Information collection using process visualisation in the risk management concept for emergency response

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ABSTRACT

Security-critical processes of emergency response are part of a complex system of people, organisation and technology. They are often characterised by their own dynamics, interconnectedness and information deficits. In addition, a wide variety of stakeholders, some from different organisations, work together, each specialising in a specific area. In order to capture this (process-) knowledge in risk management, information from the experts is necessary. However, experts are difficult to access, often separated locally, cost-intensive and usually have little time (discussion-) capacity. A pictogram-based process visualisation was developed within the risk management concept. The method could be validated within a European project in an expert workshop. This was done using the example of a CBRN mass casualty incident. By using the methods presented, very good qualitative and quantitative results can be achieved from the perspectives of various organisations and their experts. The limited resource "expert" is used optimally.

Keywords

Pictogram-based process visualisation, risk management, risk identification, emergency response, CBRN

INTRODUCTION

Risk management is a management area, which is described in different areas. It is often not uniformly defined, contains different procedures and is integrated in different ways. In civil security organisations, organisational risk management (RM) is often inadequately described and given little consideration (Montag *et al.*, 2017, pp. 38–40; Kern & Hartung, 2013, pp. 113–114). A consistent approach to operational risk management, which combines strategic and operational risk management in particular, has so far not been conceptualised enough (Kern & Hartung, 2013, p. 114). In addition, retrospective risk assessments are often not carried out methodically, inadequately or sustainably - this presents a major problem.

The current state of research offers numerous sources on risk management, which, however, mostly describe risk management in an industry-specific and different way. It was not possible to establish a direct link to emergency response that would describe an overall concept. Even quality management (QM) is not yet widespread in civil emergency response or it is controversially discussed. (Becker, 2013, p. 15) Therefore, the question arises whether a holistic concept can be developed which can be applied in emergency response. It can be assumed that a sustainable, effective, applicable, accepted and resource-saving concept can be developed from the combination of different concepts.

Standards are the basis for such an approach. Their contents are analysed and brought together under the objectives of the concept for emergency response. Moreover, appropriate methods are highlighted and validated. In addition to the standards and their data, practical experience is available as a basis for information.

RISK MANAGEMENT CONCEPT

The risk management concept considered here is taken from SANDER (Sander, 2018) and is based on the comparison and combination of various elements of ISO 9000 (DIN Deutsches Institut für Normung e.V., 2015), ISO 31000 (ISO International Organization for Standardization, 2009), ONR 49000[1] (Austrian Standards, 2014) and HERCZEG's (Herczeg, 2014) remarks.

None of the risk management concepts in the standards can be fully understood and implemented in terms of emergency response. The concepts can be linked to each other and partly overlap in content. The most important element of ISO 31000 and ONR 49000 is the risk management process (RM process), which contains the risk assessment. For its implementation, ISO and ONR indicate various methods and their evaluation, whereby only the evaluation and description of the methods is comprehensible in ISO. ONR adds emergency, crisis and continuity management as additional elements to the RM process. It consciously deals with the fact that events are not 100 per cent prevented. HERCZEG defines risk as complementary to safety, which is one of the most important qualities. It considers the occurrence of events and their analysis and states that risks are identified and dealt with when designing process control systems and that the risk analysis is part of the event analysis. ISO 9000 considers risks in the form of risk-based thinking in the planning phase of the plan–do–check–act (PDCA) cycle of the QM system. Therefore, the positive aspects of the different standards of SANDER were combined to the following Risk Management concept (Figure 1). (Sander, 2018, p. 94)

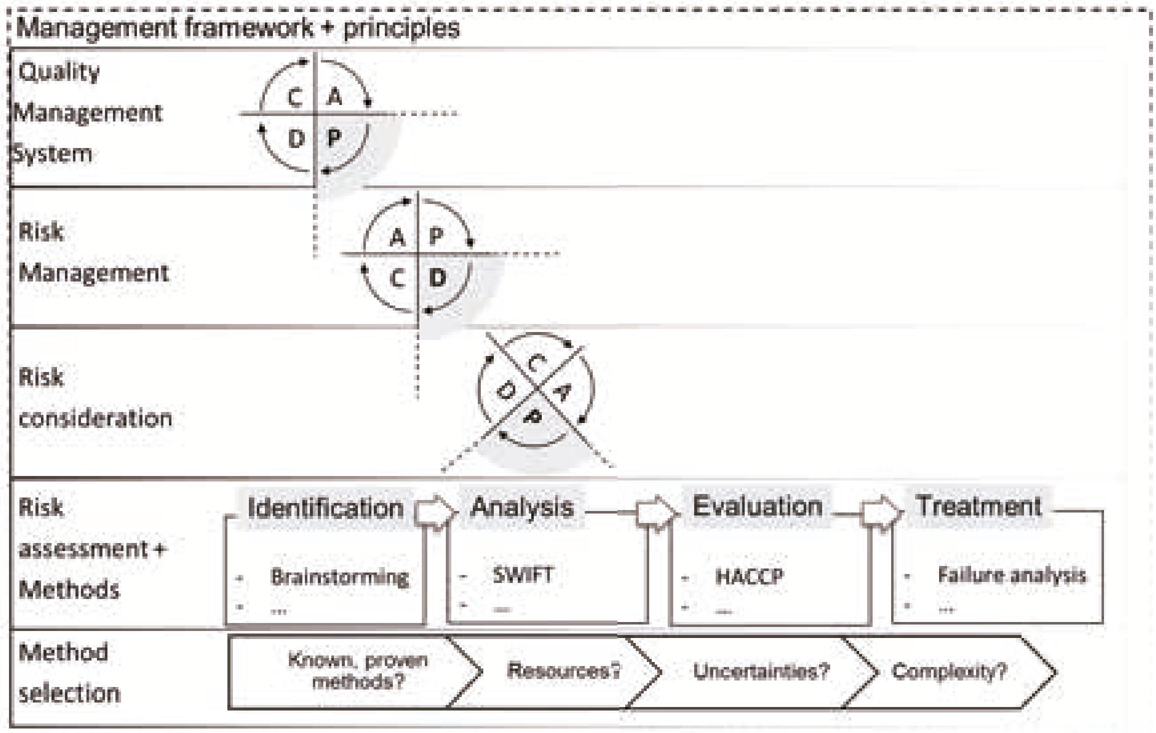

Figure 1. Risk Management concept (according to Sander, 2018, p. 99)

The *management framework* defines the principles and basic framework conditions for a management task in an organisation (e.g. company, institution). It is only intended to provide assistance in integrating the components into the organisation-specific overall management system. The principles are derived from the context, the stakeholders and their expectations of the organisation. The management framework and the principles are set by the top management and are determined by the specific responsible persons. The principles apply at all times and throughout the organisation. (ISO International Organization for Standardization, 2009; Sander, 2018)

