

# THE BUSINESS PROCESS KNOWLEDGE FRAMEWORK

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**Keywords:** business process management, knowledge acquisition, information systems, semantic technologies

**Abstract:** Organizations today are confronted with huge problems regarding following and implementing their own business process models. On the one hand, due to a lack of planning and requirements analysis, process models are often unfeasible or difficult to execute in practice. On the other hand, process designers often ignore the importance of studying the different roles and their perspectives on a business process when constructing a process model. This leads to the deployment of process models that do not “satisfy” process stakeholders. This paper addresses those two problems and proposes a business process knowledge framework as a possible solution. Our framework for business process knowledge management integrates three elements that we consider fundamental to correctly model business processes: stakeholders’ perspectives, knowledge types and views. It is shown how the business process framework can contribute to the improvement of the process knowledge acquisition phase of process design, and how it can support process knowledge communication to stakeholders. Finally, we argue that the latest developments in the Semantic Web are an interesting solution to support the integration of information and knowledge represented within our framework.

## 1 INTRODUCTION

The importance of business processes as a major asset of an organization is becoming more and more accepted and recognized as a crucial factor in the success and development of businesses. As a current survey (BPM Study, 2006) shows, the importance of business process management (BPM) from the point of view of the organization is still growing, and almost 80 percent of companies are deeply or very deeply committed to the concept of business process management. The major reasons why organizations apply BPM are increasing efficiency, reducing costs, improving process effectiveness and innovation, compliance management, and IT systems development and introduction.

In recent years some of the major processes of the process management life cycle such as process analysis (Biazzo, 2000), process design (Cousins and Stewart, 2002), and process measurement (Cardoso et al., 2006) are reaching, from the companies’ point of view, a satisfying level of

maturity, on the other hand deficiencies become apparent when processes are actually implemented (BPM Study, 2006). In other words, in spite of all business process approaches, methodologies, models, standards, which in specific contexts and different focuses address BPM and improvement of business processes, there is still a large gap between “theory” – how an organization wants to function, and working practice – what actually happens in business process execution. Organizational practice and market analysis reports (Strohmaier et al., 2005) point out various reasons for difficulties in this area with which organizations are confronted. In this paper we propose a solution for two of the identified problems: (a) “inadequate” business process analysis (e.g. the way process models are built) and (b) “poor” process description communication (e.g. the way of how, in what scope, abstraction level, semantic and “language” that process models are communicated to stakeholders).

(a) “*Inadequate*” process analysis: One of the essential tasks in the construction and adaptation of

process models when using the incremental approach (Teng and Kettinger, 1995). The analysis needs to correctly identify the processes that have to be executed (“to-be” models) and understand the current “state” of the organization (“as-is” models). This is a complex and time-consuming task since the specific knowledge about processes is distributed in the “heads” of its various stakeholders (Habermann, 2001). On the other hand, it can also be found in working practice, documentation (e.g. organization manuals, guidelines, work performance reports...) and supporting information systems (e.g. business process management systems, expert systems, ERP systems, and CRM systems). Often, important parts of the relevant information about business processes necessary for the analysis do not even exist within organizations. If it is available it is often not up-to-date, especially if it is documented (Strohmaier et al., 2005), often understood wrong (e.g. process owner performs a process according to misunderstood goals) or contradictory. Different stakeholders, also those who actively participate in processes, have different views and convictions about “what is actually happening” in the organization and in performed processes. Frequently the people who have to manage and execute processes do not participate in the definition and maintenance of these processes.

Incomplete analysis and deficient understanding of the organization leads to the creation of unfeasible process models, whose successful design and later implementation are impeded from the beginning.

(b) “poor” process model communication: At the same time, even if process models are feasible, they are, from different process stakeholders’ points of view, hard to follow in practice. The reason for this situation is that current process models only represent a restricted number of perspectives on the process (e.g. functional, data, organizational). The process models are designed and created mostly for one stakeholder (e.g. ISO 9001 auditor (ISO 9000:2000, 2005), quality manager, process modeler, or workflow administrator) using a modeling language that is not always easily understandable for the other stakeholders. Therefore, the models have very often an inappropriate scope and abstraction level.

