierung des Bankgeschäfts.* Retrieved from http://www.die-bank.de/archiv/2004/06-2004/industrialisierung-des-bankgeschaefts

Lee, H. L., & Billington, C. (1992). Managing supply chain inventory: Pitfalls and opportunities. *Sloan Management Review*, *33*(3), 65–73.

Lee, Y. W., & Strong, D. M. (2003). Knowing-why about data processes and data quality. *Journal of Management Information Systems*, *20*(3), 13–39.

Li, C., Reichert, M., & Wombacher, A. (2010). The MinAdept clustering approach for discovering reference process models out of process variants. *International Journal of Cooperative Information Systems*, *19*(3), 159–203. doi: 10.1142/S0218843010002139

Lin, S., Gao, J., Koronios, A., & Chanana, V. (2007). Developing a data quality framework for asset management in engineering organisations. *International Journal of Information Quality*, *1*(1), 100–126.

Link, M., & Ortner, E. (2010). Dynamic enterprise (as a composite service system). In *Proceedings of the 2010 International Conference on Service Sciences (ICSS)* (pp. 66–70). Los Alamitos, CA: IEEE. doi: 10.1109/ICSS.2010.52

Loshin, D. (2011). *The practitioner's guide to data quality improvement*. Boston, MA: Morgan Kaufmann.

Macdonald, J. (1995). Together TQM and BPR are winners. *The TQM Magazine*, *7*(3), 21–25. doi: 10.1108/09544789510087706

Madnick, S. E., Wang, R. Y., Lee, Y. W., & Zhu, H. (2009). Overview and framework for data and information quality research. *Journal of Data and Information Quality*, *1*(1), 2:1–2:22. doi: 10.1145/1515693.1516680

Maguire, S., Ojiako, U., & Said, A. (2010). ERP implementation in Omantel: A case study. *Industrial Management & Data Systems*, *110*(1), 78–92. doi: 10.1108/02635571011008416

Malone, T. W., Crowston, K., & Herman, G. (Eds.). (2003). *Organizing business knowledge: the MIT process handbook*. Cambridge, MA: MIT Press.

Malone, T. W., Crowston, K., Lee, J., & Pentland, B. (1993). Tools for inventing organizations: Toward a handbook of organizational processes. In *Proceedings of the 2nd IEEE Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises* (pp. 72–82). doi: 10.1109/ENABL.1993.263061

Marca, D. L., & McGowan, C. L. (1988). *SADT: Structured analysis and design technique*. New York City, NY: McGraw–Hill.

Markus, M. L. (2004). Technochange management: Using IT to drive organizational change. *Journal of Information Technology*, *19*(1), 4–20. doi: 10.1057/palgrave.jit.2000002

Mayfield, M. (2011). Innovation. In M. A. Runco & S. R. Pritzker (Eds.), *Encyclopedia of creativity* (2nd ed., pp. 658–666). San Diego, CA: Academic Press.

McCormack, K., Willems, J., van den Bergh, J., Deschoolmeester, D., Štemberger, M. I., Škrinjar, R., ... Vlahovic, N. (2009). A global investigation of key turning points in business process maturity. *Business Process Management Journal*, *15*(5), 792–815. doi: 10.1108/14637150910987946

McQuater, R. E., Scurr, C. H., Dale, B. G., & Hillman, P. G. (1995). Using quality tools and techniques successfully. *The TQM Magazine*, *7*(6), 37–42. doi: 10.1108/09544789510103761

Melão, N., & Pidd, M. (2000). A conceptual framework for understanding business processes and business process modelling. *Information Systems Journal*, *10*(2), 105–129. doi: 10.1046/j.1365-2575.2000.00075.x

Mendling, J., Reijers, H., & Recker, J. (2010). Activity labeling in process modeling: Empirical insights and recommendations. *Information Systems*, *35*(4), 467–482. doi: 10.1016/j.is.2009.03.009

Mertens, S. K. (2006). IT-Fabrik beflügelt die Prozessorganisation. *PIK – Praxis der Informationsverarbeitung und Kommunikation*, *29*(2), 109–110.

Miller, G. A. (1998). Nouns in wordnet. In C. Fellbaum (Ed.), *Wordnet: An electronic lexical database* (pp. 23–46). Cambridge, MA: The MIT Press.