Quality management (QM) is a basic management system of the organisation. QM is characterised by its typical PDCA cycle. QM deals with aspects such as the definition of the quality policy, the creation of processes for the implementation of the quality policy and the QM system. In addition, limits and the scope of application are defined as well as regulations for documentation and communication. It is to be implemented at all times and throughout the entire organisation, whereby changes can be incorporated regularly (PDCA cycle). (DIN Deutsches Institut für Normung e.V., 2015; Sander, 2018, p. 96)

[1] Risk Management for Organizations and Systems - Terms and basics - Implementation of ISO 31000

Risk Management (RM) deals with all risk-relevant aspects of the management framework and the QM system. The risk management level in the whole concept corresponds approximately to the risk management framework listed in ISO 31000. The RM is also characterised by its PDCA cycle, which is part of the planning phase of the QM cycle. The RM defines risk policy, agrees risk criteria and establishes a risk culture. This applies at all times and throughout the complete organisation, whereby changes in the RM are also caused by the PDCA cycle. (Sander, 2018, p. 96)

The *risk* consideration (Figure 2) comprises all processes and procedures that are necessary for the proactive and reactive contemplation of risks. On the proactive side, potential risks are minimised in advance and on the reactive side, risks (events) that have occurred are dealt with. Risk consideration is also characterised by a PDCA cycle, which represents the DO phase of risk management. In the planning and implementation phase of the risk consideration, the risk management process is carried out for proactive monitoring. The Check phase consists of the occurrence and noticing of an event. The Act phase is the reactive phase. In this stage, the events are dealt with in concrete terms (according to Herczeg, 2014, pp. 197–198). Risk consideration is the first operational level (from above) that does not take place at management level. It refers to a specific observed process (e.g. production order, production) and can be applied before or during this process. (Sander, 2018, pp. 96–98)

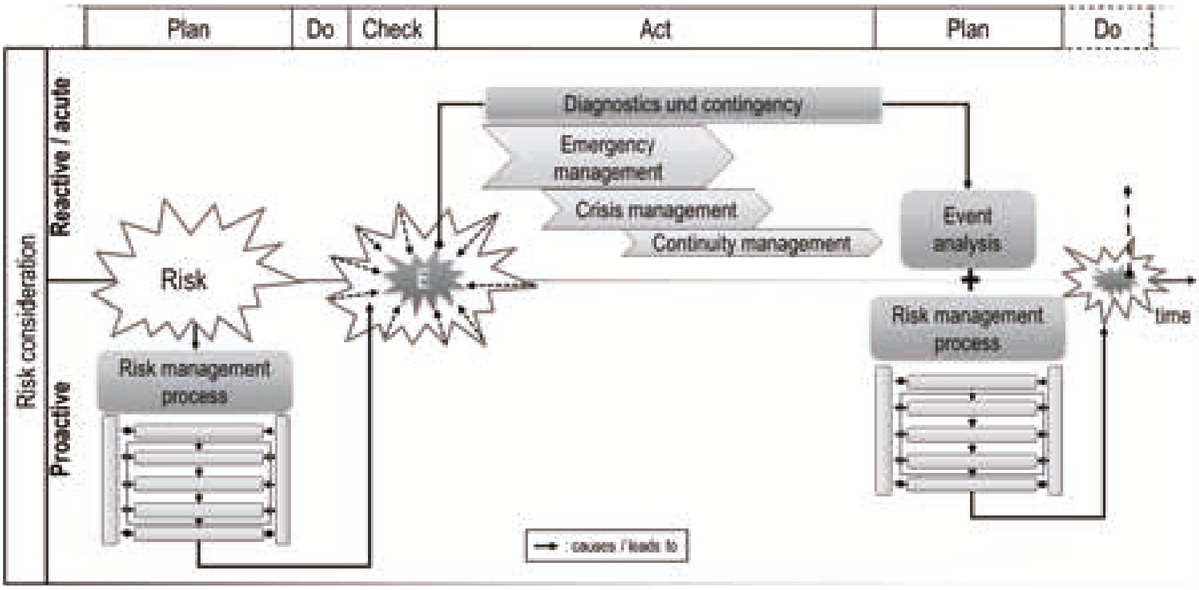

Figure 2. Risk consideration (according to Sander, 2018, p. 98)

Risk assessment is a sub-process of the RM process and an integral part of the planning phase of risk consideration. It represents the lowest level and forms the foundation of the concept presented here. The risks are identified, analysed, evaluated and treated. It is important that *one* risk assessment only applies to the observed process (e.g. production order and production) and the current point in time. Therefore it is part of the PDCA cycle of risk consideration and must be repeated regularly. (Sander, 2018, p. 98) A complex and volatile process should therefore be assessed closely.

When selecting methods, the criteria of known methods, resources, uncertainties and complexity (Figure 1) are applied. The criterion of "known methods" states that methods are to be chosen which are systematically imparted, applied and improved in the organisation of the risk assessor (Herczeg, 2014, p. 155). The nature and quantity of resources required refers to the time and level of expertise, data demands and costs involved. The method(s) to be selected here are those that correspond to the availability of resources in the risk assessment. The nature and degree of uncertainty about the information available and the complexity of the methods chosen must be acceptable to the risk assessor. An evaluation of the methods with regard to the last three criteria mentioned can be found in DIN 31010, so that the risk assessor must compare these with his capacities and guidelines. (DIN Deutsches Institut für Normung e.V., 2010, p. 19, 2010, pp. 21–25)

RISK IDENTIFICATION CONCEPT

Risk identification is part of the risk assessment in which risks are recognised and described. Risk identification lays the foundation for further risk assessment (risk analysis, evaluation and treatment). Since all further steps are based on identification, quality also plays a backward role. It is therefore particularly important to carry out risk identification in a correspondingly good quality.

In this phase, internal and external process risks can be defined and differentiated. The internal risks originate within the process, i.e. within the sphere of influence of those involved in the process and external risks outside the process and the sphere of influence. This means that the identification of risks should not be restricted to those directly involved in the process. The participants (experts) in risk identification should be broadly positioned. For example, in the CBRN process direct process participants (fire brigade) and indirect participants (chemical experts or technology experts) will be involved in risk identification.

When risks occur, one talks about events and their effects[2]. The direct effect of an event can cause consequences, so that events can be defined as the concatenation of causes and effects. (Austrian Standards, 2010, p. 10; Herczeg, 2014, p. 15) A recognised risk can thus be effect and cause too equal.