Process models that do not represent process stakeholders’ perspectives can hardly be expected to be executed properly.

This paper is structured in the following way: the first part defines business process knowledge, its perspectives, types, views and its most important stakeholders. The problems regarding process

knowledge sources are discussed. In section 3 our business process knowledge framework is introduced. Its application in supporting process knowledge acquisition and process knowledge communication phases (Hrastnik, et al. 2004) is shown in section 4, where possible solutions for (a) and (b) are presented. In section 5, we suggest a semantic Web-based approach to implement a theoretical model to support our framework.

## 2 BUSINESS PROCESS AND PROCESS IMPROVEMENT KNOWLEDGE

Business process knowledge (knowledge about business processes) is knowledge about the motivation behind processes, reasons for their existence, knowledge about process structure and logic, the required resources for their execution, as well as its interfaces, process environment, capability, performance and documentation.

Business process knowledge can be seen as a part of business *process improvement knowledge* (Hrastnik et al., 2004), i.e. the knowledge required for process improvement, which comprises in addition to business process knowledge, knowledge about the organization’s criteria (e.g. organizational goals), knowledge about employee’s mental models (Johnson-Laird, 1983), personal attitudes, perceptions, awareness, understanding, motivation, and commitments.

Business process knowledge is a critical resource, which is required by all the processes of the business process management life cycle (Figure 1).

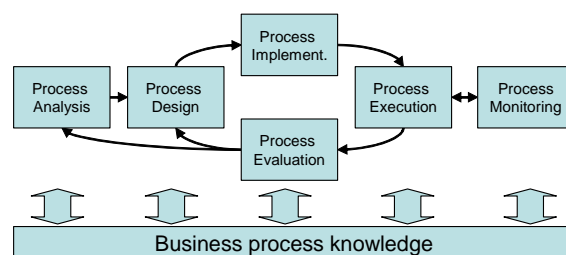


Figure 1: BPM meta processes – BPM life cycle.

Business process knowledge is a necessary input for the process analysis process, where in the knowledge acquisition phase, the knowledge about the current “to-be”, “as-is” situation and its discrepancy is collected. The new “to-be” model is

again required in the implementation and process execution process.

## 2.1 Process Knowledge Sources

Process knowledge is available in people's heads. Examples include the heads of employees, heads of representatives of external stakeholders, customers, suppliers and partners. Process knowledge in people's heads differs strongly according to its scope and its degree of abstraction. Some employees are familiar only with particular process activities, whereas a quality manager may have an overview of an entire process. A department manager will have a relatively detailed knowledge about processes within his range, whereas an executive manager generally gets along with overview knowledge. In many cases process and process improvement knowledge is available in documented form as organization manuals, quality system documentation, lessons learned and best practices, recordings of earlier process improvement initiatives, or in knowledge management projects (Figure 2).

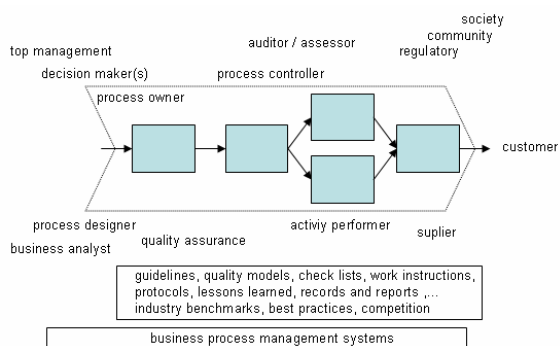


Figure 2: Business process knowledge sources.

Beyond that, further relevant knowledge can often be won from workflow management systems, ERP systems and business process tools. External knowledge such as industry benchmarks or best practices of other enterprises can be partly procured also at the market and/or be obtained by participation in appropriate initiatives.

## 2.2 Business Process Knowledge Types

Process models can be seen from different perspectives. Several views of the parts of process knowledge and process models have been proposed. Curtis et al. (1992) proposes the functional, behavioral, organizational and informational perspective. The functional perspective looks at the

activities that are being performed and their relationships. The behavioral perspective looks at when and how process activities are performed. The organizational perspective looks at who performs the activities and where they are performed. The informational perspective looks at the informational entities produced or manipulated by a process.

