The Myth of Business Process Modelling for Emergency Management Planning

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ABSTRACT

Over the last two decades a significant number of projects tried to convey the concept of business process management to the domain of emergency management. Most of these approaches sought a partial automation for the execution of standard operating procedures in the sense of workflow support, while others strived for the support and integration of information management and data streams in command centres during a crisis. This paper focuses on the planning of disaster response for reasons of better preparedness. It discusses whether emergency management organisations can capitalize on off-the-shelf business process modelling tools to prepare for disasters more effectively, and whether the concepts of process modelling can be applied to standard operating procedures and vice versa. Moreover, it investigates whether such tools can efficiently support a collaborative preparation of police, fire departments, and rescue organizations. This paper will demonstrate why conventional business process means are inapplicable as planning tool in this domain. And it will also give an outlook to so called smart checklists that might be better suited both for the planning and response phase of emergency episodes.

Keywords

Process Management, Business Processes, Standard Operating Procedures, Smart Checklists

INTRODUCTION

Looking back the last two decades, several security related projects have been started with a more or less active role of emergency management organisations like police or fire departments. Several projects have tenaciously been trying to directly apply process management means to standard operating procedures for emergency response, but not fitting the bill of rescue organisations. Many of these approaches sought a partial automation of control flows for the execution of standard operating procedures (Rüppel and Wagenknecht 2007; Paulheim, Döweling et al. 2009; Khalilbeigi, Bradler et al. 2010; Becker, Lee et al. 2011). Other approaches strived for seamless information flows by integrating information management and data streams in and between command centres (Soini and Polancic 2010; Kittel and Sackmann 2011; Ziebermayr, Huber et al. 2011) or between command centres and rescue units during a crisis (de Leoni and Mecella 2010; Franke and Charoy 2010; Franke, Widera et al. 2011). In the course of their projects all of them discovered that the identification of procedures of rescue organisations is essential for any research contribution that strives to improve the support of rescue workers and their organisations (Kunze, Rodriguez et al. 2009). Unfortunately, they found no adequate means for domain experts to grasp, to describe, or to formally model their courses of action themselves in daily work or for large-scale crisis. As far as we know no other research group investigated to date a modelling methodology custom-tailored for the emergency domain. Our objective is to support emergency experts in their modelling endeavours themselves. (Ziebermayr, Huber et al. 2011) discuss their ideas on customising a modelling language and on so-called activity templates, but do not elaborate on modelling concepts, tool support, and evaluation results.

At a first glance, means for process modelling come to mind. They are well established for software processes and business processes (BP) with proven benefits. But we witnessed that the term process modelling is very

often only used as buzz word in many security projects in order to give a semblance of professionalism for disaster preparation. Essentially, we experienced that conventional business process modelling means are completely inappropriate to formalize standard operating procedures by emergency management organisations themselves. Consequently, BP software is also unfitting as planning support in this domain.

However, the core objectives of business process modelling still provide vital contributions towards empowering rescue forces amid emergency preparation. On the one hand, process modelling is instrumental for establishing transparency inside and across organisations. A process model represents the activities planned as well as anticipated and their respective organisational units responsible for execution. Hence, courses of action can be communicated inside and across organisational boundaries. On the other hand, a process model can serve other purposes such as performance analysis, generation of checklists, simulation of counter measures, etc. These opportunities basically strive for quality improvement and rely on analysing patterns of the schema as well as simulation of admissible instantiations.

We present a critical reflection of deploying process modelling for the planning of counter measures for major disasters. And we discuss the objectives and concepts of process modelling, e.g. does the functional scope of tools for process modelling coincide with the objectives of rescue organisations or do the modelling concepts adequately address the objectives of rescue organisations.

The paper characterizes means for process modelling and contrasts them to experiences gained in a variety of projects in the realms of emergency management. It represents also in some parts a confessional account by not showing just results proofing a research theory, but by also describing reasons for research, technical and empirical evaluation results as well as setbacks and frustrations experienced. This type of research report is acknowledged since (Schultze 2000).