Risk identification is the process of searching for, recognising and recording risks. More specifically, it is a matter of finding out which circumstances influenced the achievement of the objectives and how these circumstances in turn could be influenced. The risks identified in this way could be events as well as situations and circumstances. In addition to their causes and sources, the consequences of the risks must be determined in their "nature". (Sander, 2018, p. 57; see DIN Deutsches Institut für Normung e.V., 2010, p. 10)

The aim of the risk identification is to develop a list of risks based on events that affect the achievement of objectives in any way. All important and far-reaching causes and consequences should be considered, using tools and techniques adapted to the organisation's objectives, capabilities and risks. (Sander, 2018, p. 57; see ISO International Organization for Standardization, 2009, p. 17)

Risks therefore arise from one or more sources. These constitute uncertain influences from various areas (internal, external) with the participation of a wide range of stakeholders. Risk is the result of a combination of likelihood and impact. At the same time, it represents the link between cause and effect. From this it can be deduced that risks and their identification represent a very complex construct. Depending on the goal, perspective and observer, different results can emerge or risks can be identified. In addition, identification requires a high level of knowledge (expert knowledge) about the object under consideration (e.g.: process) and a lot of development time. This is in direct contrast to reality. There are only a few experienced experts for certain safety-critical processes. They are also difficult to access, often separated by location, cost-intensive and usually have little temporal (conversation) capacity.

Methodological sequence

The methods for risk assessment and risk identification presented in ISO and ONR all have an implicit prerequisite: *a common understanding of the object under consideration* (here, below: process). This is achieved by the following concept. The consideration can refer to different questions or goals, e.g. risks, requirements. The methodological procedure is shown in the following diagram (Figure 3).

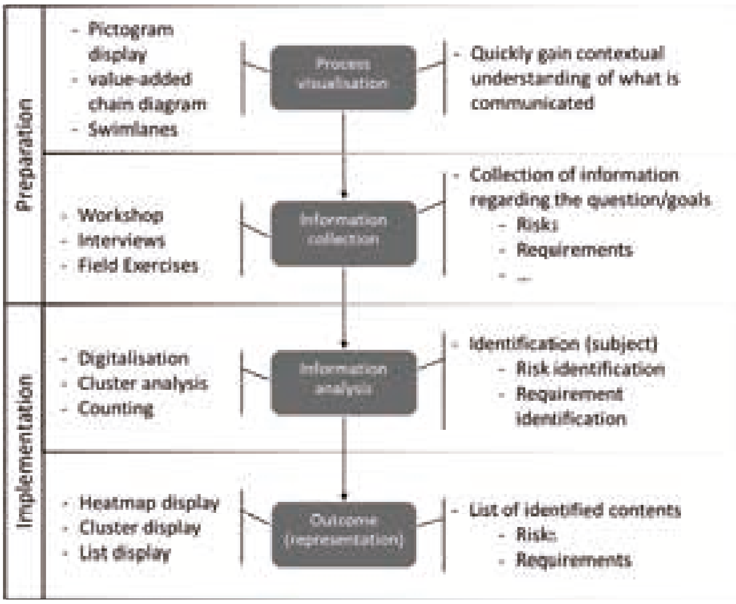

Figure 3. Methodical process of risk identification

[2] An effect is the outcome of an event affecting the targets. Austrian Standards (2010, p. 10)

The first step of the visualisation lays the foundation for a common communication. It is essential to ensure that the same things are spoken of in the following steps. Due to the different experiences of the individual stakeholders, a detailed information collection is connected to the visualisation in order to consider all possible aspects. In the analysis of this information, the actual identification takes place. The identified objects must then be presented in a final step as a result of the process.

Process visualisation

The emergency response situations fulfil the Hofinger characteristics of complexity (according to Hofinger, 2013, pp. 3–8) and can therefore be described as complex situations. Complexity is characterised, among other things, by a high degree of inherent dynamics, a high degree of interconnectedness and a lack of information. It follows from this that the actual problem cannot always be determined. In their search for a scientific basis for such problems, Rittel and Webber have defined the “Wicked Problems” (Rittel & Webber, 1973, pp. 155–169) in the field of planning processes. With the “Wicked Problem” the concrete description of the problem and thus also its solution eludes the observer. This description can therefore also be assumed for emergency response.

If problems and their solutions are not explicit, there are many possible courses of action. These can be implemented in the process visualisation in two ways. On the one hand, there is the possibility to limit or define the actions or the problem by framework conditions and thus to enable a detailed representation. On the other hand, the representation can remain abstract in order to consider as many options for action as possible and thus possible risks. In the case of the holistic view, with many stakeholders, of processes of emergency response, an abstract representation should therefore take place.

The more a process diagram explains, the less it is understood (Herrmann, 2012, p. 170). In order to avoid this, an intentional incompleteness is created in which the critical segments are represented disproportionately present and at the same time other details are omitted. Thus the goal of the representation is emphasised, the complexity of the process is reduced and the comprehensibility is increased. At the same time, the abstract representation creates an open image that leaves room for free thinking, e.g. for risk or requirement identification. The omission of explicit descriptions prevents the discussions from drifting into a kind of “definition discussion” and becoming resource wasters.