Similar perspectives or sub-models were presented by Lonchamp (data, activity, prescription, resource, role, organizational) (Lonchamp, 1993), Conradi et al. (data, activity, tool, role, organizational) (Conradi et al., 1992), and Benali et al. (data, operator, expression, rule, ordering, characteristic) (Benali et al., 1989), Scheer (organization, data, function, control) (Scheer, 2000). Burlton (2001) proposes scoping, relationship, processing, performance, functional/organizational views.

For the purpose of our business process framework we propose the following classification of business process knowledge: *Process logic* which covers knowledge about process elements (processes, tasks), their cross-linking and connections (transitions), operators, and conditions. *Process information* designates knowledge about inputs and output of processes as well as about resources needed for their execution. *Process environment* consists of knowledge about the critical success factors, interference factors and possible obstacles of processes. *Process capacity* usually contains quantitative statements about process capacity as well as the measuring system standing behind it (e.g. metrics, measurement categories, measuring points, target values, performance indicators). *Process justification* gives answers to questions about the sense and purpose both to the existence and the concrete arrangement of individual processes and the process logic.

## 2.3 Business Process Knowledge Perspectives

The allocation of competencies can, of course, vary from organization to organization. From the process management view, however, several roles can be differentiated according to which types of knowledge are relevant to them: *process owner* (on different levels), *activity performer*, *process designer*, *superior decision maker* as well as *internal* and *external customers*. Since the needs for different process knowledge types are always similar, independent of the process abstraction level (organization, sub-processes, activities) (Zesar and Mesaric, 1999), all levels of the process hierarchy

can be operated with the same process roles. For the acquisition phase it is important to note that both a role can be assigned to several persons, and one person can have several roles.

Each of those process roles represents a unique perspective on the process knowledge from the business process knowledge stakeholder's point of view. All these *perspectives* together can provide a complete view of the process.

### 3 PROPOSAL FOR BUSINESS PROCESS KNOWLEDGE FRAMEWORK

The business process knowledge framework visualizes descriptively both dimensions introduced in the previous section (Figure 3).

The business process knowledge framework can offer multipurpose support. On the one hand it helps to consider where certain process knowledge types are located or can be acquired (e.g. the gotten, expected and desired information about quality of the process output as part of the process information knowledge is to be expected from internal and/or external customers). This provides better orientation and can also minimize the acquisition efforts. On the other hand the process knowledge framework is a good aid for identifying alternatives (e.g. where else to search if the knowledge that has already been collected is not meaningful enough). Beyond that, the process knowledge framework shows connections which are not always obvious and helps by identifying process knowledge sources, which "possess" more knowledge than is required. For example an activity performer can provide valuable input about better process logic.

The business process knowledge framework can also offer similar assistance for documented process knowledge, whereby instead of the process stakeholders' perspectives, different sources such as manuals, and business process systems are to be considered.

Process Knowledge Types					
Process Knowledge Perspectives	Process Knowledge Types				
	Process Logic	Process Information	Process Environment	Process Capacity	Process Justification
Superior Decisions Maker					
Internal/External Customer					
Process Designer					
Process Owner					
Activity Performer					

Figure 3: Business Process Knowledge Framework

The framework can be extended for the process knowledge acquisition phase. Each person can contribute different *views* (opinions): first of all a subjective picture of the current condition (current condition from the view of this person about how the process is performed in organizational practice: "as-is"), secondly, an understanding of how it should be according to the organization (interpretation and understanding of the current "to-be") and thirdly, a personal opinion of how it should be (improvement suggestions). The extended business process knowledge framework is shown in Figure 4.

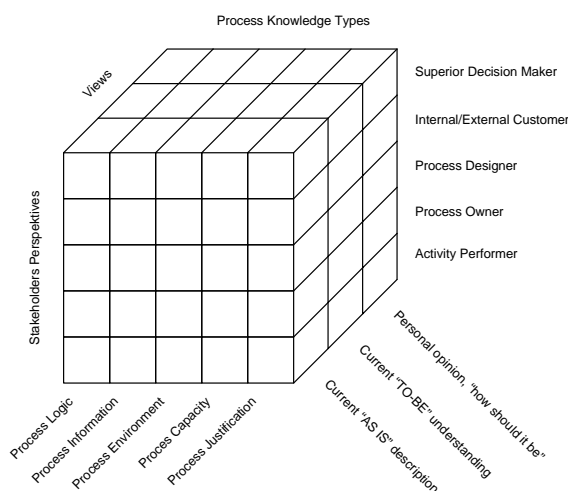


Figure 4: Extended Process Knowledge Framework.