The paper is organized as follows. After an introduction about business processes we present in the third section the highlights of our experiences gained in the use of process modelling methods and tools for emergency management. Following this case story we will contrast objectives of business process modelling with our experiences made. In section *Outlook* we will outline our future research work trying to overcome the restrictions of the process world. Finally, we draw our conclusion for the sake of planning counter measures.

BUSINESS PROCESS MANAGEMENT

Industry intensively employs business process management means to model, analyse, and execute recurrent and predictable business procedures. Very famous and market-leading is a software based on a graphical modelling language named event-driven process chain (EPC), developed by a research group under August-Wilhelm Scheer in 1992 (Keller, Nüttgens et al. 1992). It describes the main concepts of a business process as: *functionalities*, triggered by *events*, executed by *organisational units* (referenced by *roles*, *positions*), passing and creating *information objects*, and linked by *connectors* allowing one to control the flow of functionalities, i.e. how functions are called (*and, or, xor).* Later, for standardisation purposes, a similar graphical modelling language named BPMN (Business Process Model and Notation) was developed (Owen and Raj 2003; BPMN O.M.G. 2004). Apart from that also other languages are available for formally representing business procedures (Mendling and Nüttgens 2004; Bartonitz 2005). They distinguish from each other with regard to the concepts used for the representation of procedures as well as in their methods for capturing processes. Several business process modelling tools are available on the market relying on these models (ARIS, ADONIS, Yawl, Innovator, etc.). Use of this technology promises quality improvement, reduction of duration time, leaner procedures, avoidance of working mistakes, possible deployment of unskilled workers, better traceability, and higher simplification of business procedures. Since rescue organisation also talk about procedures, business process management means come to mind as natural candidate to ease and improve emergency planning processes.

Moreover, emergency management organisations have discovered for themselves the concept of standard operating procedures (SOP) for describing commonly agreed courses of actions, which fire brigades, police departments, and rescue organisations should follow when in action (see for example (Cook 1998), (FW FfM 2011)). It seemed obvious for us to elaborate whether these commercial business process modelling solutions might also be able to represent these SOP. We based our research on experiences made when trying to apply business process management means to medical guidelines (Sedlmayr, Rose et al. 2007).

CASE STORY

We started to investigate the potential of process modelling for emergency management by translating the so called ÜMANV (supra-regional *mass casualty* situation by trauma- and / or ill human beings) operational concept (Schmidt 2007) into a formal process model. The specification of this concept, in which 500-1200 injured

persons have to be treated, was the starting point of our modelling exercise. The original concept description encloses a text document of approximately 45 pages length, enriched by some graphics and visualization diagrams that already suggest a process-orientated view, however do not go beyond it towards formalization. Objectives and requisites are mentioned in the specification although not explicitly exposed. The outcome of this research was a modelling methodology for emergency management processes, based on a commercial BP management tool and developed in collaboration with domain experts. It comprised several modelling views that illustrate the strategic level of the operational concept together with separate views on the services and the organizations that deliver them. The resulting model promoted an analytical evaluation of the procedures, thus boosting a high professional precision (Arsenova 2008; Rose, Peinel et al. 2008).

But, our experience of this modelling endeavour was sobering.

Most process modelling tools available stick to their own terminology and that is basically not changeable and not adaptable to new nomenclatures. This is inacceptable for somehow military oriented organizations like fire or police departments. They have to follow their own rules, legislation, and standards; a change of terminology could lead to confusion and failure especially with respect to the command structure. Also, ambulances, fire departments, and police use different terminologies. Translation and explanation of terms have to be provided for a collaborative planning. And, different goals and their consequences have to be unveiled (Smith, Dowell et al. 1999).

The underlying meta-models and analysis services of prevailing process management tools are tailored to business activities, not emergency management activities. Thus, they mostly suppose financial interests of the user. To give an example, the tools can analyse concerning resources like time and money, but not according achievement of objectives or goals. Correspondingly, the underlying meta-models of the tools do not tackle goals or objectives adequately. But in the world of police and fire departments the fulfilment of tactical and operative goals is the core driver of operations.

