Smart Checklists for Crises Management Planning

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Abstract: Planning in crises management is essential in order to guide operation staff through noise and chaos and also to counter stress, panic and overburdening of emergency services. This planning results in so called standard operating procedures (SOP), sketched out by legislations and handbooks, and adapted to local directives and conditions. SOPs are learned, trained and also translated to checklists, while hand-outs are placed in emergency vehicles and control centres for permanent availability. But so far, scant IT support is available to support the process of emergency planning. Emergency services have to rely on Office tools for creating and managing these plans, resulting in MS Word documents for a written description and Excel or Word tables for checklists. In this paper we present our concept of smart checklists and its first implementation, which enables emergency service organisations to design and exchange plans in terms of IT-supported checklists. A checklist resembles a lightweight process representation giving users the freedom to sketch their processes while maintaining sufficient formalization.

Keywords: Emergency Management Planning, Smart Checklist, Business Process Management

1 Introduction

Emergency management deals with the "organisation and management of resources and responsibilities for dealing with all aspects of emergencies, in particularly preparedness, response and rehabilitation" by involving plans, structures and arrangements [Un12]. Our research work concentrates on these plans, particularly on how to create and manage them and on how to share them between different emergency organisations. We investigated the process of planning and elaborated on potential IT support for the planning process as demanded by [PL03].

At first glance, Business Process Management (BPM) appears as promising for promoting planning processes in emergency management, i.e. BPM as means to formalize SOPs (see section 6 for applications). However, the underlying models, terminology, and tech-

niques of prevailing BPM systems do not match with the characteristics of the world of emergency management as argued in [PR13]. Thus, we have been embarking on the design and development of a planning support tool, which on the one hand directly builds upon users' concepts, terms and objectives, and on the other hand incorporates an abstract model to formally map plans to enable exchange and analysis. Once plans are formally represented and mapped to a BPM model, analysis methods can directly be applied. Basically, our approach capitalises on the established means of checklists and extends usage scenarios to collaborative planning thanks to IT support.

In this paper, we present our concept of smart checklists and its implementation as our genuine solution for emergency management planning. We define checklists as smart, if they are elaborated to a data model, which allows one to analyse and to initialise checklists. Our prototype Plan your actions - Tool (Plan-T) has already been co-designed amid development and iteratively evaluated with our end users of project InfoStrom [In11], i.e. fire departments and public emergency response authorities of two counties in Germany. Further extensions and respective evaluations are currently in work.

This paper is organised as follows. Section 2 gives the motivation of our research in the context of operational planning in emergency management. In section 3, we introduce the concept of smart checklists, while section 4 presents the implementation of our prototype Plan-T. Section 5 summarises our evaluation and tests with our end users while section 6 discusses related work. Finally, the last section draws conclusions on our next steps and research work to be done.

2 Motivation

We undertook several projects with emergency management organisations to investigate how they are planning their SOPs, which methods they use and which tools they employ. Due to the similarities between the definition of SOPs and business processes, which are obvious for IT researchers with a focus on Business Process Management, we tried to bring the world of business processes to the emergency management domain. But we failed due to terminology, organisational culture, model differences and way of operation [PR13]. Hence, we tried to build a bridge between these two worlds concentrating on checklists, since related service regulations and manuals often prescribe SOPs as checklists to obey. We experienced that emergency management organisations are hoarding a large amount of paper-based checklists for specific cases; they complained about management and maintenance of these checklists mostly created and maintained with Office tools:

- An update of the paper documents, which are spread inside and across organisations, even requires itself checklists, since they are scattered over several vehicles and operation rooms.
- Changes of checklists over time are hard to trace and to comprehend: who changed what for which reasons. Since written plans are living documents, changed by experiences of exercises, by new equipment as well as due to threat changes [PL03], reasons for changes should be documented in order to follow and learn from decisions. Hence, rationales behind checklists are currently hidden.

- Partly, checklists are already instantiated. They might contain specific phone numbers, names, addresses, tool names and the like, so they are not always abstract in terms of content and description. If one or more of these information do change, significant search and update efforts are required, which are irksome to do.
- Links and relations between checklists (a checklist might contain another checklist) are not (technically) supported and thus unmanageable.
- A search or specific inquiry on checklists can only be solved by simple text searches. More complex questions like "how many and which resources will an emergency physician need when treating 50 medium casualties?" cannot be answered. Any such analytics are not possible working on text-based checklists without structure.

