Process Modeling for Network Organizations – The Impact of the Process Environment

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Abstract: Attention to the specific characteristics of rather unstructured processes and the consequences for the modeling of these processes can only rarely be observed. This paper presents the results of a process analysis in a research network covering highly cooperative processes. The analysis shows that the network exhibits processes were conventional modeling methods fail to generate meaningful results. An in-depth analysis reveals that an optimized execution and an optimized outcome depend more on the environment of the processes than on an optimized sequence. Therefore it can be concluded that in order to achieve optimization it is fundamental to analyze the environmental factors.

1 Introduction

Although Keen and Scott Morton already differentiated between highly structured, semi-structured and unstructured processes in 1978 [KS78], until today there is only little attention to the specific characteristics of these types of business processes [Da07]. This is especially notable in the face of constant change of value adding structures towards more flexible and dynamic organizational structures [Or02]. The rapidly changing organizational environment forces companies, as well as scientific organizations, to cooperate in networks in order to access and develop the knowledge necessary to achieve flexible adjustments. Since the 1990s, business processes in organizations have been effectual analyzed and optimized using well-established Business Process Modeling (BPM) methods [Da93, HC93]. However, due to the increased process dynamic and flexibility as well as the emergent role of knowledge within the process design and for the processes itself, the analysis and design of business processes faces new challenges [DJB96, MMG02]. Therefore the suitability of traditional modeling methods in this changing context needs to be evaluated.

In this paper the authors present a process analysis that has been carried out in the research network GARNET (www.garnet-eu.org). The network covers structured as well as more unstructured processes. GARNET is a Network of Excellence (NoE) that is being funded by the European Commission (EC) within the 6th Framework Programme. It was the objective of the EC to strengthen research and technological development within the European Union and to increase the international competitiveness. The purpose of the network is to strengthen and develop community, scientific and technological excellence by means of integrating existing and emerging research activities and by exchanging knowledge. It aims to integrate the research capacities of the network partners and, at the same time, to advance knowledge within their topic domain [Eu03a]. GARNET is a science network addressing the phenomenon of globalization and regionalization. It comprises 42 leading research centers and universities from 17 European countries.

Within the GARNET network the authors of this paper were in charge of the development of a collaboration platform and its introduction into the network. The platform aims at supporting communication, coordination, and collaboration within knowledge creation processes. Carrying out a web usage analysis, we observed that the GARNET users did not use the platform in the intended way – which is mainly for collaborative purposes – but instead for coordinative and administrative tasks [BG08]. Driven by the results we subsequently carried out an analysis and optimization of the processes in the GARNET network. The results are presented in this paper. The analysis was directed to achieve a better integration of the platform with the network processes. The integration aimed to optimize the support of coordinative and administrative tasks as well as to foster virtual collaboration. One objective was to create a better environment for information exchange to initiate the emergence of new relationships. The idea was to create the essential social capital that guarantees knowledge exchange and a functional network [Ri05]. For further details about the GARNET network, the platform, and its analysis please refer to [RBRG08, BG08, BRR08].

The objective of this paper is to present the results of the process analysis and optimization, as well as a discussion thereof with respect to the problems that appeared during the modeling phase. We will show that the modeling worked well with administrative and coordinative processes, but due to a lack of structure it was not reasonable to model the core processes of the network. First, in section two we provide an introduction to the remainder of the paper with a presentation of the research context; we then present related work in section three. In section four we discuss the problems experienced during the modeling phase and present the results of a series of interviews that have been carried out afterwards in response to the problems. Based on the interview findings we then argue that it is the environment of the unstructured processes that fundamentally affects its outcome. We will conclude the paper with a short summary.

2 Research Design

2.1 Research Question

Subject of our research work is the management of research networks. Research networks aim to provide increased connectivity between the network partners in order to improve the dissemination of knowledge within the network [CCMV08]. In order to analyze the applicability of specific management methods in a network organization, in this paper we present the results of the application of BPM in a research network. BPM provides methods to analyze and design processes within the process management lifecycle [We07]. Through analysis and optimization of the processes, we aim at a better integration of technology with the working practices. Within this paper we want to focus on the limitations of traditional modeling methods. Therefore our research question is:

Which potentials and limitations characterize the application of traditional process modeling methods in research networks?