For documented process knowledge the different perspectives must be correctly interpreted. In a concrete case, however, usually a certain view stands in the foreground. For example, a process manual should describe how it should be according to the organization, whereas e.g. workflow management systems logs (van der Aalst and Weijters, 2004) permit conclusions on the current situation.

## 4 PROCESS KNOWLEDGE FRAMEWORK APPLICATION

### 4.1 Knowledge Acquisition

The path to business process knowledge is usually very long, cumbersome and takes a lot of effort. Business process knowledge is distributed, is of different kinds, and can be never complete. It also can not be assumed that the sources are completely reliable and objective. The people who are

interviewed often know too little, and do not always say what they know. Sometimes they contradict each other, and often even themselves.

The process knowledge framework could be very helpful in the process knowledge acquisition phase. Based on the overview of available sources of process knowledge, and with the help of the process knowledge framework, it is easier to decide, depending on the goals to be reached, how much of what knowledge can be acquired with reasonable effort. Here criteria such as accessibility, reliability and in the case of employees as sources, their willingness, are important.

The next decision is about the most suitable method of knowledge acquisition.

To integrate employees and possibly external people, most often structured interviews and workshops are used. In the latter case, it should not be forgotten that employees often behave completely differently when no managers are present. Managers, on the other hand, tend to talk in terms of to-be processes, even if they are asked about the actual process. Basically, different groups speak different languages. They describe the same situation differently, and in some cases different situations suspiciously similarly. A single technical term can be understood completely differently by people in different roles, for example, the word "process" would be interpreted one way by a process designer, and in a completely different way by a person from the management department.

As far as investigating mental models and personal attitudes (business process improvement knowledge), there are basically only two methods to choose from. On the one hand, you theoretically have the possibility to carry out a psychologically based, thorough knowledge acquisition, which of course takes a lot of effort. On the other hand, the person acquiring the knowledge can simply be conscious of this additional dimension and can record it during discussions whose goal it is to acquire process knowledge. The result is heavily dependent on his interpretation and may not be objective, however, this approach is more cost-effective in most cases.

The acquisition method for knowledge available in documented form is usually unproblematic in comparison. It is worth mentioning further methods that in some cases can extract relevant knowledge from much less specific data. For example there is the analysis of electronic trails (e.g., Web server log files or exchanges of e-mail) (Cardoso and Lenic 2006) as well as the analysis of social networks.

Certainly, all mentioned process knowledge sources of documented knowledge in practice not available. In addition, the presence of documentation is no guarantee for its quality.

After successful collection of different knowledge types, contrasting of the acquired knowledge according to the dimensions of the process knowledge framework offers considerable support during generation of process improvement knowledge by identifying potential for process improvement and a more feasible "to-be" model. An example is the contrasting of acquired process capacity knowledge from activity performers with the process capacity knowledge acquired from process designers: different views by those people involved lead almost unavoidably to a discussion of misunderstanding, weak points in the processes, and potential for improvement. Contrasting process roles according to a specific process knowledge type is, however, only one possible approach. Also, contrasting different dimensions of the cube with each other (e.g., process roles and specific views) can contribute significantly to generation of comprehensive process improvement potential.

## **4.2 Process Knowledge Communication**

### **4.2.1 Adaptation of Content**

Simply deciding for a certain future "to-be" process description or model has little effect; only through the communication of knowledge that employees will need in the future can improvement take place.

While the necessary change management is not a subject of this paper, there is a clear connection: Who will need which knowledge and when they will need it depends not on the desired result ("to-be" model), but also on the path the organization takes (the change process for the organization) in an attempt to introduce the new process to the organization in a sustainable and visible manner. Typically there is an improvement plan, which contains the measures for change that have been decided upon, and the order in which they will be taken, as well as goals and priorities.