Mintzberg, H. (1983). *Structure in fives: Designing effective organizations*. Englewood Cliffs, NJ: Prentice-Hall.

Mittelstraß, J. (Ed.). (1995). *Enzyklopädie Philosophie und Wissenschaftstheorie*. Stuttgart, Weimar: J. B. Metzler.

Mohamed, S., & McLaren, T. S. (2009). Probing the gaps between ERP education and ERP implementation success factors. *AIS Transactions on Enterprise Systems*, *1*(1), 8–14.

Mohr, M., Simon, T., & Krcmar, H. (2005). Building an adaptive infrastructure for education service providing. In O. K. Ferstl, E. J. Sinz, S. Eckert, & T. Isselhorst (Eds.), *Proceedings of the 7. Internationale Tagung Wirtschaftsinformatik (WI2005)* (pp. 847–859). Bamberg, Germany. doi: 10.1007/3-7908-1624-8_44

Moon, Y. B. (2007). Enterprise resource planning (ERP): A review of the literature. *International Journal of Management and Enterprise Development*, *4*(3), 235–264.

Morsy, H., & Otoo, T. (2012). *Ruby on Rails 3.1* (2nd ed.). Bonn, Germany: Galileo Press.

Mu, L.-F., Tang, J., Chen, Y., & Kwong, C.-K. (2008). A fuzzy multi-objective model of QFD product planning integrating Kano mode. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, *16*(1), 793–813. doi: 10.1142/S0218488508005625

Mullins, L. J. (2005). *Management and organisational behaviour* (7th ed.). Londong, England: Prentice Hall.
Myers, M. D. (2011). *Qualitative research in business & management*. Los Angeles, CA: Sage Publications.
Neubauer, T. (2009). An empirical study about the status of business process management. *Business Process Management Journal*, *15*(2), 166-183. doi: 10.1108/14637150910949434
Nicolescu, V., Heiler, M., Visintin, F., Funk, B., Wittges, H., Kleine Stegemann, B., . . . Kienegger, H. (2010). *Practical guide to SAP NetWeaver PI - development*. Bonn, Germany: Galileo.
N.N. (2010). MTM in der Praxis. In B. Britzke (Ed.), *MTM in einer globalisierten Wirtschaft: Arbeitsprozesse systematisch gestalten und optimieren.* Munich, Germany: mi-Wirtschaftsbuch. FinanzBuch-Verl.
Object Management Group (OMG). (2011). *Business process model and notation (BPMN) – version 2.0.* Retrieved from http://www.omg.org/spec/BPMN/2.0/
Orlikowski, W. J., & Hofman, J. D. (1997). An improvisational model for change management: the case of groupware technologies. *Sloan Management Review*, *38*(2), 11–21.
Ortner, E. (2010). Die konstruktive Methode. In *Konstruktive Informatik: Modellierung und Entwicklung von Anwendungssystemen* (pp. 1—20). Aachen, Germany: Shaker Media.
Österle, H., & Winter, R. (2003). *Business Engineering: Auf dem Weg zum Unternehmen des Informationszeitalters* (2nd ed.). Berlin, Germany: Springer.
Otto, B. (2011a). Catchword: Data governance. *Business & Information Systems Engineering*, *3*(4), 241–244. doi: 10.1007/s12599-011-0162-8
Otto, B. (2011b). A morphology of the organisation of data governance. In M. Nandhakumar, M. Rossi, & W. Soliman (Eds.), *Proceedings of the 19th European Conference on Information Systems (ECIS 2011).* Helsinki, Finland.
Pacicco, L., Ravarini, A., & Pigni, F. (2010). Business process modelling within the cycle of continuous improvement. In A. D'Atri & D. Saccà (Eds.), *Information Systems: People, Organizations, Institutions, and Technologies* (pp. 91–99). Berlin, Germany: Physica. doi: 10.1007/978-3-7908-2148-2_12
Pande, P. S., Neuman, R. P., & Cavanaugh, R. R. (2000). *The six sigma way: How GE, Motorola, and other top companies are honing their performance*. New York City, NY: McGraw-Hill.
Park, T., & Kim, K. (1998). Determination of an optimal set of design requirements using house of quality. *Journal of Operations Management*, *16*(5), 569–581. doi: 10.1016/S0272-6963(97)00029-6
Pedrinaci, C., Domingue, J., & de Medeiros, A. K. A. (2008). A core ontology for business process analysis. In S. Bechhofer, M. Hauswirth, J. Hoffmann, & M. Koubarakis (Eds.), *Lecture Notes in Computer Science: Vol. 5021. The Semantic Web: Research and Applications* (pp. 49–64). Berln, Germany: Springer. doi: 10.1007/978-3-540-68234-9_7
Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45–77. doi: 10.2753/MIS0742-1222240302
Peppard, J., Ward, J., & Daniel, E. (2007). Managing the realization of business benefits from IT investments. *MIS Quarterly Executive*, *6*(1).
Picot, A., Reichwald, R., & Wigand, R. T. (2010). *Die grenzenlose Unternehmung: Information, Organisation und Management: Lehrbuch zur Unternehmensführung im Informationszeitalter*. Wiesbaden, Germany: Gabler.
Poluha, R. G. (2005). *Anwendung des SCOR-Modells zur Analyse der Supply Chain: Explorative empirische Untersuchung von Unternehmen aus Europa, Nordamerika und Asien*. Unpublished doctoral dissertation, Universität zu Köln, Cologne, Germany.
Rahm, E., & Bernstein, P. A. (2001). A survey of approaches to automatic schema matching. *The Very Large Database Journal*, *10*, 334–350. doi: 10.1007/s007780100057
Rath & Strong. (2002). *Rath & Strong's six sigma pocket guide*. Rath & Strong.
Redman, T. C. (1996). *Data quality for the information age*. Boston, MA: Artech House.
Reinhardt, A., Schmitt, J., Steinmetz, R., Walter, P., & Schwantzer, S. (2011). PROWIT – Kontextsensitive Telekommunikation im Geschäftseinsatz. *Praxis der Informationsverarbeitung und Kommunikation (PIK)*, *34*(3), 156–157.
Reinhardt, A., Schmitt, J., Zaid, F., Mogre, P. S., Kropff, M., & Steinmetz, R. (2010). Towards