Other important model differences revolve around the representation of the organisation and their units. While enterprises are mostly built upon permanent organisational units, emergency organisations rely on temporal units, with changing location, roles, capacities, and the like. In many instances, specific roles or positions require specific capabilities of a person by law or directives. On the other hand, resources sometimes require certain capabilities, i.e. only specifically trained persons can use a specific resource (e.g., rescue diver, rescuer from heights and depth, special crane driver). Also, organisational changes might happen due to changes of phases caused by triggers (Hoogendoorn, Jonker et al. 2005).

Most tools are geared towards an automatic execution of processes as workflows. While doing so, this intention impacts strongly the methodology on how and in which order to model. Often, it forces users to enter details unnecessary for a non-automatic planning process. For the same reason user interfaces are packed with complex functions, most of them unnecessary for a planning process. We found no tools allowing one to scale up or down the interface to different application purposes. Consequently we received a strong feedback from our end users (fire fighters) that they are not able to use the tool and we concentrated on the research question on how process management means can be used by emergency managers themselves.

Another research endeavour was to apply process management means to smaller communities and virtual organisations like harbours or airports. An EC-project named ERMA (Electronic Risk Management Architecture, 6th FP, FP6-2005-IST-5 034889) strived to support risk management processes in small to medium-sized communities in case of natural or man-made disaster. The supported life cycle of risk episodes ranged from key indicator-based monitoring services, via process-oriented guidance for prevention and relieve, up-to public alerting services that are accompanied by citizen relationship management components to advise the public and gather information from the public (Berger, G. et al. 2007a; Berger, G. et al. 2007b; Peinel and Rose 2010).

Considering the user feedback on the commercial tool, our research result should now serve as a user-friendly, easy-to-use process modelling tool for better planning and supervision of activities during crises. But frankly, it did not really create a wave of excitement from our application partners (harbour management team or responsible managers of a small town). They argued that they do not plan for events which might happen, but have not happened yet (because waste of time and resources; and because there is no regulation, which forces them to plan more than evacuation paths and contact persons details). And, worse, that they might be responsible for any damages, if a plan can be proved wrong by hindsight (see also discussion on standard operating procedures and liability by Bentivoglio (Bentivoglio 1995)). Moreover, we experienced that abstract thinking about procedures and then translating these procedures into a diagram of icons with computer software is still mostly too abstract for local crises managers. A moderation approach for process capture might be better. But then, during a crisis, they will not know how to use the tool for guidance.

In parallel we analysed processes for data capture in case of a MANV (mass incidents with a high number of patients). Processes have been designed for paper-based patient documentation and data transfer by radio communication. Questions arose on how these processes can be re-designed once a mobile device for data capture is available and what added-value can be reached. Thanks to the seamless information flow from the scene to the command centre faster assessments of the disaster are a definite surplus. On the other hand, several documentation steps and radio transmissions can be saved, once data capture happens directly in front of the patient with a mobile device (Soboll, Binder et al. 2009). Again we learned that rescue fighters do understand the process properly when modelled by modelling experts. But the obstacles for defining a process by rescue fighters are still too high.

But we did not give up researching the use of process management means for the planning of disaster response measures. The follow-up research project InfoStrom (InfoStrom Konsortium 2011) strives to foster the communication and collaboration among crisis management actors in case of a severe power blackout (*Schwarzfall*). Specific attention is devoted to the transparency of procedures amid counter measures that are initiated by different rescue organizations, e.g. fire brigades and maintenance teams of utility providers. Our tasks in this project are to find process structures in regulations, rules, and procedures, to select the important ones, to model and visualize them by a software tool, and maybe to employ it as a guide during blackout episodes. With *important* we mean all processes intersecting with processes of other organizations, i.e. due to communication needs, use of the same resources (machines, places), mutual help, and the like. We concentrated on intersections, since they bear the most critical problems (Jäger 2003; Schafer, Carroll et al. 2008; Lasogga and von Ameln 2010).