Our objective is to highlight two major findings. Firstly, we want to show that when conventional process modeling are applied in a dynamic work context, a significant part of the network's activities remain uncovered. Secondly, we want to point out that for the optimization of those processes that are left uncovered, in this context it is the process environment that plays a significant role. To substantiate these findings we will present the procedure and the results of a process analysis in the GARNET research network.

2.2 Research Design

As a preparation for the process analysis we developed a regulatory framework for the classification of the process models. Sources for the creation were publications of the European Commission within the 6th Framework Programme [Eu03b, Eu03a]. These documents structure activities in a research context and are therefore also representative for other types of research networks. To model the processes we picked Value Chain Diagrams on an abstract level and the Event-driven Process Chain (EPC) due to its wide acceptance in practice ([Da04]) on a detailed level. The EPC comprehends different views on a process: data, function, service, organization and process view. For details please refer to [Sc99]. The data used in the process modeling was collected in a series of interviews. The analysis was followed by an optimization that aimed at improving process efficiency through a better integration of collaboration systems. During the modeling phase we encountered problems modeling the core research processes due to their lack of structure. In order to better understand these problems, we applied a further set of modeling techniques which we identified from the literature (see section 3). Motivated by the problems we encountered and in order to better explore the factors that drive and determine the flow within this type of processes, we initiated a second series of interviews. The interview results show that the process environment is more important than the optimization of the temporal and logical chain of process activities for achieving intended network process outcomes.

The two interview series were open but guided [Kv96]. The guidelines have been slightly modified for every interview partner to take their role and position within GARNET into account. Face-to-face interviews were chosen where possible. Alternatively we arranged telephone conferences. As interview partners, we selected actors that play key roles within the network. Altogether 10 different GARNET members including the network manager, the PhD School manager, network and research group coordinators, as well as senior and junior researchers, have been consulted. The interview partners came from all organizational units that have been identified in the reference framework. They have been prepared in the run-up to the interviews with information on the intended topics. Some of them have been consulted in both interview series. Every interview lasted between 1 and 2.5 hours. A summary of the interview guidelines is shown in Table 1. It was in principle the same for the first and the second interview series. While the interviews in the first series concentrated on the sequence and characteristic of activities, those in the second focused on why specific activities were performed in a specified way and not in a way that might be more efficient or effective from a technical point of view.

Interview section	**Questions Synopsis**
Personal and Research Background	What is your research background? What kind and characteristics do other research projects you are also involved in have? If there are any, what kind and characteristics do other collaboration platforms you already used have?
GARNET	What's your position and role within the GARNET network? What is your attitude towards GARNET? What is your contribution to GARNET? What is the contribution of GARNET to your work? How cooperation in general does take place in GARNET? How do you characterize your working activities related with GARNET in detail? - Which tasks do you perform in which sequence, which documents, organizational units and technical tools are related with the tasks?
GARNET Collaboration Platform	How important is the platform for your personal work – what did you like and dislike? Do you have suggestions for improvements? Can you think of other situations where the platform might be of use in GARNET? Compared to other research projects, are there any particular advantages and disadvantages concerning the GARNET platform?

Table 1: Interview Guideline

3 Related Work

Our research focuses on methods for managing network organizations. Since the 1990s and based on the publications of Hammer, Champy and Davenport [Da93, HC93], Business Process Management and BPM are well established as management methods in research and practice (e.g. compare [BK03, Sc99]). However, our analysis within the research network revealed a specific type of process that cannot be modeled sensibly due to their inherent lack of structure. Therefore the following literature review focuses on publications that deal with semi- and unstructured processes. The review aims to characterize this type of processes and to also identify methods that describe approaches for handling these processes.