seamless binding of context-aware services to ubiquitous information sources. In *4th International Conference on Complex, Intelligent and Software Intensive Systems (CISIS 2010)* (pp. 69–74). Krakow, Poland. doi: 10.1109/CISIS.2010.77

Röglinger, M., Pöppelbuß, J., & Becker, J. (2012). Maturity models in business process management. *Business Process Management Journal*, *18*(2), 328–346. doi: 10.1108/14637151211225225

Rosemann, M. (2006). Potential pitfalls of process modeling: part a. *Business Process Management Journal*, *12*(2), 249–254. doi: 10.1108/14637150610657567

Rosemann, M., de Bruin, T., & Power, B. (2008). BPM maturity. In J. Jeston & J. Nelis (Eds.), *Business process management: Practical guidelines to successful implementations* (2nd ed., pp. 313–329). Amsterdam, The Netherlands: Butterworth-Heinemann.

Rosemann, M., Recker, J., & Flender, C. (2008). Contextualisation of business processes. *International Journal of Business Process Integration and Management*, *3*(1), 47–60. doi: 10.1504/IJBPIM.2008.019347

Ross, R. G. (2009). *Business rule concepts: Getting to the point of knowledge* (3rd ed.). Hous, TX: Business Rule Solutions Inc.

Saaty, T. L. (2003). Decision-making with the AHP: Why is the principal eigenvector necessary. *European Journal of Operational Research*, *145*(1), 85–91. doi: 10.1016/S0377-2217(02)00227-8

Samek, M. (2009). *A crash course in UML state machines.* 3-part article. Retrieved from http://www.state-machine.com/resources/articles.php

SAP AG. (2012a). *SAP Business ByDesign.* Retrieved from http://help.sap.com/byd

SAP AG. (2012b). *SAP NetWeaver PI – Business Process Management.* Retrieved from http://help.sap.com/saphelp_nwpi71/helpdata/en/e1/8e51341a06084de10000009b38f83b/frameset.htm

Scheer, A.-W. (1992). *ARIS – Architecture of integrated information systems: Foundations of enterprise modelling*. Berlin, Germany: Springer.

Scheer, A.-W. (1999). *ARIS – Business process frameworks.* Berlin, Germany: Springer.

Scheer, A.-W. (2001). *ARIS – Modellierungsmethoden, Metamodelle, Anwendungen*. Berlin, Germany: Springer.