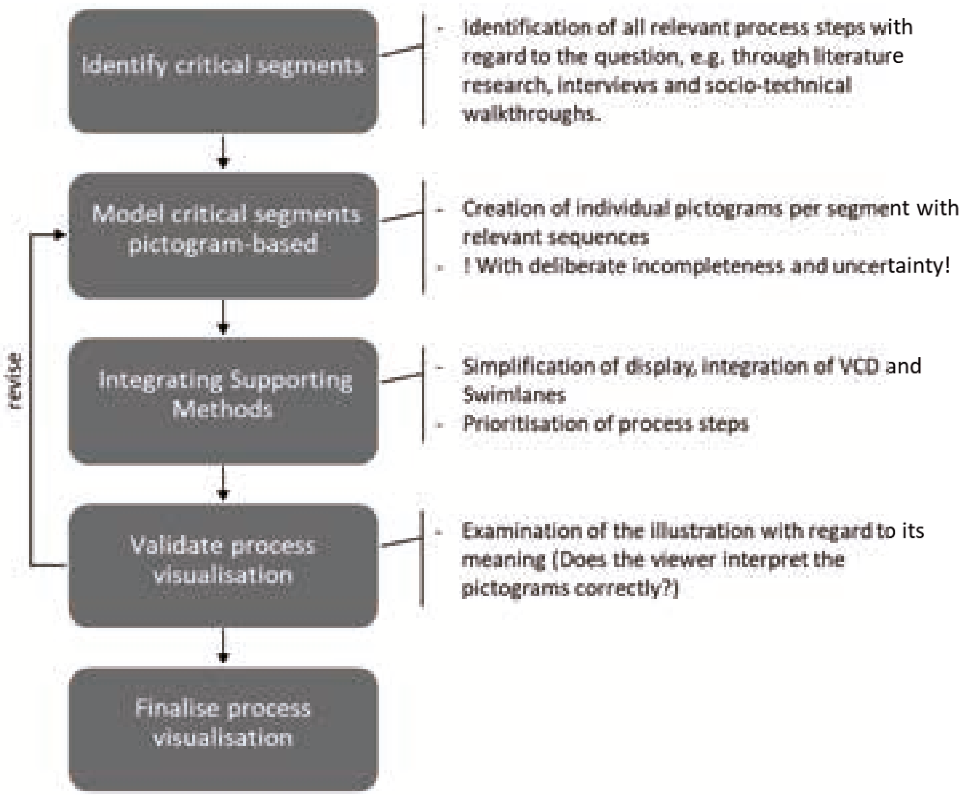

Figure 4: Procedure for process visualisation

This approach to process visualisation (Figure 4) makes it possible to create a simple representation (Figure 6) which simplifies complex topics and presents them in an understandable way so that the information can be used effectively. In addition, it is easy to use, quickly available and can be adapted individually. This makes it possible to reach a good quantitative and qualitative result with several experts in the information collection in a short time. The focus in process visualisation is on pictogram-based presentation.

Pictograms serve as part of a visual world language of the transmission of information. They have a simple form of design with a character of challenge and visual language and are application-specific. By using pictograms, relationships and dependencies between processes can become more understandable for the end user. Pictograms can be iconic, symbolic, or hybrid. Iconic pictograms depict objects or situations that are very easy to understand. Symbolic pictograms, on the other hand, use characters that must be defined and learned. Hybrid pictograms combine these two types and are supplemented by text elements. (Hasselbring, 1998, pp. 217–218; Böhringer *et al.*, 2011, p. 411)

Thus the pictograms concerning their use in the process representation fulfil the requirement of a fast comprehensibility after HERMANN (Herrmann, 2012, p. 156). The type of presentation has references to the already existing world of experience, its syntax and semantics are simply structured, no high memory performance is required and it provides simple means of expression.

The pictogram-based visualisation serves as a reference process for the various expert groups (Figure 5). It represents the function of information collection and communication by forming the "bridge" between the different expert groups and thus connecting them with each other. The processes are made comparable on an abstract level. Even if the process flows look different in detail for the individual stakeholders, they can still be assigned to a reference process step. On the one hand you can communicate directly without prior definition description, e.g: "In zone 2 we always have the problem of ...", on the other hand individual information (e.g.: risks) can be assigned directly. Stakeholders are divided into four groups. Internal and external describes the affiliation of the respective stakeholders. The affiliation can relate to different areas, such as Project staff, company affiliation, working groups. (Partial) process knowledge and process unfamiliarity describes the level of knowledge of the respective stakeholders about the object (process) under consideration.

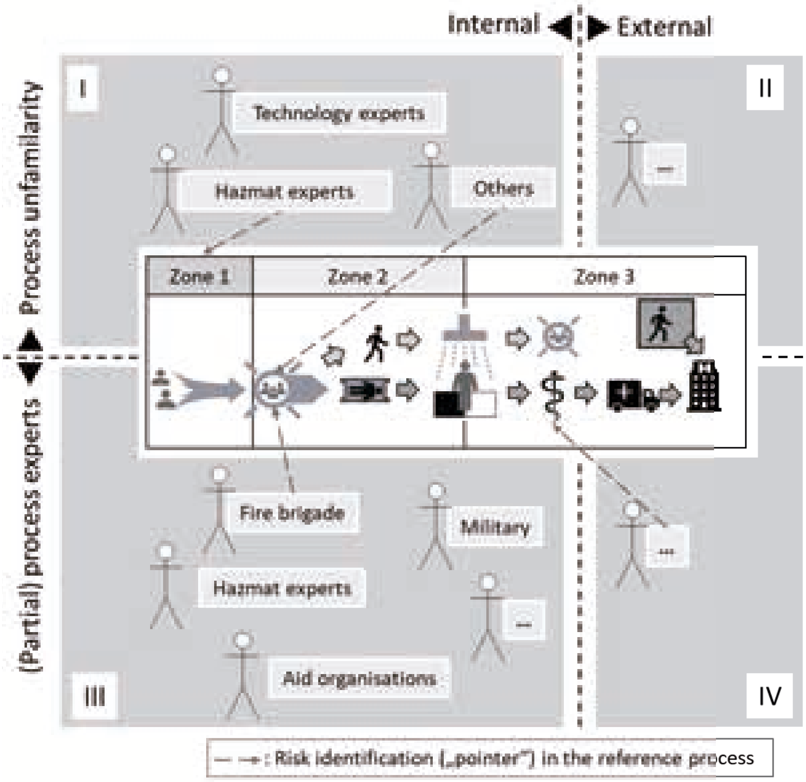

Figure 5: Information collection function of the reference process (example: CBRN process)

The process visualisation can be optimised in addition to the pictogram-based representation by integrating the following methods.

The method of *Swimlanes* is a concept for organising and structuring processes through separate visual categories. This type of spatial planning is used to further simplify the visualisation. The description of the swimlanes is not bound to any conventions.

Value-Added Chain Diagrams (VCD) represent the process compared to the pictograms in a text-based form. With this form of representation, additional relationships and information can be visualised alternatively. In addition, other process levels can also be displayed. (Amelunxen *et al.*, 2018) This enables process modeling for a detailed analysis of the processes. It should only be used for support and should not undermine the objectives of the abstract representation.