One central characteristic and at the same time the main reason for the weak structure of processes within GARNET is the impact of creativity. In the literature some theoretical contributions have looked into the characteristics of creativity (e.g. compare [Br89, DL02, FCG08, Sh00]). Creativity is an inherent part of scientific collaboration; research work quite often is innovation, it manifests as interaction between a person's thoughts and a socio-cultural context. The specific role of creativity within business processes has been analyzed by Seidel et al. [SMRB08, SRB08]. They introduce the concept of *pockets of creativity* to identify and describe creative parts of business processes. It is referred to these process parts as creative tasks. The pocket framework is based on four aspects of creativity identified by Rhodes: the creative product, the creative process, the creative person and the creative environment [Br89]. The creative product corresponds to the business process object; the creative persons are the actors within the process. The creative environment including creative tasks, creative persons and creative products is referred to as a pocket of creativity. A creative-intensive process is a single pocket of creativity or a business process that at least contains one pocket of creativity [SMRB08]. Creative tasks happen in a creative environment [Rh61]. They are characterized by a lack of predictability concerning their sequence within a process and the process outcome, by knowledge intensity, communication intensity and a high risk. Seidel et al. emphasize the complex interplay between various conditions that shape creativity-intensive processes.

Closely related to the impact of creativity on business processes is the impact of knowledge intensity. Domain-specific knowledge appears to be a necessary condition for creativity [FCG08]. Human beings need knowledge "to guide their actions to a successful outcome" [Cr90]. Hence, the application of knowledge is an important part of most business processes to some extent. Knowledge-intensity in processes often leads to higher complexity [DTHS05]. Knowledge and the processes affected from it are subject to knowledge management (KM), which is well established as a distinct research area. A KM strategy is derived from the overall business strategy. Within the KM context, in newer publications the concept of knowledge workers is often applied. Knowledge workers are those workers within organizations that are concerned with highly complex jobs. They need to analyze as well as to solve complex problems, to develop plans and to design products, services or processes [Ha07]. Therefore knowledge workers strive for as much flexibility and autonomy as possible [RRMA05]. Their work is characterized by spontaneity, communication-intensity and low predictability. The processes and their outcome are determined by high context variability and high action complexity [RRMA05]. The context of a process is shaped by the factors that influence the process execution (e.g. people, knowledge, culture, topic etc.). The high variability within the context makes it impossible to specify details of specific process steps. Complexity of actions concerns the process steps itself. A high variability of the steps makes it difficult to describe the process as a whole including all execution alternatives. High variability in general influences the ability to plan a process.

Within the KM research area different approaches have been developed that aim at an integration of specific knowledge-related elements into existing or new modeling languages. Remus for example presents *blueprint* whose development was guided by the idea of reference modeling [RS03]. Blueprint consists of a procedure model and a conceptual model. In the conceptual model all KM activities are described that support the knowledge life cycle. The procedure model is based on the conceptual model and contains an activity set necessary to prepare a business process for KM and to integrate the business process in the enterprise-wide knowledge management concept. The conceptual model provides reference processes for knowledge management. Papavassiliou et al. present a concept that is based on the idea of specific knowledge objects [PM03]. A knowledge object represents the explicit knowledge required in a specific business process. In order to model knowledge-intensive processes, they differentiate between standard tasks and knowledge management tasks (KM tasks). KM tasks describe work associated with the generation, storage, application and distribution of knowledge in the business processes. Though knowledge-intensive processes are defined as weakly structured within the concept, no special conclusions for the modeling of processes are drawn at all. The concept of Remus as well as that of Papavassiliou is partly based on the EPC. In contrast, Gronau et al. introduce a proprietary modeling language for knowledge-intensive business processes [GH06]. The KMDL enables the modeler to add detailed information describing the transformation of a business process object within a specific process task. It provides elements to model the task input, the task output, and information- and knowledge-transformation flows. Figure 1 shows a simple KMDL example (the creation of a publication) from the activity view. The activity view extends the process view and visualizes the transformation of knowledge objects.