Once emergency services possess an electronic and formalised version of its checklists, they could easier maintain and exchange emergency management plans. An electronic version could be re-used, traced for changes as well as exchanged with other organisations in order to identify collisions of resources and locations during a crisis. Such exchange of plans would also foster the understanding of goals, methods, and organisational structures of partners. We also want to address non-obvious partners like infrastructure operators involved in the recovery after a large damage: they could benefit from plans of procedures for rescue and relief of local authorities to adapt their own plans to them and vice versa.

3 Our Concept of Smart Checklists

Checklists are written guidelines that guide actors "through the key steps in any complex procedure" [Ga10]. Checklists are used in several areas, especially where the order, integrity, and completeness of work are of great importance for human lives, for instance in medical care, aviation, construction, and military. Besides avoiding errors caused by boring routines or by stress, checklists offer a solution to people with increasing complexity of responsibilities [WKK11]. Checklists are typically paper-based and contain briefly defined tasks as crisp items in a more or less strict order, often with boxes to be checked for each task to mark when started or accomplished. A checklist is created for a specific role and summarises all necessary tasks for a certain scenario.

We experienced in several projects, that emergency management organisations use checklists for defining their SOPs (see for example [Fw11]). These checklists are mostly created with Microsoft Word or Excel and their respective hand-outs are then used in action. One of our project partners represents an emergency service organisation of a county, i.e. a county fire association. The fire fighter responsible for planning complained that he has to wrestle with the maintenance of more than 600 checklists and respective files; he even implemented with Excel a table of content with associated links to these files. Worse, he struggles with a clever solution for content search and replace, especially with regard to crosslinks.

It was our goal that end users of the emergency management domain create and edit their plans themselves, while any complexity resulting from representational formality for analysis and exchange is hidden from their eyes. Thus, we analysed the characteristics of

a checklist and identified that a checklist contains tasks to do in a given order. Each of these tasks can be described by five capital W's: Who is doing What and Where with What and Why. That sentence expressed exactly the feedback of our emergency management partners, when we asked them, which information of comrades of other organisations could be of interest for them. The level of detail may vary. If they plan for themselves, the types of vehicles used may be of importance for resource planning. If they exchange plans, the information that five vehicles will be send out, which might block streets and thus the access route, might be sufficient and important information for other organisations being in planning as well as in operation phase.

We modelled these five W's as follows. A plan is a checklist, with several tasks to do. Each task can contain subtasks serving as partial checklists on its own.