The process representation (Figure 6) shows the different visual methodological contents described above. Here the vertical swimlanes divide the process according to the spatial order. They offer the possibility to discuss the process in an even more abstract way. Independently of this, the horizontal swimlanes allow further options of classification. The pictograms or process steps can also be moved into the respective lanes. A special case of spatial decoupling of process steps is represented by an inserted block within a lane in order to be able to form a basis for discussion here as well. If it is necessary to consider the temporal course of a process or sub-processes, different versions with the respective changes are created. (Amelunxen *et al.*, 2018)

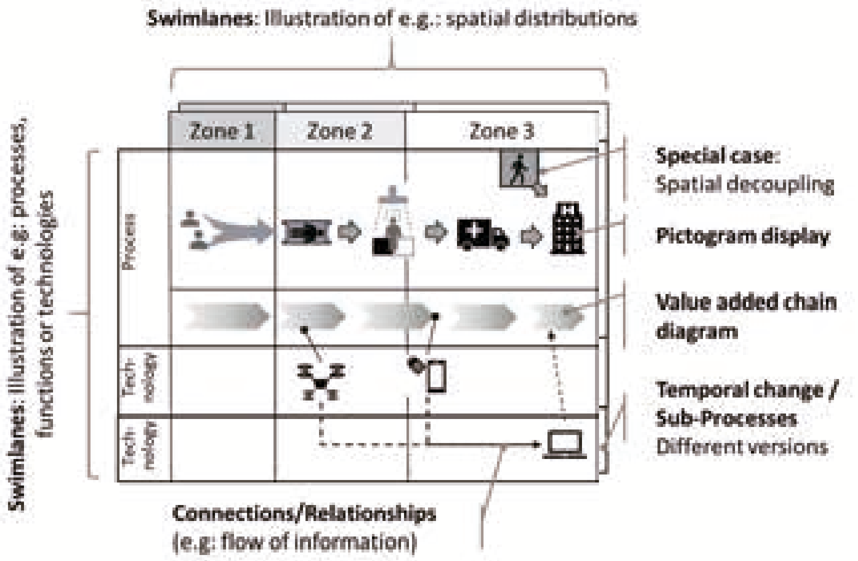

Figure 6. Process visualisation using the example of the CBRN reference process with technical systems (according to Amelunxen *et al.*, 2018)

RISK IDENTIFICATION IN THE EU PROJECT „TOXI-TRIAGE"

Within the European project „TOXI-triage[3]" an adaptive European triage process for CBRN layers in connection with new technologies is being developed and improved. It is an interdisciplinary European project in which different native languages are spoken. The CBRN process is subject to various national laws and is described, implemented and executed by various stakeholders.

In Germany alone, for example, a total of 64 laws regulate the decontamination of injured persons at federal state level. In principle, four different legislations are involved: the Police Act, the Fire Brigade and Fire Protection Act, the Disaster Control Act and the Rescue Service Act. The 16 federal states each describe this in two to six different laws. (Densow *et al.,* 2005, pp. 28–33)

If one extrapolates this number of laws to the European levels, it quickly becomes clear that it is difficult to establish a common definition. It is therefore important for risk identification to address the question of how the process can be communicated on the one hand and how it can be ensured that all stakeholders have the same understanding of the subject under discussion on the other. To generate this common understanding, the CBRN process is visualised.

The above-mentioned properties of pictorial information transmission are implemented here. In the information collection (risk identification) different groups of persons from the project meet, e.g. from different occupational fields, organisations and countries. In particular, their communication is sometimes fundamentally different with regard to designations and definitions, which leads to problems. In order to counter these problems, the above-

[3] Integrated and adaptive responses to toxic emergencies for rapid triage: engineering the roadmap from casualty to patient to survivor (TOXI-triage); This project has received funding from the European Union's Horizon 2020 (H2020) research and innovation programme under the Grant Agreement no 653409.

mentioned method of process visualisation is used. This keeps the introductory phase of the workshop, in which a common understanding of the object under consideration is generated, extremely short.

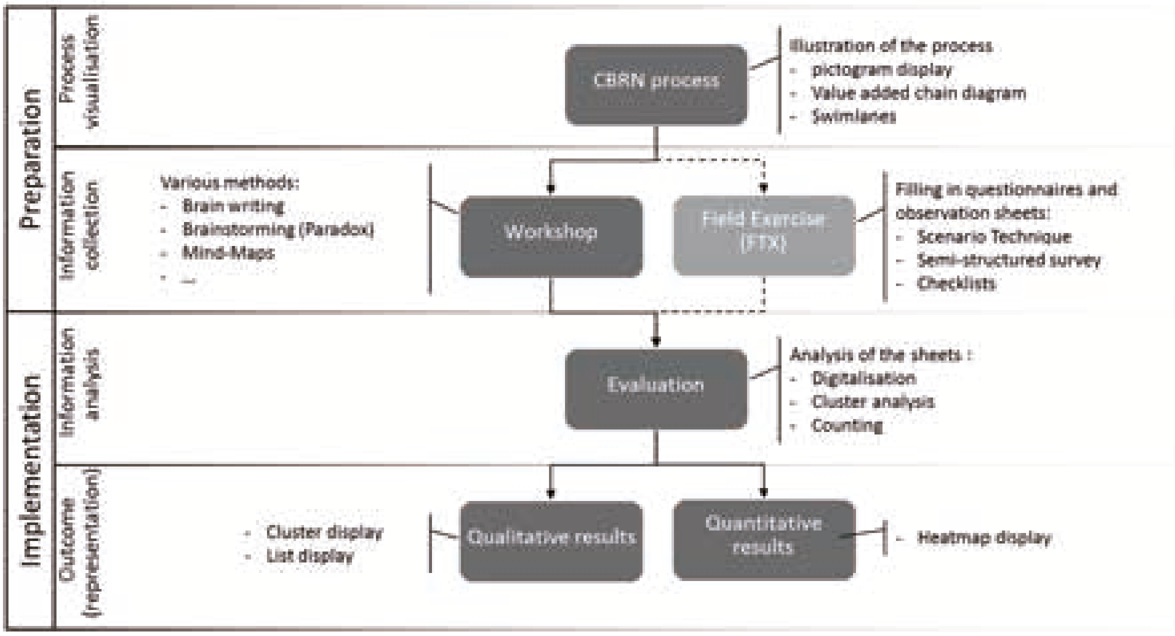

Figure 7. Risk identification procedure

Different methods were selected for the information collection in the framework of the EU project TOXI-Triage. The methods are used in modified variants in order to be able to use the already pre-planned project activities. This minimises the additional effort and counteracts the scarcity of resources (resource: process knowledge). Basis of the risk identification (Figure 7) is first the *process visualisation* for the CBRN process, which should serve as discussion basis and reference model in the inter-European environment.

The process visualisation is inserted as a template in the workshop and as an orientation aid in the questionnaires as well as in the observation sheets of the Field Training Exercises (FTX). The workshop and the exercise take over the information collection step. They work with creativity techniques as well as the scenario technique, the checklists and the semi-structured survey. The information collection as well as the information analysis and the presentation of results for the workshop have already been completed and are presented below.

Workshop

Risk identification through the workshop (method according to (Rupp, 2007; BMI/BVA - Bundesministerium des Innern/Bundesverwaltungsamt, 2018)) is implemented through various creativity techniques (Figure 8) (Nöllke, 2015; Rupp, 2007). The workshop[4] was attended by 59 experts from the fields of fire brigade, medicine and rescue, military, research and others. The participants worked in nine small groups on the tasks set by moderators and guided by them. The moderators with practical experience in emergency response were prepared for the workshop according to the moderation method (BMI/BVA - Bundesministerium des Innern/Bundesverwaltungsamt, 2018).