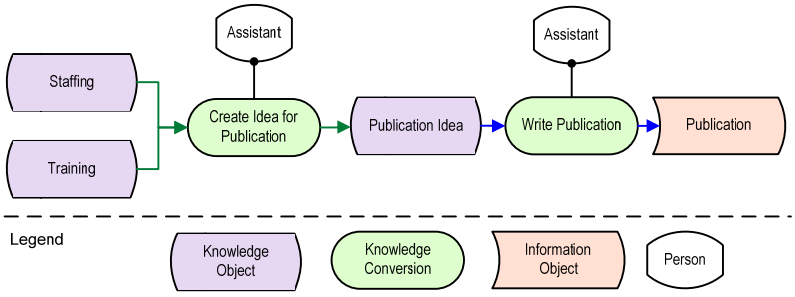

Figure 1: KMDL example (compare [GH06])

Some more work that especially focuses on a theoretical foundation has been carried out by Dalmaris and Markus. Dalmaris presents a framework for the improvement of knowledge-intensive processes [Da07]. It consists of three components: an epistemological foundation, a business process ontology, and an improvement methodology. The business process ontology is used for the capturing of data on those key components of the business process that are critical for the improvement effort. The improvement methodology provides concrete steps for a business process improvement taking the ontology into account. The process analysis is applied on the process level as well as on the function level. Markus et el developed a set of principles for the design of organizations based on a design theory [MMG02]. The principles focus on the design of IT systems to support enterprise decision support systems. The principles are shaped apart from the usage of specific modeling methods for the design of business processes.

Summing up the literature review, we conclude that especially knowledge-intensity and creativity lead to processes with a lack of structure. Flexibility and autonomy with regard to process flow are a typical (and necessary) characterization of processes whose output is characterized by a high level of knowledge-impact and creativity. Furthermore we conclude that whereas the analysis of the characteristics of more unstructured processes and the development of new modeling approaches has gained some interest in the literature, an analysis of conventional process modeling techniques for the improvement of collaborative processes can only rarely be found.

4 Discussion of the results of process modeling in research networks

4.1 Discussion of the experiences of applying conventional modeling to collaborative processes

Our process optimization project led to a detailed understanding of the functionality needed to support the research network from a technical point of view. The results show that the collaboration platform is well positioned to meet the core needs of the network but that it also needs some enhancements for an efficient integration into the existing processes. A central document repository including version management and a dedicated rights management is indispensable to overcome the regional fragmentation of the GARNET network. This is especially true when organizational units that consist of representatives of different partner institutions (e.g. the Project Management Committee) work together. The document repository also functions as an archive and as a base for the preparation of information dissemination on the website. The second component is a member and expert database comprising detailed profiles and social network browsing functions. Social browsing facilitates the creation of social networks and increases the awareness of other members and research groups [Ri05]. This is especially important for the functioning of the network, which depends on an appropriate density of social ties. Therefore not only the members should be linked with oneself, but also the members with other objects on the platform they are related to. In addition, the expert database should also allow the inclusion of external contacts. Also important is an Email-based automatic notification system that informs about ongoing changes and thus increases workspace awareness on the platform.

The regulatory process framework differentiates the processes into core and support processes. Core processes create value for the network. According to the European Commission, this applies to knowledge creation as well as to the integration of the partners' resources and competences [Eu03a]. Furthermore, the core processes can be separated into integrating activities, spreading excellence activities, jointly executed research activities and management activities. The support processes do not directly provide knowledge creation or spreading of excellence but facilitate the core processes. Our process modeling revealed one elemental perception very early on: while it was relatively easy to model processes in the context of integrating, spreading excellence, and with regard to management activities, modeling of the jointly executed research processes was only possible to a certain extent. Within this area we can differentiate between coordinative processes, the modeling of which is again relatively easy (e.g. preparation, execution and wrap-up of workshops or reporting), and the core research processes that could not be sufficiently modeled (e.g. publication creation or collaborative research).

In order to develop a more detailed understanding concerning the nature of our modeling problem, we tried to apply other knowledge-related modeling methods on the case. Papavassiliou et al. provide a workflow-oriented model that focuses on modeling objects and typical knowledge management tasks to transform these objects [PM03, PNAM03]. A typical knowledge object in our case may be a publication. Typical tasks (generation, storage, distribution and knowledge application [PM03]) could also be identified. A problem was the decomposition of the tasks into subtasks and the concatenation of the tasks to processes. It was impossible for the interview partners to specify a sequence of the tasks. In principle they could be executed in random even if they are loosely coupled. Remus et al. alternatively provide a three step approach for the modeling of knowledge-specific processes and integration into the value chain processes [RS03]. In the first step reference knowledge processes are provided that need to be adapted and integrated into the business processes. In the second step the processes are further decomposed into EPC knowledge chains. The reference processes have been deduced from KM methods and instruments and therefore are more comprehensive than necessary in the network context. But again the major problem is the concatenation of the processes as well as the decomposition into tasks and their concatenation. The KMDL as a modeling method especially for knowledge-intensive processes [GH06] provides a more detailed knowledge modeling approach in combination with a more abstract task description. It facilitates the modeling of knowledge flows and of specific knowledge transformation types. Due to the more abstract nature of the tasks it was possible to assign knowledge objects to the tasks and to describe how they are transformed within the tasks. But due to the more abstract nature it was also impossible to assign specific information system features or specific network roles to specific tasks. A great variance depending on the work context of the interviewed person made it impossible to define clear solutions for a specific situation using the KMDL.