Scheer, A.-W., & Brabänder, E. (2010). The process of business process management. In J. vom Brocke & M. Rosemann (Eds.), *Handbook on Business Process Management 2 - Strategic Alignment, Governance, People and Culture* (pp. 239–265). Berlin, Germany: Springer. doi: 10.1007/978-3-642-01982-1_12

Scheer, A.-W., & Habermann, F. (2000). Enterprise resource planning: Making ERP a success. *Communications of the ACM*, *43*(4), 57–61. doi: 10.1145/332051.332073

Schekkerman, J. (2008). *Enterprise architecture good practices guide: How to manage the enterprise architecture practice*. Victoria, BC, Canada: Trafford Publishing.

Schmidt, A. (2002). *Ubiquitous computing, computing in context.* Ph.D. thesis, Lancaster University, Lancaster, England.

Schmidt, A., Beigl, M., & Gellersen, H.-W. (1998). There is more to context than location. *Computers and Graphics*, *23*(6), 893–901. doi: 10.1016/S0097-8493(99)00120-X

Schwegmann, A. (1999). *Objektorientierte Referenzmodellierung – Theoretische Grundlagen und praktische Anwendung*. Wiesbaden, Germany: DUV.

Shah, H., & Kourdi, M. (2007). Frameworks for enterprise architecture. *IT Professional*, *9*(5), 36–41. doi: 10.1109/MITP.2007.86

Shahzad, K., & Zdravkovic, J. (2009). A goal-oriented approach for business process improvement using process warehouse data. In A. Persson & J. Stirna (Eds.), *Lecture Notes in Business Information Processing: Vol. 39. The Practice of Enterprise Modeling. Second IFIP WG 8.1 Working Conference* (pp. 84–98). Berlin, Germany: Springer. doi: 10.1007/978-3-642-05352-8_8

Shaw, D. R., Holland, C. P., Kawalek, P., Snowdon, B., & Warboys, B. (2007). Elements of a business process management system: theory and practice. *Business Process Management Journal*, *13*(1), 91–107. doi: 10.1108/14637150710721140

Shin, N., & Jemella, D. F. (2002). Business process reengineering and performance improvement:

The case of Chase Manhattan Bank. *Business Process Management Journal*, *8*(4), 351–363. doi: 10.1108/14637150210435008

Silver, B. (2010, May). *Integrating process and rules – part 2.* BPMS Watch. Retrieved from http://www.brsilver.com/2010/01/05/integrating-process-and-rules-part-2/

Snee, R., & Hoerl, R. (2003). *Leading six sigma*. New York City, NY: Prentice Hall.

Software AG. (2012). *ARIS method.* Darmstadt, Germany. Retrieved from http://documentation.softwareag.com/aris/platform_72sr3e/method_manual_aris_s.pdf

Spring, M., McQuater, R., Swift, K., Dale, B., & Booker, J. (1998). The use of quality tools and techniques in product introduction: an assessment methodology. *The TQM Magazine*, *10*(1), 45–50. doi: 10.1108/09544789810197855

Stiehl, V. (2012). *Prozessgesteuerte Anwendungen entwickeln und ausführen mit BPMN: Wie flexible Anwendungsarchitekturen wirklich erreicht werden können*. Munich, Germany: dpunkt.verlag.

Stroppi, L., Chiotti, O., & Villarreal, P. (2011). A BPMN 2.0 extension to define the resource perspective of business process models. In *Proceedings of the 14th Congreso Iberoamericano en Software Engineering (CIBSE 2011).* Rio de Janeiro, Brasil.

Sullivan, L. P. (1986). Quality function deployment. *Quality Progress*, *19*(6), 39–50.

Supply Chain Council. (2008). *Supply-chain operations reference-model: SCOR overview version 9.0*.

Talwar, R. (1993). Business re-engineering: a strategy-driven approach. *Long Range Planning*, *26*(6), 22–40. doi: 10.1016/0024-6301(93)90204-S

Tan, K. C., Kannan, V. R., & Handfield, R. B. (1998). Supply chain management: Supplier performance and firm performance. *International Journal of Purchasing and Materials Management*, *34*(3), 2–9.