[4] A Workshop/Master Class on Triage & Toxicity, August 30, 2017, Düsseldorf (Germany)

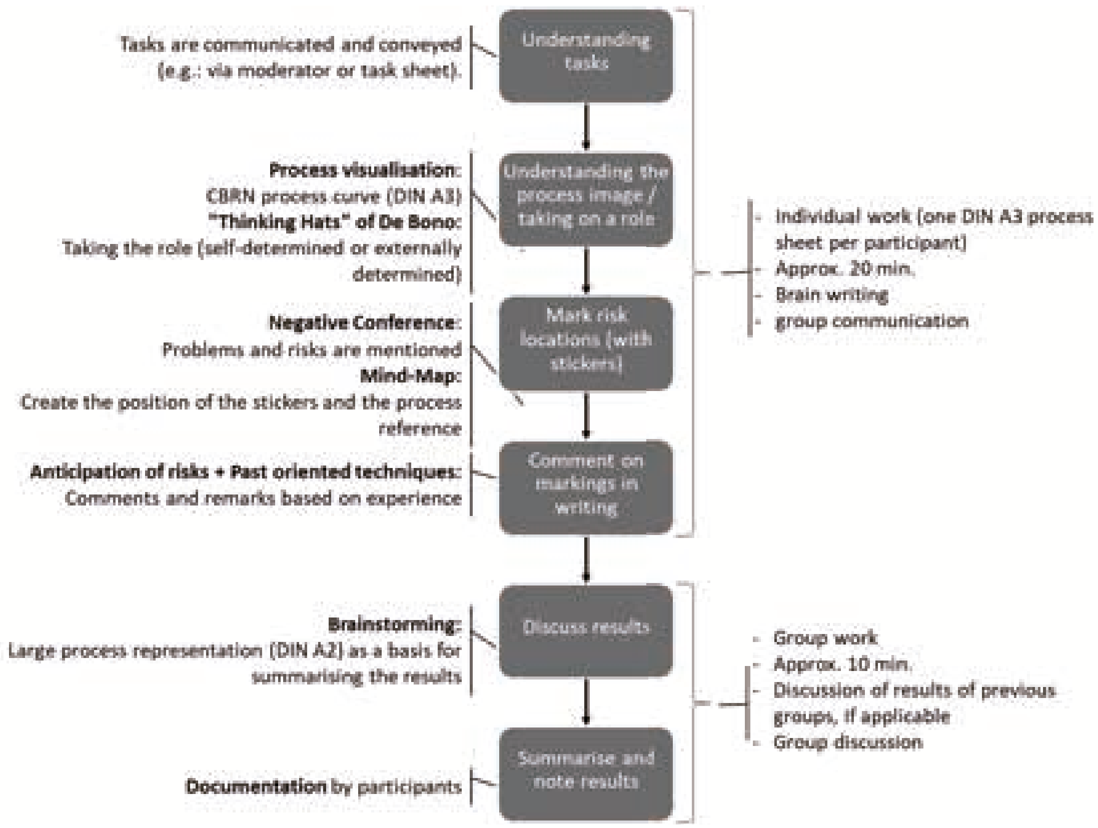

Figure 8: Workshop procedure

At the beginning, each participant received a DIN A3 image of the visualised CBRN process and stickers for the four technology types used in TOXI-triage as well as exclamation marks to label risk points. Participants provided some personal information and the perspective from which they viewed the process. In the following, the largest risk locations were to be marked and, if possible, commented on in their own process image for later evaluation. Following this 20-minute individual work phase, a 10-minute discussion was moderated in which the most important results of the table groups were summarised and noted on a DIN A2 process map. (Amelunxen *et al.*, 2018)

As a result of the workshop the used DIN A3 (A2) sheets with the process representation, the comments and stickers of the participants were available. The analysis of these sheets was divided into two parts for quantitative and qualitative results.

Quantitative evaluation and presentation of results

As a quantitative evaluation method, the number of stickers in each CBRN process step is counted and displayed in separate "heatmaps" (Figure 9). A heat map is a type of analysis that quantitatively visualises results and differences with colours. The results of the analysis should serve as preparation for further investigations and support the improvement of the CBRN process. For each sticker type and each subgroup, a heatmap is created and presented in relation to the segments of the CBRN process structure. The visual distinction of the meaning of a sticker ranges from red (highest number) to violet (lowest number). The following is an example of the heatmap of the risks over the rolls. For this purpose, 59 workshop sheets with a total of 620 stickers (138 risk adhesives) were evaluated. (Amelunxen *et al.*, 2018)

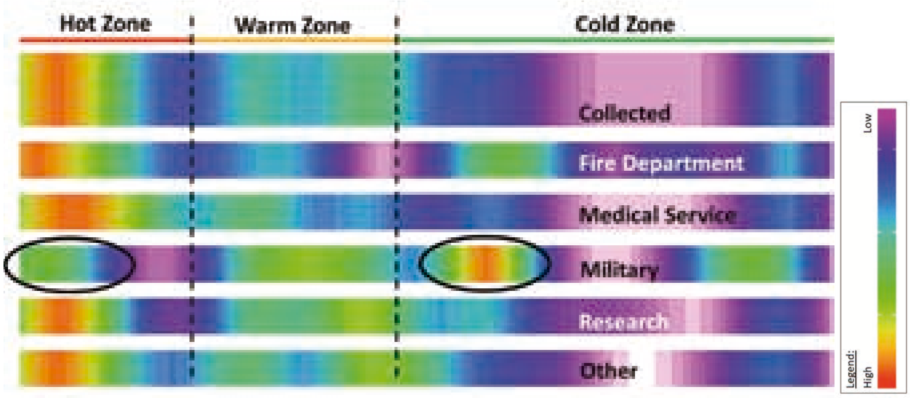

Figure 9. Extract: Risk-Heatmap with conspicuous deviations after rolls (Limper & Rammert, 2017)

This type of presentation allows conspicuous features, risk emphases per role or even deviations to be easily derived. In the following analyses, you can concentrate on these special points and analyse them more deeply. This 2D heatmap can be extended by another dimension. On another axis, for example, the probability of occurrence of the risk can be displayed. (Amelunxen *et al.*, 2018)

Qualitative evaluation and presentation of results

For the qualitative analysis of the workshop results, a concept was first developed to ensure that risk identification was completed and risk profiles or risk clusters listed at the end of this process.

The aim of risk identification is to obtain a list of all risks. For this purpose, the comments on the workshop forms were analysed according to the following procedure (Figure 10).