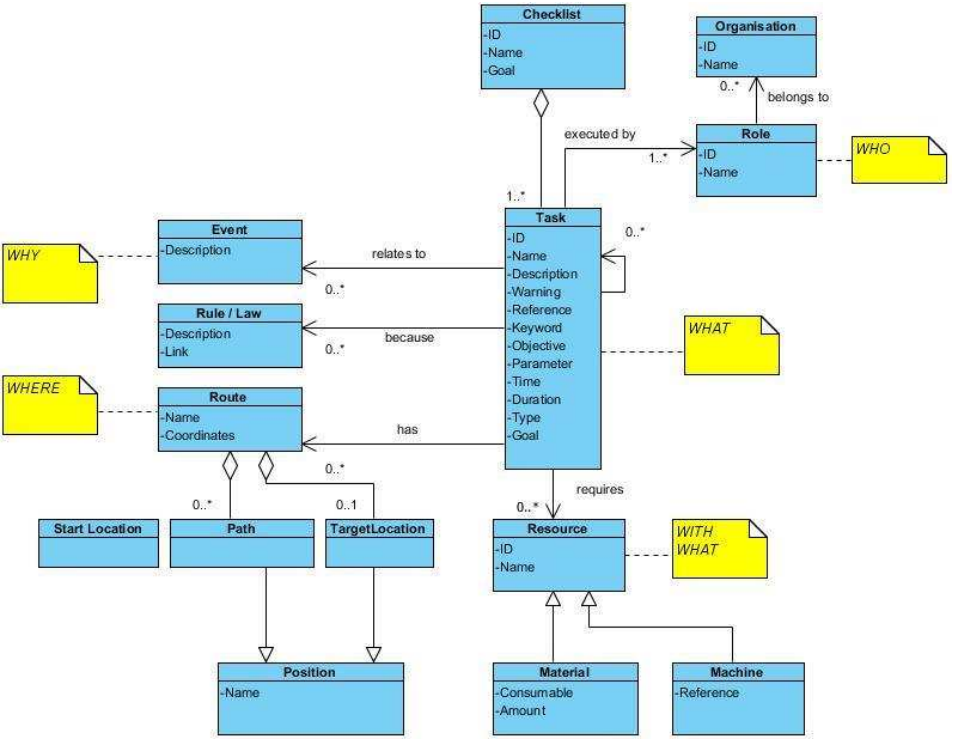

Figure 1: Data Model of a Checklist of Plan-T

Figure 1 shows the data model of a checklist we elaborated. A checklist contains tasks and a task can itself be a (sub-) checklist by having sub-tasks. A task has several attributes and relations:

- Most attributes (apart from name and ID) of entities are optional depending on the intended level of detail of the user.
- Role is mandatory, since it carries the information about Who is doing it.
- Relations to Resource, Route, Event, Rule / Law are optional.

- Resource can be Material or Machine, which gives the answer to the question With What. And Route as Where might be important for example for the line-up of emergency vehicles and for evacuation and shelter places, to avoid collisions when occupying the same location.
- It might also be necessary to take down Why a task has to be done: with the Event entity information about the circumstances, and with the Rule entity further hints on regulations can be stored. Thus, changes of regulations that might carry an impact on checklists can be filed for reasoning.

This data model has been the basis for our prototype of checklist editor Plan-T (Plan your actions - Tool). In the following we describe implementation and functional scope of this application.

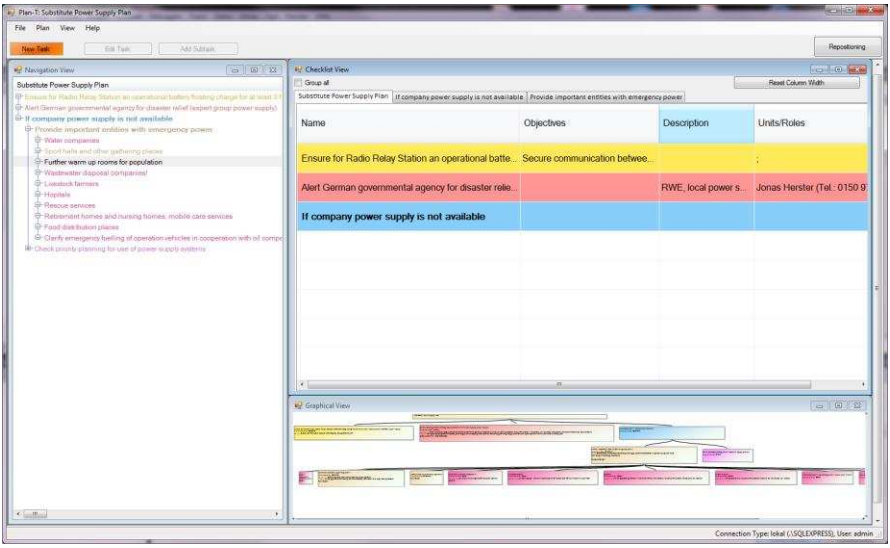

Figure 2: Plan-T – Main User Interface with three Views

4 Implementation

The implementation of Plan-T followed an agile software development methodology. After taking up user requirements, we designed first mock-ups and prototypes, one based on Excel and VBA as built-in programming language for Office programmes. Then we gathered user feedback iteratively by interviews with emergency management organisations. Plan-T was advanced out of these design studies towards a full-fledged application incorporating steady feedback from our emergency services' partners. Figure 2 shows the resulting main user interface of Plan-T, the checklist editor.

Since most users have preferences concerning more textual or visual likes, we implemented different presentation views in three main windows: a checklist view (in Figure 2

top right), a hierarchical ordering view (left) and a graphical (over-)view (bottom right). These views are described in the following sections.