One of the first tasks was to comb through regulations, rules, directives as well as local conventions and adaptations to identify processes or at least process fragments. Surprisingly, only rudimental process structures have been unveiled. Check lists or task skeletons prevail that are even sometimes distributed across organizations.

Then, we built two prototypes for process capture. The first one was based on Microsoft Excel and presents a list of activities - not surprisingly - as a list in a table. By referencing other tasks with numbers and by inserting patterns like *or*, *and*, and *xor* it is possible to model control structures, but we did not need them for the examples of our users. The second prototype, currently under implementation, will add some graphical features, terminology support for different user groups, as well as simplified assignments and specific views.

But again, our findings concerning the usefulness of traditional process management means for emergency planning were disappointing:

In all examined documents no regulations or rules are presented in a process similar way. They provide mostly written full text or rarely checklists. Described activities are somehow hidden behind terms like “responsibilities” and “tasks”, which we believe could not be converted one-to-one to processes. If activities have been found, they are mostly not sorted in temporal or logical order.

The few emergency plans found are concentrating on internal processes, while external connections and relationships are somehow neglected or only superficially mentioned. A clear “when what who with whom with which means” is missing. Moreover, if processes have been identified at all, they merely revolve around the rather abstract observe-orient-decide-act cycle in order to improve communications inside this cycle.

Also, operating procedures are mostly generally described and not adapted to specific disasters. Rescue forces, fire departments, and police agencies of the project are arguing that in the majority of cases a large event can be broken down to a sum of smaller events, which in turn can be handled “as usual”. As such, only specific events are pre-planned, aiming to guarantee sufficiency of resources. An anticipation of “what could happen”, “who will call when and why” does currently only take place, if major events are planned such as a soccer world cup or other happenings with such an anticipated high number of visitors.

Another problem we experienced was that responsible organizations do not want to expose their activities to other organizations; specifically fire brigades and medical services are tight-lipped due to data privacy, and police units due to matters of secrecy. But, to formalize procedures and unveil resource conflicts partners have to disclose what they are doing where and with what. Even our proposal of a careful selection or automatic filtering could not overcome the distrust; and we heard that the police are insulating their command and control systems in general.

Formalization and abstraction are normally not the business of “normal” fire department chiefs or respective staff responsible for planning. Not to forget that staff can also come from voluntary organizations and are thus following a completely different business in everyday life. We often experienced that while *we* can easily translate the description of courses of actions in entities of the process world, many persons of this domain struggle with this net of concepts and its logical linking. Thus, tool support can only partly overcome the missing routine to abstract; we have to allot a moderator or translator operating the tool, too.

DISCUSSION

Process management has proven to be instrumental for the engineering and assessment of courses of actions to meet specific objectives (Curtis, Kellner et al. 1992). Starting with early work on process management for software projects, process management has been carried to an increasingly growing number of application domains. However, major application domains still include manufacturing and production industries that can be characterized by their well-defined processes. But, support of knowledge-intensive and complex processes is scarce. Only recently, the medical sector has started to capture process know-how. Although several control structures have been studied for the representation of medical processes (Mulyar, van der Aalst et al. 2007), the focus is still on procedures for organizational aspects similar to the emergency domain (Mak, Mallard et al. 1999).

Process modelling basically strives for three objectives: automation, quality, and transparency.

In many applications the automation of processes is the driving objective, because automation by information technologies saves time and costs. But, an overwhelming body of activities for emergency management is outside the scope of IT systems. Merely information management and alarming and alerting procedures can be improved by information technology. Hence, methods and tools for automation in the realms of process management do not affect emergency preparation and planning.