Building upon that, it can be decided what knowledge should be available to a given person. The process knowledge types that are necessary for their work must be communicated to every employee. A connection between the theory of the new "to-be" description and actual examples from

day-to-day business is very important for employee's understanding.

Also in this case observation of the process knowledge framework often proves helpful, since for example, the special knowledge needs of individual roles suggest the content of different process knowledge types to different extents and in different degrees of abstraction. At the same time, the employee should be able to access the complete process knowledge to establish a more common view of the different roles. This pertains particularly to the communication of the reasons for the change, that is the *process justification knowledge*, but also more generally to the relationship to the goals of the organization. Regarding the dimension of the various views, emphasis is only on communication of the dimension of understanding of the employee how things should run from the perspective of the organization. With respect to the acceptance of the new process design, personal opinions are also addressed.

The question dealt with till now about the knowledge that is ultimately necessary for an employee is indeed not equivalent to the question of what concrete content should be communicated to this person, because completely different factors are in play here. The extent as well as the degree of abstraction of the content to be communicated in order to build up a certain level of knowledge in a person depend upon previous knowledge, in particular upon mental models (as basis for understanding). An employee who has been on the quality management staff for many years will typically need less explanation to achieve the same level of knowledge than a new staff member, who has little overview of anything outside his immediate work environment.

Employees who have thorough background knowledge react impatiently when their time is used unnecessarily. This brings up the relevance of a further type of process improvement knowledge, namely knowledge about personal attitudes. The significance of this knowledge goes even further. Every employee should not just be informed of the absolute minimum of process knowledge, but rather they should be given an overview in order to improve their total understanding. Without a feeling for the personal attitude of an employee it is difficult to tell how far one can go without annoying him and in so doing endangering the acceptance of the total concept.

#### **4.2.2 Adaptation of Form**

Besides customizing what needs to be communicated, the form of communication needs to be customized as well. The perfect quality process manual, which only serves to collect dust, is to be avoided. This does not mean that process manuals are fundamentally pointless. It is, however, important to be conscious of various possibilities for transferring knowledge, and their customized application for various target groups. The range of options goes from classic training courses to workshops and personal discussions to procedures and graphic visualizations.

The social-communicative aspect should be used in training courses and workshops. Discussions between employees can be particularly valuable when people in different roles who otherwise rarely associate with one another are talking to each other. Such open discussions are excellent as forums for new suggestions and thus as an impetus for the next round of improvements, not only regarding content, but in particular with respect to awareness and acceptance.

In documents on paper or in electronic (possibly even interactive) form various types of writing and graphics can be used. This includes the entire palette of established models, languages and standards for process description. The use of such forms of presentation is not limited to documents; visualizations are also extremely useful.

Here we would particularly like to emphasize the possibility of almost completely automatically personalized electronic access. The currently established process modelling and visualization tools are meant for specialists and are barely usable outside this target group. The potential for a new class of systems, which also supports current standards such as semantic technologies, is huge.

As was the case for customizing information for a target group, choosing the appropriate mental model and having knowledge about personal attitudes plays an important role when deciding on the form of communication to use for a given target group. For example, certain forms of diagrammatical presentation may be proven to facilitate the understanding of complex information. However, such presentation will not accomplish anything if the target group, for whatever reason, does not like this form of presentation.

In conclusion, the communication stage is about transferring knowledge about processes to the employees in such a way that it is both understood and accepted. By customizing both the information and its form for different target groups, understanding is maximized, assuming willingness

on the part of the employees, and of course that the amount of effort necessary for this customization is reasonable. This stage can be supported by a large range of interpersonal as well as system-based (computer-based) options for interaction. The result is a key requirement (from a knowledge perspective) for successful improvement of processes: better employee knowledge about better-designed business processes, compared to the time needed for acquisition.

## 5 KNOWLEDGE INTEGRATION

Our framework needs to achieve two main goals. On the one hand, as we have explained previously, we need to integrate and consolidate the perspectives that different stakeholders have on processes. On the other hand, the framework needs to represent a communication tool that stakeholders can understand and share. The most suitable model to deploy our framework is the use of Semantic Web technologies.