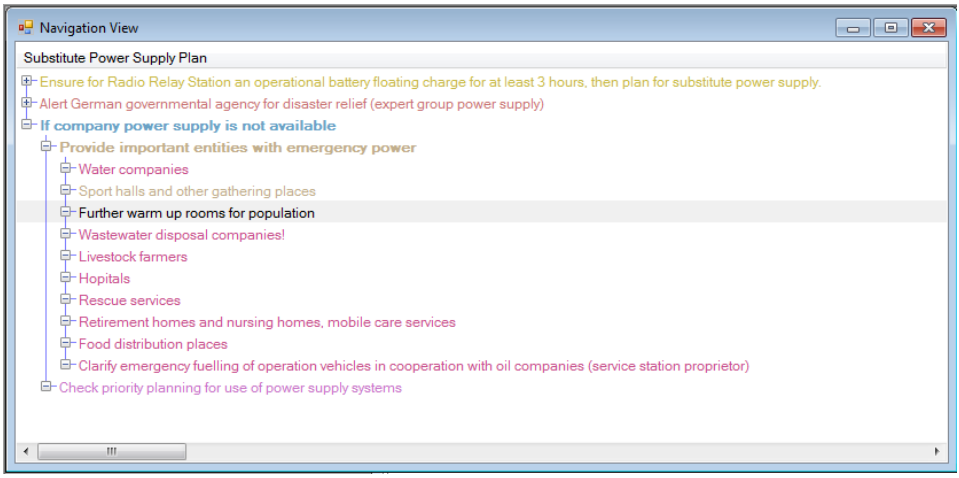

Figure 3: Plan-T – Navigation View

The tree-based Navigation View represents the hierarchical formation of checklist(s) in a typical tree structure (see Figure 3). The focus lies on the hierarchy of a plan allowing users easier orientation and navigation. The window shows the names of tasks or respective checklists and their hierarchical position in the plan. The type of the checklist (see the following description) colors the entry in the tree.

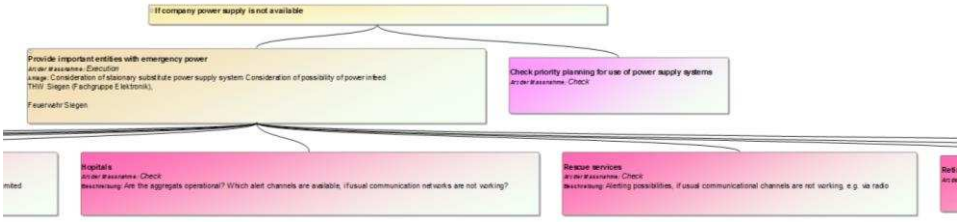

Figure 4: Plan-T – Graphical View

The Graphical View (Figure 4) represents the plan as a tree diagram. This view provides a quick overview of the hierarchical structure of the plan. Branches of subtasks can be hidden on mouse-click giving a better overview of the big picture. The user can zoom in and out of the diagram in order to get more or less details.

Figure 5: Plan-T – Checklist View

The Checklist View shows a checklist in a classical chart style (Figure 5). Tasks of a plan are listed in the given order with all parameters as columns; empty parameters are masked. The window also provides tabs for each checklist of a plan and for the plan itself. Items in bold font style depict that this task represents a checklist to be opened by double-click to see the sub-tasks. So-called types of tasks have been implemented, because our users explicitly wished to distinguish between actions like, e.g., Check, Execution or Alerting, and they also wanted a highlighting of differences by colour.