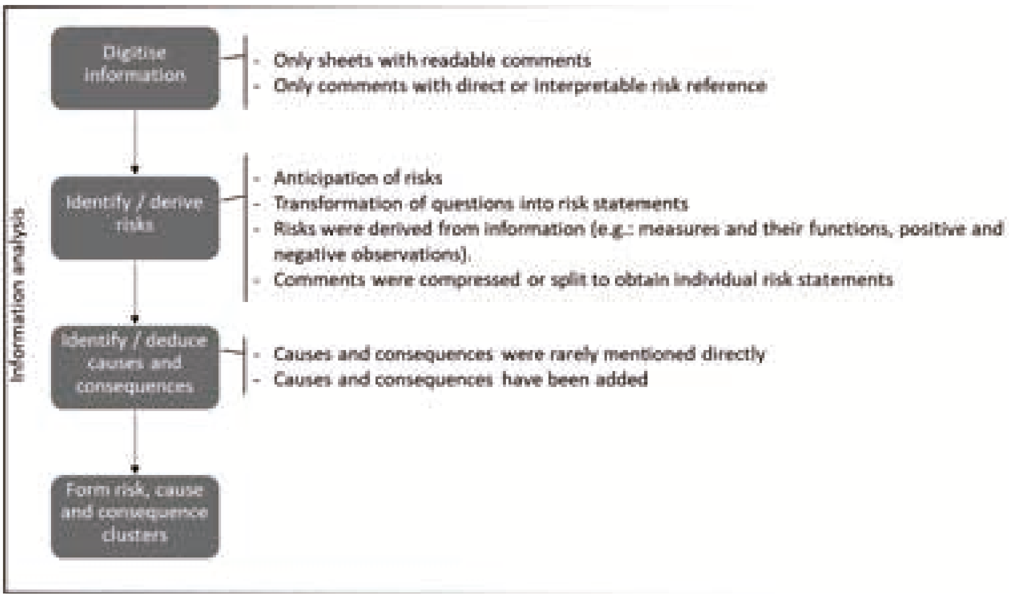

Figure 10. Procedure of qualitative information analysis

In a first step of *digitisation*, the readable comments with a direct or indirect reference to risks were recorded digitally and in written form. Questions were converted into risk statements and risks derived from measures. Long comments were compressed and divided into individual risks. There were 134 risks that were clustered (Figure 11).

Cluster analysis is a mathematical multivariant analysis. It can be assigned to the field of segmentation, which is defined as follows: The objects to be examined are combined into classes on the basis of similarities in the significant or important characteristics. When forming groups, *intuitive* or *formal* clustering can be used. In the intuitive clustering used here, the performing scientist uses his intuitive, non-explicit or explicable understanding of similarities. Greater objectivity is offered by the formal variant, which provides for a formal procedure. (Amelunxen *et al.*, 2018; Bradtke, 2003, p. 168; Eckes & Roßbach, 1980, p. 15)

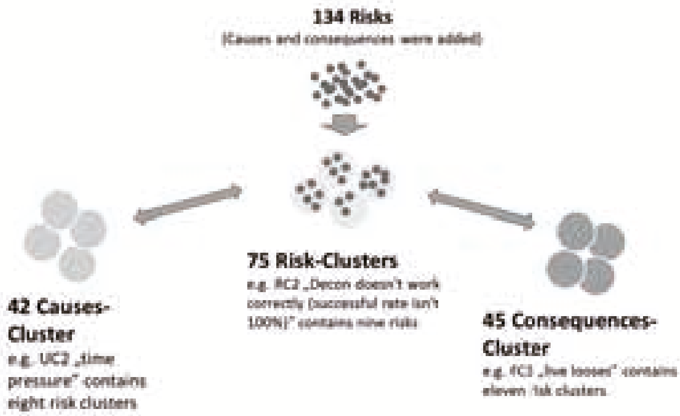

Figure 11. Procedure and results of the cluster analysis

The first cluster analysis bundled the risk descriptions and formed risk clusters. For many risks, these can be grouped into risk profiles (Austrian Standards, 2010, p. 11). These risk clusters correspond to the risk profiles defined in ISO 31000. All causes and consequences for the cluster have been collected and sorted according to the number of risks they contain. The risk clusters were then bundled according to cause or consequences and sorted according to the number of risk clusters contained. There were 42 cause clusters and 45 consequence clusters.

A large number of risks can be identified by the *risk identification* procedure. Depending on the level of detail of the analysis, a very complex system of cluster relationships emerges. This procedure promotes the understanding of the process solely on the basis of the execution of the analysis. Statements can be made about the probability of occurrence and the consequences based on the number of entries. (Amelunxen *et al.*, 2018) The biggest advantage is the optimal use of the available time of experts in the workshop. The time recording (Figure 12) of the qualitative risk identification carried out here shows that only a small part of the total time falls back on the experts.

Step		**Time in hours**	**percentage**
Process visualisation		35	55,1%
	Editing, visualisation, meetings, etc..: (several persons involved) >30h		
	Workshop Preparation >5h		
Information collection: **Expert w**orkshop (3 groups each 30 min.)		1,5	2,4%
Information analysis (qualitative result analysis)		27	42,5%
	Digitisation of diagram sheets 15h		
	Clustering 12h		
Total time requirement		63,5	100,0%

Figure 12: Time recording of qualitative analysis

OUTLOOK

The FTX[5] in TOXI-Triage is used for a second type of information collection. As Figure 7 already shows, the information is obtained via an observation sheet (Technology Evaluation Observers sheet), two questionnaires (End-User Evaluation of Usability and End User evaluation of technology aims) and the transcript of a debriefing (Post FTX Debrief open discussion).

The *information analysis* in FTX corresponds to the analysis from the workshop (Figure 10). In the second step of risk identification, a meta-analysis of the externally created questionnaires is also carried out. The questions indicate potential risks that the creators have identified in advance. Furthermore, the documents are first analysed

[5] TOXI-triage - FOCUS exercise, October 17, 2018, Athens (Greece); The FOCUS scenario simulated a chemical incident in an airport.

and all risk-relevant contents are listed. This includes the questions on the questionnaires and the comments of the observers. These include those that represent a direct or interpretable reference to risks.

A striking feature of the information analysis in comparison to the workshop is that causes and consequences are relatively frequently stated and the consequences outweigh them. In addition, risk statements can be made by naming causes (e.g. “Technology was observed many times scanning fluidly and easily despite glare and PPE being worn”).