Even if it was not possible to model straight sequences, it was possible to identify typical phases that affect the processing of the concerned knowledge object. The succession of the phases follows typical patterns. However, the patterns are not necessarily applied. The application depends on the research context, i.e. the country, the research group or the cultural background. These phases are comparable to knowledge-related tasks (e.g. those identified from Remus or Papavassiliou), but in comparison to EPC activities they are more vague, abstract and less formalized. Especially the modeling of an optimized chain is not possible. An approach for a definition of specific phases for example provide Shneiderman, who specifies four phases and eight activities describing creative processes [Sh00], and Papavassiliou [PM03]. The formulation of phases may help to analyze rather unstructured processes. Within every phase an analysis of related persons, knowledge object and application systems can lead to findings that facilitate the optimization of the working patterns.

4.2 Discussion of environmental factors that influence the collaborative processes

In order to analyze these phases and the cultural environment that affects them, we conducted a second interview series in the GARNET network. The interviews revealed some more qualitative and cultural aspects that affect the efficiency and functioning of the processes. One issue for example is that often senior researchers avoid using the platform by instructing junior researchers to execute the platform-dependent work. Junior researchers however are generally only poorly connected within the network [RBRG08]. In a network context that depends heavily on the creation of social capital, this is especially problematic, because the ability of the senior researchers to create a denser network structure cannot become effective [RBRG08]. Another issue is that most researchers seem not to hold much interest in collaborative work because single author publications are much more appreciated within the GARNET network. Furthermore, applying for mobility funding in many cases is motivated more by financial than by collaborative aspects. These cultural framework conditions highlight the importance of the environment in which the collaboration is taking place. It shows that the creation of a cooperative culture that facilitates a creative collaboration is important. A third issue stems from the observation that we detected some phases of intensified platform usage that exist outside the typical usage processes. An example is an increased usage before or after social events, because of the need to inform about the event or the attending participants. It is especially important to support these phases through appropriate process and platform design because they are essential for the buildup of social relationships that last longer than the one conference event. In this context it is notable that several interviewees explicitly pointed to the importance of trust as basis for effective collaboration.

The platform facilitates several features that are typically used within a Web 2.0 context and therefore act as tools for collaborative online content creation. However, our optimization project has shown that these features are not always used on the platform in an efficient way and that improvements are possible for some processes. A corresponding discussion in the interviews showed that network members knew about these features but did not know how to use them in their personal and well-established workflows. Hence the flexibility of the platform is on the one hand essential for an appropriate usage because of the rather unstructured usage context, on the other hand however this also acts as a barrier to its adoption. Additionally it was pointed out that using the platform was often perceived as extra workload, because parallel work inside and outside the platform was necessary to deal with specific problems (e.g. providing event information). To solve this problem, a better technical and organizational integration of the dissemination channels is necessary. On the one hand, an integrated system might provide data-centered workflow patterns (e. g. for the preparation, execution and wrap-up of conferences and seminars). On the other hand, these workflows should be adaptable to meet the needs and customs of specific user groups and in specific situations. Solutions for this can be found in the Workflow Management Systems research area (e.g. compare [ATEA06, ATPS08, AWG05]).