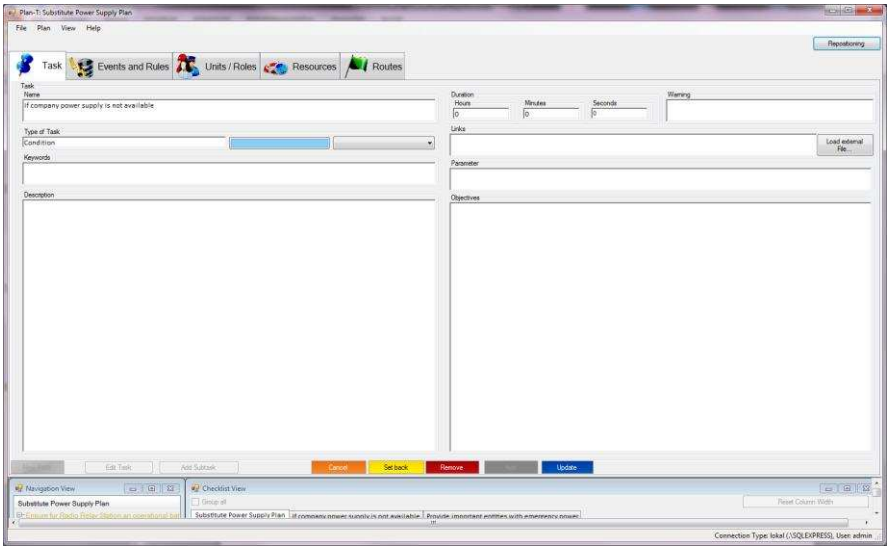

Figure 6: Plan-T – Editor

A double click on a task of this list opens a window called Editor (see Figure 6). Here, user can fill entry fields for attributes of tasks, events and rules, units and roles, ressources, and routes. Pre-filled lists can be selected according to the domain in question. These lists are loaded at startup of Plan-T, after login of the user and after selection of the domain of the user. Assignments of this editor can be seen in the checklist view of Figure 5, filled-in columns are added to columns of the respectiev chart.

Additional Features of Plan-T include:

Internal Terminology Glossaries: Rescue forces are training their courses of action using certain alarm codes and tactical icons. Individual terminologies allow a focused communication adopting acronyms for commands and resources. However, this somehow alien terminology that interspersed each sentence hinders the cross-communication between organisations in action. Although police, fire departments, and medical service often use similar terms and even share some acronyms, this might also lead to misunderstandings due to false friends, i.e. same words, but different meaning. Even in the same type of organisation, the meaning of a term can differ from one municipality to another yet in direct neighbourhood [RPP11]. Thus, we employed a glossary in Plan-T. The graphical user interface (GUI) adapts to the selection of a domain by a user when starting Plan-T. The titles of GUI-elements are taken from a glossary database. Predefined attributes selected from drop-boxes adapt also to the respective domain terminology. Projects that are loaded in a different domain will be "translated" depending on the terms assigned in the database. Each term in the glossary has also links to web pages containing meta-information or lead to documents of term definitions. Thus, more background knowledge of a subject or term is provided. Apart from input from external glossaries, this glossary database can be supplemented and edited manually by users.

Export: Our users benefit from non-paper plans by sending their plans electronically to other organisations in advance or maybe also during a case of emergency. The project files are stored in the database, but can be exported to XML and thus opened by many other applications. Also, Plan-T can export to an Excel file with the same table layout as in Plan-T. A BPMN export is also ready filling only the most basic parameters of a BPMN model, but providing a first rudimentary bridge to the BPM world [Dö13]. In addition, PDF and Word Export are supported. PDF files are created as forms, which allow a user to edit fields of the checklist, for example by adding a time stamp during execution. This Export window provides also access to a social web platform for discussion (SiRena from Project InfoStrom, [In11]) and to email. In addition, a simple printout can be invoked. Users can select and deselect attributes and parameters they want, and they can decide, which of the checklists should be included in the export.

5 Evaluation & Field Test

We incorporated several iteration rounds with continuous feedback of our users to refine and improve Plan-T as proposed by the agile development guidelines including continuous planning and automate testing [Sh08]. Hence, we did not deliver a "surprising new"

product the users had finally to evaluate against predefined requirements, but all wishes and feedback for improvements were integrated during the development cycle.

Several of such feedback interviews took place in the headquarters of crisis authorities of two counties in Germany comprising fire brigades, police as well as local authorities responsible for crises management. The first version we presented was merely an Excel-similar interface. We gathered feedback, made improvements, and then we introduced an Excel-application with a categorisation tree. Soon, we were pushed at borders due to users' wishes concerning overview and formatting functions. Thus, we switched to the full-fledged application Plan-T adding also a graphical overview, which we implemented in Microsoft Visual Studio with C#.

For exemplification, we populated Plan-T with alerting and response plans for a mass casualty incident (MCI) stored in the emergency dispatch computer systems of the respective command centres. According to these plans, specific actions will be taken (like switching the radio channel), units will be alerted (appropriate trucks and ambulances), and ranks in charge and on duty will be informed. While the tasks and their order are stored in their dispatch systems, any documentation on "why in this order" or "why to choose this truck with this equipment" is currently not kept in a formalised way. We showed them the use of Plan-T for such a documentation and formalisation and received very positive feedback. Additionally, we presented a Plan-T checklist they developed during the course of the project (arrival of the first ambulance at a mass casualty incident place: what to do and whom to inform in which order) and showed them the advantage of adapting and changing such checklists with such a tool.

We undertook an Out-of-box-test by delivering a ready to install software to the users. They now started using the system for checklist planning and their feedback is still positive. More response from this long-term evaluation will certainly follow.