Another motivation for process modelling is improving and leveraging the quality of courses of action. Once a course of action has been formally modelled in terms of a process model, it can be analysed with regard to performance, resource consumptions, communication needs, etc. Although several criteria for process analysis appear crucial for rescue organisations, the ultimate question and criterion for process design remains unanswered: does my process adequately address the disaster? In order to address this question, strategic and operational goals have to be assessed and orchestrated rather than restructuring control flows in courses of actions. Unfortunately, the majority of methods and tools for process modelling do not support the elicitation of goals and objectives. At best, some tools support the representation of linkages among activities and respective processes with goals, but they do not support the networking of goals and their dependencies. Since goals and their balanced consideration are of crucial importance, process modelling means have to be enhanced by goal elicitation and means for unveiling design rationales (Potts and Bruns 1988) important for reuse and exchange of plans. Independent of the lack of goal-orientation, leveraging the quality of processes is the driver for modelling processes, i.e. different users should implement a comparable level of quality. This certainly also applies to rescue organisations, which is perfectly illustrated by the definition and use of standard operating procedures for fire brigades and standard medical services.

Process models also raise the transparency inside and across organisation. On the one hand, organisations can learn their practices from process models. They also learn the reasons for actions conducted by others and ultimately they can also anticipate future actions by themselves or others and prepare for them.

To re-iterate, process modelling unveils some laurels & darts for emergency preparation. Transparency and leveraged quality of courses of action is definitely a surplus of process modelling for rescue organisations. But the missing dedication to goal-orientation in most process modelling environments is felt as serious weakness for supporting the objectives of rescue organisations. By the same token, the complexity of terminology and functional scope of prevailing tools is considered as unfocused for the objectives of emergency planning.

In an execution stance, additional concepts for dynamic control flow are required. One typical control flow element in emergency management is escalation (going from a lower alarm level to a higher) with a complementary de-escalation. Emergency management planning does also cover different procedures according to different warning levels, be it flooding, storm, or rain with respect to gauge levels, wind speed, or precipitation rate. Procedures of a higher level often include activities of lower levels, increased or extended specific measures, and possibly replacement of resources or activities, if a level is skipped. The same goes for de-escalation, where activities have to be "reversed" step by step (e.g. evacuation of a hospital or rest homes). Currently, modelling and execution of such "escalation" processes is neither implemented nor in research investigated as far as we know. Such dynamic control flows are typically not part of prevailing tools for business process management. Although they can be implemented with so-called worklets for different instances of a sub-process in principle, more natural implementations are desirable.

However, the most decisive impediment of process modelling is the quest for completeness. A process model always claims by nature a complete understanding of the intended course of action without any discrepancy. Incomplete and partial models are not valid with regard to the philosophy of process modelling. Unfortunately, many courses of action have to be prepared in a stepwise approach and call for customisation during the event (Kittel and Sackmann 2011) since "effective response to a crisis is a combination of anticipation and improvisation" (Lalonde 2011). Although process modelling has given birth to adaptive and ad-hoc workflows, incompleteness and flexibility is still an open research issue.

For your overview, we compare and contrast in the following table the characteristics of off-the-shelf BPM Tools with the requirements of emergency management organisations.

Characteristics of BPM Tools	**Requirements of emergency management organisations for planning**
Concentration on automatic execution (office execution)	Concentration on planning, simulation, learning, and traceability
Analysis according to costs and time	Analysis according to fulfilment of goals and objectives Analysis concerning overload of resources (staff) or double use of locations and rescue means
Expect complete model	Want to model skeletons of processes to be filled during operation based on situation, reusable process fragments
Large amount of functionalities, also for export, import, execution, database connection, etc.	Easy to use interface, scalable, i.e. only necessary functions visible
Fixed meta-model of processes	Change of meta-model to specific ones for different emergency management domain organisations
Rudimentary organisational meta-model, concentration on company terms and permanent units	Specific organisational meta-model with focus on non-permanent units, roles, capabilities, positions, ranks and the like Support of organisational changes due to switch of alarm level or phases
Fixed terminology	Change of terminology to user-specific "language"
Mostly single user environment	Collaborative access by different organisations Outlining of intersections between process models Discussion groups for exchange of opinions Translation features for interchange
Rare support of design patterns, no means for traceability of decisions	Support of design patterns and provision of means for traceability of decisions
Bilateral agreements for cross-organisational processes	Ad-hoc process interchanges between several different organisations with own models and terminology (Kittel and Sackmann 2011)
Predictable, foreseeable events triggering actions	Modelling of an unknown number as well as unpredictable timing and existence of events triggering actions
No support for "escalation" of processes	Concepts for the planning of "escalation" processes