Preliminary results of the information analysis are 92 listed risks with a focus on technical risks. Risks are mentioned several times and overlaps with the identified risks of the workshop can be identified. What is striking here is that possible measures/solutions are also mentioned relatively frequently. The technical focus of the results can be traced back to the questions which correspond to the project objective of TOXI-Triage. The next step in the analysis of cluster formation has not yet been completed. Following the cluster analysis, the risks from the workshop and those of the FTX are compared. From this, conclusions are drawn on the applicability and their differences to the information collection.

Once the risk identification has been completed by the workshop and the FTX, a *risk analysis* can be carried out. The risk analysis analyses the causes and sources of risks. Various combinable analysis methods are used for risk analysis. These methods could be designed qualitatively, semi-quantitatively and quantitatively. Qualitative methods work with so-called significance levels such as “high”, “medium” and “low” and require a clear legend. The semi-quantitative methods, on the other hand, worked with a numerical classification. For quantitative methods, estimated values are used. However, these methods are often not used due to a lack of information or the high effort involved. (Sander, 2018, p. 57; see DIN Deutsches Institut für Normung e.V., 2010, p. 11) Based on the risk management concept presented above (Figure 1), the methods are selected.

CONCLUSION

For the risk identification in the EU project “TOXI-Triage”, a pictogram-based visualisation of the CBRN process, which was elaborated in detail, provided the basis for a resource-saving risk identification. In the current project, the first half of the risk identification process has already been completed with the collection of information through a workshop. Extensive and very complex interrelated risks were identified. At present, the first information collection by FTX has already been completed and the analysis is being carried out. A second information collection by FTX is currently in preparation. A concept for the risk analysis is currently being developed.

The presented concept shows the approaches for a holistic risk management in the area of emergency response. The focus here is on the integration and use of pictogram-based process visualisation. For risk identification and analysis, a high degree of methodological knowledge is sometimes required (Figure 13). This includes all methods presented. The advantage here lies in the good learnability, which does not require explicit process knowledge.

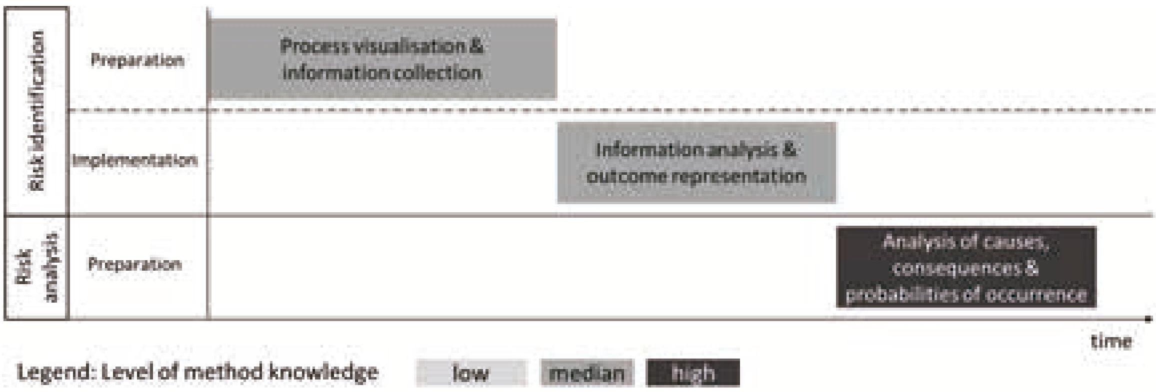

Figure 13. Resource needs of risk identification & -analysis – Resource “method knowledge”

The time intensive preparation of the risk identification with the elaboration of the process visualisation requires a low process knowledge (Figure 14). The resource “process knowledge” is only required to a large extent for the collection of information for a (very) short period of time. For the information analysis and the outcome presentation, medium or low process knowledge is sufficient. The depth of detail of the information analysis depends on the objectives of the following risk analysis. Due to the often complex dependencies on causes, risks and consequences, the need for resources can increase massively. The following risk analysis requires a high degree of methods knowledge and expert knowledge in order to gain detailed knowledge about the risks.

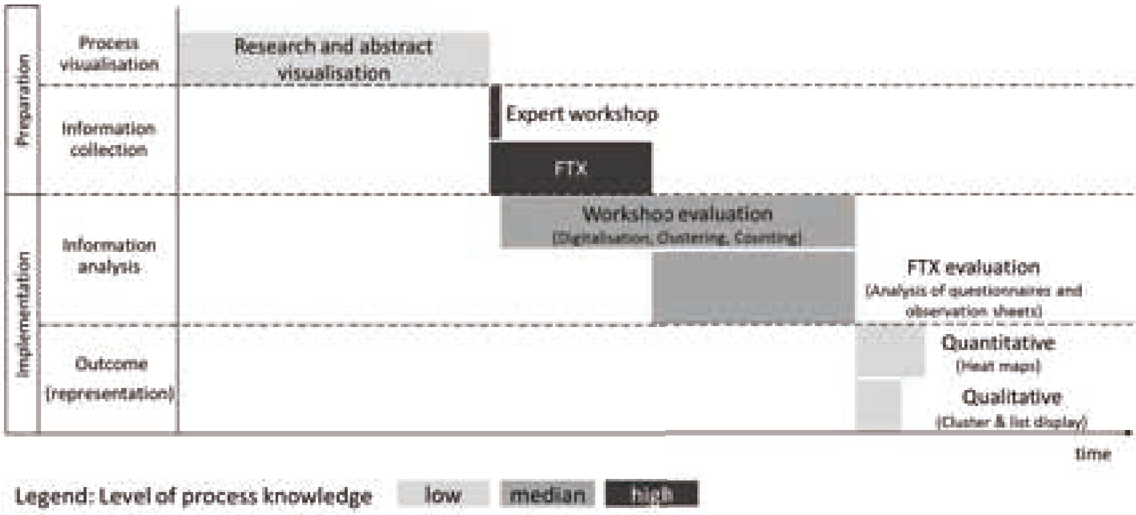

Figure 14. Resource needs of risk identification & -analysis – Resource "process knowledge"

The concept presented here shows a holistic concept, which is strongly characterised by the abstract process visualisation. The concept achieves good quantitative and qualitative results in a short "expert" time and can be flexibly applied to various questions/objectives. In addition, the information collection can also be integrated into project activities planned by third parties. The time available to experts is used highly efficiently. This is made possible by intensive preparation without the presence of experts. The further validation of the results is carried out against the results of the FTX.

A possible weakness of this method lies in the preparation phase. For the creation of the process visualisation sufficient information must be available, e.g. information about the considered object, the users and their knowledge as well as the goals. In the evaluation of the results, errors may occur in the interpretation of statements. These weaknesses can be counteracted by increasing resources and expert knowledge. . In the following it is also necessary to examine in which areas this type of process representation can additionally be applied and how or with which information systems it can be linked.

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