We can summarise their assessment of Plan-T: They found our solution very instrumental, specifically for the organisation and update of checklists. Export variety, manifold attributes, search and replace functions as well as the use of a glossary has distinguished itself better than plain Office-documents.

6 Research Context

Several projects have straightforwardly applied process management means to standard operating procedures for emergency response [RW07, Ku09, Pa09, DM10, FC10, Kh10, SP10, BLK11, KS11, Zi11], but they did not investigate how and whether users of this domain are able to model their procedures themselves and whether these process models reflect their way of thinking and acting. So far, they did not found any adequate means for domain experts to grasp, to describe, or to model formally their courses of action. Our objective is to support emergency experts themselves in their modelling endeavours with the future goal to support a collaborative planning course taking into account different terminology, structures, and goals of emergency organisations, since collaborations bear the critical points [Ja03, Sc08, LA10].

From our experience, we draw the conclusion that emergency management experts cannot use business process management methods and tools as is. Even though SOPs and business processes appear as siblings, our findings suggest the conclusion that business process management methods and tools cannot be directly applied to the emergency management domain because of mismatches among tool support, intentions, organisational practices and experts' folklore [PR13].

We also investigated plan authoring tools [KB03, Ai05, Le08] primarily used in the military context, and came across their presentations of actions-to-do in a simply listed or hierarchical order. In addition, we spotted checklists as proposed by [Ga10, WKK11], that is, written guides that walk actors "through the key steps in any complex procedure" [Ga10]. However, the written checklist itself tends to draw attention away from the process of planning [PL03]. Thus, we also need a planning tool with a method acting as guideline for continuous improvement.

One of our project partners put us in the right direction with its over 600 checklists. Certainly, we did not invent the idea of checklists and, of course, not the idea of a checklist editor. But from our knowledge, no one so far has investigated a model for such a checklist, structuring it in these five W's: Who does What with Whom Why and Where. This modelling allows us now to compare, to initialise and to update individual parts of such a formalised plan. Parts of such a plan can be reused in other plans, and the tool itself can serve as a toolbox or database of samples.

Main advantage is also, that we are now able to export such checklists to other languages like BPMN or XML. This allows us to use other tools for visualisation and analysis even we are working only with process skeletons.

7 Outlook

In this paper, we have presented an approach to enhance the planning in order to prepare for emergency management scenarios. The tool has been implemented "under surveillance" of several emergency management organisations and federal state authorities. All of them share a common interest for using Plan-T for emergency management preparation.

Plan-T is still in an early development state. Future work includes

- Versioning, tracking and notification of changes, i.e. change management of checklists;
- Exchange of information between organisations: a semi-automatic "resume generator" summarising the essential facts of procedures. Our users said that individual steps of others are less important than a short summary of time, resources, and quality of service(s) of other organisations.
- Connection to command centre software to access its resource data.

We and our emergency management partners mutually risked a view in the future and anticipated that a server system controlling the execution of checklists could also help

directly amid crises situations. Take as example the tasks of an emergency physician on-site the place of emergency (in Germany, physicians are always accompanying paramedics to the place of emergency). They might employ such a checklist presented on a tablet PC as an online medical guideline, use it also for information from and to their assistants, and for information exchange from and to hospitals and command centres. In addition, post-processing could be supported, since documentation of operations is often late and for the rescue station also laborious to chase after. Moreover, such checklists can remind actors to describe any reasons for deviance from guidelines and this might in turn lead to better quality in the future.

Thus, we have to investigate mobile interfaces and an export to such interfaces on the one hand and we have to establish a bridge between the operational command centres' software and our system. The latter will cause some intense discussions about integrity and security with emergency management organisations and control centre software providers.

We did not yet investigated planning methods together with our users. The process of planning including collaboration with other organisation should be framed by a guideline, with what to start, what to control, what to do next, and so on.

We are now able to transfer a checklist into a business process model. This export will allow us to analyse checklists as rudimentary processes or process skeletons with BPM analysis means. But still an open issue is how we can now pave the path to process management means in order to allow one a sophisticated analysis of procedures unveiling bottlenecks and overlaps. Introducing sequence ordering might be a smaller barrier for the user interface. But, logical operators guiding the way through decisions are currently both, a difficult concept to establish in emergency management services, and also a user interface challenge when relying on charts.

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