OUTLOOK

If we cannot use existing business process software or modelling methods, the question arises on how we can support emergency management planning with a proper tool for modelling and analysing, but by not changing their way of working, by speaking their language, and by supporting their mind-set? How can several organisations plan collaboratively their courses of actions? And how can they possibly detect conflicts of resources and needs for co-ordination?

In project InfoStrom, we developed a concept we name "smart checklist". Checklists are well known in the aviation industry as well as emergency management domain (see e.g. (FW FfM 2011; Wucholt, Krüger et al. 2011)). But currently, IT-support for creating or using such checklists is mainly based on Microsoft Word or Excel and respective print-outs. However, paper or Office documents cannot ensure that checklists in planning or execution are not occupying the same resources. Thus we want to design and develop a smarter approach by referencing resources from a common pool and by detecting location conflicts with checklists.

Figure 1 shows the meta-model of our planned checklist concept. It concentrates on the essential elements important for emergency management organisations:

A **Checklist** consists of several	Maybe sorted in hierarchical categories
Items describing	due to events, based on rules, in chronological order
• **Who** makes	Organisations with units/persons
• **What**	Measures with respective attributes
• **Where** and	Location
• **With What**	Material and Machines
• **Why**	Because of Event or by Rule

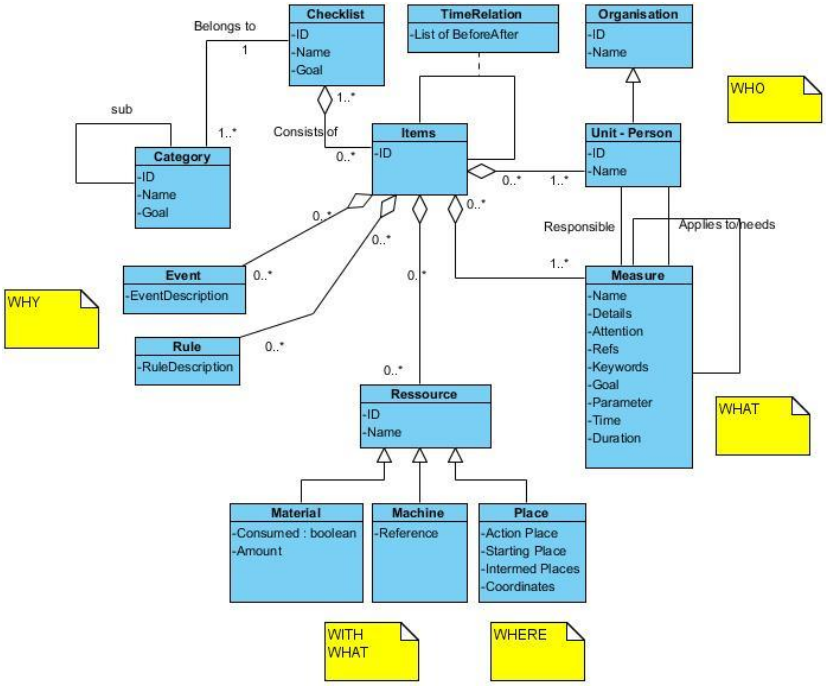

Figure 1. Meta-Model of Checklists for Emergency Management

The "smart" factor will be implemented, when the corresponding editor of these checklists can detect relations between different checklists of organisations, i.e. same location, same use of resources, in same time. Then a warning will appear.