Telnov, Y., & Fiodorov, I. (2012). Functional and process modeling of business processes (in Russian). *Economics, Statisits, Informatics, Journal of UMO*(2), 193–200.

Thomas, O. (2006). *Management von Referenzmodellen. Entwurf und Realisierung eines Informationssystems zur Entwicklung und Anwendung von Referenzmodellen*. Berlin, Germany: Logos-Verlag.

Tiernan, C., & Peppard, J. (2004). Information technology: Of value or a vulture? *European Management Journal*, *22*(6), 609–623. doi: 10.1016/j.emj.2004.09.025

Valiris, G., & Glykas, M. (1999). Critical review of existing BPR methodologies: The need for a holistic approach. *Business Process Management Journal*, *5*(1), 65–86. doi: 10.1108/14637159910249117

van der Aalst, W. M. P. (2011). *Process mining: Discovery, conformance and enhancement of business processes*. Berlin, Germany: Springer.

van der Aalst, W. M. P., ter Hofstede, A. H. M., & Weske, M. (2003). Business process management: A survey. In W. M. P. van der Aalst, A. H. M. ter Hostede, & M. Weske (Eds.), *Lecture Notes in Computer Science: Vol. 2678. Business Process Management, International Conference BPM 2003* (pp. 1–12). Berlin, Germany: Springer. doi: 10.1007/3-540-44895-0_1

Vanderhaeghen, D., Fettke, P., & Loos, P. (2010). Organisations-und Technologieoptionen des Geschäftsprozessmanagements aus der Perspektive des Web 2.0. *Wirtschaftsinformatik*, *52*(1), 17–32. doi: 10.1007/s12599-009-0087-7

Vergidis, K., Tiwari, A., & Majeed, B. (2006). Business process improvement using multi-objective optimisation. *BT Technology Journal*, *24*(2), 229–235. doi: 10.1007/s10550-006-0065-2

Vernadat, F. (1996). Enterprise integration: On business process and enterprise activity modelling. *Concurrent Engineering*, *4*(3), 219–228. doi: 10.1177/1063293X9600400303

vom Brocke, J. (2003). *Referenzmodellierung – Gestaltung und Verteilung von Konstruktionsprozessen*. Berlin, Germany: Logos.

vom Brocke, J., & Sinnl, T. (2011). Culture in business process management: A literature review. *Business Process Management Journal*, *17*(2), 357–378. doi: 10.1108/14637151111122383

Walker, L. (2007). IBM business transformation enabled by service-oriented architecture. *IBM Systems Journal*, *46*(4), 651–667. doi: 10.1147/sj.464.0651

Walter, J., Fettke, P., & Loos, P. (2012). Zur Identifikation von Strukturanalogien in Prozessmodellen. In *Tagungsband der Multikonferenz Wirtschaftsinformatik (MKWI 2012)* (pp. 1703–1715). Braunschweig, Germany.

Wedekind, H., Ortner, E., & Inhetveen, R. (2004). Informatik als Grundbildung. *Informatik Spektrum*. (6 articles: 27(2004) No. 2 – 28 (2005) No. 1)

Weske, M. (2012). *Business process management: Concepts, languages, architectures* (2nd ed.). Berlin, Germany: Springer.

Wittges, H. (2005). *Verbindung von Geschäftsprozessmodellierung und Workflow-Implementierung*. Wiesbaden, Germany: Deutscher Universitäts-Verlag.

Žabjek, D., Kovacic, A., & Štemberger, M. I. (2009). The influence of business process management and some other CSFs on successful ERP implementation. *Business Process Management Journal*, *15*(4), 588–608. doi: 10.1108/14637150910975552

Zachman, J. A. (2003). *The Zachman framework for enterprise architecture: A primer for enterprise engineering and manufacturing*. Electronic book.

Zhai, L. Y., Khoo, L. P., & Zhong, Z. W. (2008). A rough set enhanced fuzzy approach to quality function deployment. *The International Journal of Advanced Manufacturing Technology*, *37*(5), 613–624. doi: 10.1007/s00170-007-0989-9

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ERCIS – European Research Center for Information Systems
Westfälische Wilhelms-Universität Münster
Leonardo-Campus 3 ▪ 48149 Münster ▪ Germany
Tel: +49 (0)251 83-38100 ▪ Fax: +49 (0)251 83-38109
info@ercis.org ▪ http://www.ercis.org/

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