The four main reasons that make Semantic Web technologies suitable for our framework are (Noy and McGuinness, 2001): (1) To share common understanding of the structure of information among people or software. This way, the model can be understood by humans and computers; (2) To enable reuse of already specified domain knowledge. (3) To make domain assumptions explicit; this means that concepts defined in the model have a well-defined and unambiguous meaning; (4) Analysis of domain knowledge is possible once a declarative specification of the terms is available.

Semantic Web software is being experimentally used by banks to help them to comply with the U.S. government's Patriot Act (the Patriot Act requires banks to track and account for the customers with whom they do transactions), by the European police force to follow crime patterns, and by telephone service providers to create applications that provide information about pay-per-view movies (Lee 2005; Sheth 2005). In addition to investment banks, the Metropolitan Life Insurance Company, the U.S. Department of Defense and the Tennessee Valley Authority have also used Semantic software to integrate enterprise data to comply with federal regulations.

According to TopQuadrant (TopQuadrant, 2005), a consulting firm that specializes in Semantic Web technologies, the market for semantic technologies will grow at an annual rate of between 60% and 70% until 2010. It will grow from its current size of US\$2

billion to US\$63 billion. According to William Ruh of CISCO, before the end of 2004, semantic languages was applied under the covers of well over 100 identified products and over 25 information service providers. Existing well-known applications that add Semantic Web capabilities include Adobe's Extensible Metadata Platform, Oracle has developed a database management platform based on a graph data model representing semantics, and Vodafone uses RDF to integrate its Live Web site with the third party providers that create content for the portal.

## 6 CONCLUSION AND FUTURE WORK

Knowledge about business processes is one of the most important assets of a modern organization today. The information about how an organization works, achieves its business goals, satisfies its customers' requirements, and how agile the company is in these respects is essential for its various stakeholders on every level, in and outside of the organization. This knowledge is also an irreplaceable resource for the introduction and application of information systems, particularly for process management and automation tools.

Current process management practices reveal problems regarding process knowledge (e.g. the process owner doesn't know the skills of the activity performer, management is not familiar with the flexibility of organizational processes, Best Practices/Benchmarks are not accessible or are unknown). Organizations have to deal with distributed, undocumented, contradictory, misunderstood, and often inaccessible process knowledge. The consequences are higher costs, poorer performance and quality, unfulfilled requirements and, in the end, unsatisfied internal and external customers.

Therefore it is important that knowledge about business processes is properly described or modeled, and that it is maintained. Only in that way can it be better acquired, analyzed, communicated, applied and continuously improved.

The business process knowledge framework is a tool that can support the management of business process knowledge in various aspects. This paper presented two of them. One is business process knowledge acquisition, where the framework helps organizations benefit from heterogeneous process knowledge sources and from different perspectives instead of seeing them as a burden. The other is business process knowledge communication, where

the framework can be of assistance in communicating knowledge about business processes to stakeholders in a fashion tailored to their different roles within or outside the organization. Using the advantages of semantic technologies, the business process knowledge framework can assist organizations in their efforts to improve their business processes.