Summing up the observations, we can identify two different problem areas that prohibit the modeling of an optimized process flow. On the one hand, we observe a situation-specific variance of the process execution depending on a set of weak factors that cannot be identified when modeling tasks and their sequences. It can be differentiated between cultural, organizational and technical factors. Cultural factors like social relationships, the culture of collaboration and established work practices determine the flow of activities and the tools being used on a micro level. These are for example dependent on the country or the research team. Organizational factors like different organizational structures or competing business and external rules caused by a country- and institution-crossing networks lead to a divergent assignment of persons and roles to tasks within specific situations and in specific work teams. The design and availability of information systems influence the way and by whom they are used. These factors shape the environment in which the process execution takes place. On the other hand the working practice itself is affected by a need for flexibility because of a high impact of creativity and knowledge-intensity. The environmental factors need to be formed in a way that facilitates creativity and flexibility in order to achieve the intended process outcome.

4.3 Conclusions for further research

This paper focuses on processes in a highly dynamic and unstructured research context. Even though the literature review indicates that a common consensus is missing as to how such a type of business processes can be characterized, there is evidence that a special class of processes exists that must be modeled and analyzed in a specific way. The descriptions for defining this type of processes vary from “unstructured” [PM03], “knowledge-intensive” [Da07, ESR99, RS03], “with a high task complexity” [Da07], “emerging” and “unpredictable” [MMG02], “weakly-structured” because of a lack of formality [PM03] to “creative” [DL02, FCG08, SMRB08, SRB08, Sh00]. The variance and the lack of a commonly accepted definition point to a need for developing a common understanding in future research. The process as the object of research must be further characterized. The characterization should aim at a separation from those processes that can be modeled in a conventional way. There is also a need to evaluate, whether or not different classes of unstructured processes exist in different organizational contexts with different profiles.

Furthermore, the factors that determine the efficiency and effectiveness of this type of processes need to be determined. Since traditional process modeling methods lack the means to cope with them, the integration of other or the development of new methods appears necessary. The identification of typical phases shows that modeling on a high abstraction level is possible, whereas the optimized outcome with optimized resource consumption is more dependent on the environment of the processes than on an optimization of the activity chain with respect to time and sequence. The publications from Seidel [SMRB08, SRB08], the work concerning creativity in general [Br89, DL02, FCG08] and the methodological work from Dalmaris [Da07] and Markus [MMG02] provide an appropriate grounding for this. Additionally, the complexity of these factors raises the question if traditional diagram-oriented modeling is an appropriate approach in this context at all. Furthermore, it needs to be analyzed, which of the factors can be predetermined in the optimization phase and which might change during execution and therefore need flexibly designed solutions. In order to further shape the understanding of process environment, a multidisciplinary approach integrating findings from the Knowledge Management and Computer Supported Cooperative Work research domains might be considered.

Finally, it must be taken into account that these observations are based on processes in a highly collaborative research network context. Therefore, the portability to other contexts needs to be examined. However, the literature review has shown that a high impact of creativity and knowledge generates processes of high complexity and with a lack of predictability. Hence, we can conclude that these observations might also hold true in other contexts. Furthermore, we only regarded the EPC as modeling method and it needs to be evaluated if these findings are also valid for other methods (e.g. BPMN). However, the similar structure of conventional modeling methods as all being chain-oriented indicates transferability of the findings.

5 Summary

The goal of business process reengineering is the identification and elimination of inefficiencies in the flow of activities of specific processes [BK03]. Hence an optimal sequence of activities with respect to time and logic needs to be designed. But for unstructured processes, which are often affected by a creative outcome or by a situation-specific flexibility, what matters more in the optimization is the quality of the results instead of an optimized sequence of activities. Therefore not the optimization of the task chain is to be focused but the optimization of the process environment in order to create a context that enables the creation of an optimized process outcome. This leads to a fundamental change of the perception of business process reengineering for this type of processes.

Based on the analysis of the process optimization and interview results in this paper we are able to draw two main conclusions for the analysis and optimization of unstructured processes. Firstly, the processes are not structured by a chain of micro activities but by phases that tend to be more abstract and less formalized. Secondly, because of the lack of structure, we need to integrate new or other approaches that facilitate the analysis and optimization of the environment of the process instead of its activity sequence. Due to the parallel and overlapping existence of highly structured and more or less unstructured processes in organizations, these approaches need to be coupled with conventional methods or may extend them. Further research is also necessary in order to to analyze the characteristics of such a process environment in more detail.

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