We are currently in an early design and implementation phase of this checklist editor. It will integrate the above mentioned Excel approach as well as extending it with some features like:

- Terminology matching by dictionaries, ontologies, description, media, as well as links to web pages for additional information, e.g. Wikipedia.
- Connection to command centre software for access to resource lists (avoiding redundancy).
- Monitoring the use of resources and showing warnings, if concurrence found.
- Several scalable interfaces showing navigation tree, flow diagrams, excel table, function bars etc.
- Simulation of plans by diagrams to test and probe different strategies.

Typically, stakeholders from many different domains are involved in a large scale crisis. Hence, plans to solve such a crisis must be created together with representatives of all domains. Unfortunately, terminologies in different domains are also dissimilar. This diversity is further compounded by the use of many acronyms in their internal communication. These acronyms shorten the duration of communication during an operation, but they also aggravate the communication to other organisations and external people, e.g. the public or private compa-

nies. Therefore, we are looking for a way to translate and interpret organisation specific terms during the process of planning. We want to provide several solutions depending on whether the terms can be translated easily with the help of dictionaries and ontologies, or whether there is no translation possible and we have to explain the concept by further descriptions (e.g. by links to web pages like Wikipedia, regulations texts or the like). And– along with the common saying "a picture says more than a thousand words"–we will support pictures as well as video and audio material to help users of other organisations to understand alien procedures.

Follow-up publications will give more information about this editor and its evaluation results.

CONCLUSION

In the last few years several disasters lead to a change of mind-set; the power outage of Münster, Germany (lasting several days in winter 2005, with large quantities of snow and a temperature below zero Celsius) as well as the Love parade 2010 disaster at Duisburg, Germany, raised critical voices concerning poor planning, lack of transparency, and bad communication of and between security organisations and authorities. Moreover, insurance companies are desperately looking for culprits to hold liable. Hence, better planning methods are required.

Although process modelling for disaster preparation has been "tried" by many projects, serious questions about the objectives and concepts of process modelling arise, e.g. does the functional scope of tools for process modelling coincide with the objectives of rescue organisations or do the modelling concepts adequately address the objectives of rescue organisations. From our experience we draw the conclusion that business process management methods and tools cannot be directly applied to the emergency management domain. Careful adaptations are required. To-iterate, major impediments include:

- Available BPM tools do not support a change of terminology or model.
- Available BPM tools are targeted at workflow execution and this gives a negative impact on modelling method and user interfaces.
- The abstract world of process modelling is not suitable for the real world staff of rescue workers, fire men, and police men when they have to model their processes on their own. However, once course of actions are modelled by process experts, processes become understandable and transparent.
- Information management lies solely in the responsibility of each single security organisation; there is no general representative taking care that information management processes are running smoothly between organizations.
- Security organizations are currently not planning their response procedures to major crises in advance. They trust in a possible decomposition of a larger event in smaller events and respective counter measures. Predicting events and planning its response is out of their scope.

Even though software companies are promising that business process systems and workflow engines would also ease planning, simulation, and execution of emergency procedures, they never were in mood to adapt terminology, method, or use. Employing such a system would require an enormous adaption at the beginning, carried out by technical professionals in cooperation with domain experts. But any maintenance would again require professional assistance and thus investments. In light of current constraints on national public finances, such a solution will currently not be accepted and thus hinder the formalisation of standard operating procedures. Not to mention the prevailing technology-averse mood in this domain (which might change when the smartphone-experienced youth occupies higher positions). With this paper we wanted to show that having a hammer like business process management, not every domain and its problems are simply nails. And especially the emergency management domain has its own rules and regulations. Thus, business process management means have to adapt to emergency management, and not vice versa; or new solutions have to be created with significantly much more domain support.

ACKNOWLEDGEMENTS

This article was supported by project InfoStrom, which is partly funded by the German Federal Ministry of Education and Research (BMBF) security research programme (Contract No. 13N10639 - 13N10643). This work was also partly funded by the B-IT Foundation, Bonn, Germany.

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