## REFERENCES

- Benali, K., Boudjlida N., Charoy, F., Derniame, J.C., Godart, C., Griths, P., Gruhn, V., Oquendo, F., 1989. Presentation of the ALF project. In *Proceedings Conference software development environments and factories*, CRIN - 89-R-188. Berlin.
- Biazzo, S., 2000. Approaches to Business Process Analysis: a Review. In *Business Process Management Journal*. MCB University Press, Vol. 6 No. 2, 99-112
- Burlton, R.T., 2001. *Business Process Management – Profiting from Process*. Sams Publishing. Indianapolis
- Cardoso, J., Sheth, A., Miller, J., Arnold, J., Kochut, K., 2004. Modeling Quality of Service for Workflows and Web Service Processes. In *Web Semantics: Science, Services and Agents on the World Wide Web Journal*, Elsevier, Vol. 1 No.3, 281-308.
- Cardoso, J., Lenic, M., 2006. Web Process and Workflow Path mining using the multimethod approach. In *International Journal of Business Intelligence and Data Mining (IJBIDM)*, Inderscience Publishers, Vol. 1, No. 3, 304-328.
- Conradi, R., Fernstrom, C., Fuggeta, A., Snowdon, B., 1992. Towards a Reference Framework for Process Concepts, In *Proceedings of the Second European Workshop on Software Process Technology*, Trondheim, Lecture Notes in Computer Science, 635, Springer-Verlag, London
- Cousins, J., Stewart, T., 2002. What is Business Process Design and Why Should I care?. Rivcom LTD. Whitepaper.
- Curtis, B., Kellner, M. I., and Over, J. 1992. Process modeling. In *Communication of the ACM*, Vol. 35, No. 9, 75-90.
- Habermann, F., 2001. *Management von Geschäftsprozesswissen : IT-basierte Systeme und Architektur*. DUV, Wiesbaden
- Hrastnik, J., Rollett, H., Strohmaier, M., 2004. Heterogenes Wissen über Prozesse als Grundlage für die Geschäftsprozessverbesserung. In: *Prozesswissen als Erfolgsfaktor*. Hrsg.: Engelhardt, Corinna/Hall, Karl/Ortner, Johann. Wiesbaden: Gabler, 37-60
- IDS Scheer AG, Pierre Audoin Consultants GmbH, 2006. BPM Study 2006. *Business Process Report 2006 - Eine repräsentative Umfrage unter 150 IT-Entscheidern*, BPM Study 2006. IDS Scheer AG, Pierre Audoin Consultants GmbH. Retrieved November 15, 2006, from <http://www.ids-scheer.com/international/english/profile/92291>
- Johnson-Laird, P. N., 1983. *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Cambridge, Cambridge University Press.
- Scheer, A.-W. 2000. *ARIS - Business Process Frameworks*. Springer-Verlag. Berlin 3rd edition
- Strohmaier, M., Farmer, J., Lindstaedt, S., 2005. *The Gap Between Information Technology and Quality Management - A Trend-Survey of Quality Managers in Austria and Germany*, Trend-Survey .Know-Center - Austria's Competence Center for Knowledge Management. Retrieved November 15, 2006, from [http://www.know-center.tugraz.at/content/download/725/4123/file/QualityCosts\\_Survey\\_Revised.pdf](http://www.know-center.tugraz.at/content/download/725/4123/file/QualityCosts_Survey_Revised.pdf)
- Lee, Y. L., 2005. Apps Make Semantic Web a Reality. In *The Industry Newspaper for Software Development Managers*. Retrieved November 15, 2006, from <http://www.sdtimes.com/article/story-20050401-05.html>
- Lonchamp, J., 1993. A Structured Conceptual and Terminological Framework for Software Process Engineering. In: *Proceedings of the 2<sup>nd</sup> International Conference on the Software Process - Continuous Software Process Improvement*. Berlin, Germany
- Noy, N.F., McGuinness, D.L., 2001. Ontology Development 101: A Guide to Creating Your First Ontology. Retrieved November 15, 2006, from [http://protege.stanford.edu/publications/ontology\\_development/ontology101-noy-mcguinness.html](http://protege.stanford.edu/publications/ontology_development/ontology101-noy-mcguinness.html)
- Sheth, A., 2005. Enterprise Application of Semantic Web: the Sweet Spot of Risk and Compliance. In *IFIP International Conference on Industrial Applications of Semantic Web (IASW2005)*, Jyväskylä, Finland, Springer.
- TC 176/SC 2., 2005, *ISO 9000:2000 - Quality management systems - Requirements*, International Organization for Standardization.
- Teng, J. T. and Kettinger, W. J., 1995. Business process redesign an information architecture: exploring the relationships. *SIGMIS Database* 26, 1 (Feb. 1995), 30-42. DOI= <http://doi.acm.org/10.1145/206476.206481>
- TopQuadrant, 2005. TopQuadrant, <http://www.topquadrant.com/>. 2005.
- van der Aalst, W. M. and Weijters, A. J., 2004. Process mining: a research agenda. In *Comput. Ind.* Vol.53, Num. 3, 231-244.
- Zesar, K.D., Mesaric, G., 1999. A Process-Oriented Quality Management Model for Software Developing Cooperation Networks. In: *Proceedings of the 6th European Conference on Software Quality*