AN APPROACH TO MANAGING EXPERTISE

“We are dealing with
complex situations, often
with conflicting interests.”

Hans de Bruin
Gabriëlle Rossing
8 juli 2014

1 RESEARCHING COMPLEX SITUATIONS

Traditionally quantitative and qualitative methods are used to analyze situations or systems. However, we are dealing with complex situations, often with conflicting interests, which these traditional methods alone will not cut. Quantitative methods yield indicators and insight in correlations between them: they indicate **what** is happening. Qualitative methods *try to address the why*, but actually do not provide an answer **why** things happen as they do not take into account time and place specific aspects nor conflicting worldviews. Qualitative research methods frequently address specific situations or examples only. It is difficult to generalize from examples and to get insight at a more abstract level in interdependencies between humans and means that might inhibit or exhibit certain human behavior. However, notable exceptions exist, such as grounded theory, which lead to broader applicable theories.

Dealing with complex situations needs research methods that provide insight in **what** is happening as well as explaining **why** it is happening. The methods have to be capable of exposing interdependencies and being able to generalize from examples. In addition, the methods should bring forward levers of change to improve a situation.

EXPERTISE MANAGEMENT

Researching complex situations can be done with help of on the Expertise Management Method (EMM), which will be discussed later. We start with the Expertise Management ontology (EM_{ont}) being the heart of EMM. EM_{ont} is a model of human knowledge (expertise) in the form of knowing-that and knowing-how knowledge. EM_{ont} is an *upper or foundation ontology*[1] providing a basis for capturing domain-specific models of human knowledge, such as **conceptual knowledge** (knowing-that) and **human activities** (knowing-how). EM_{ont} is used for modeling the behavior of systems and interactions between these. Within systems ‘actors’ act to achieve goals. These actors can be humans but also non-human subsystems such as machinery and physical systems. Although EM_{ont} is a relatively small ontology with only a few concepts, it is powerful as its concepts can be applied recursively. This allows for modeling human behavior at all levels of abstraction, ranging from social networks comprising human interactions to the nitty-gritty details of individuals.

CONCEPTUAL KNOWLEDGE OR KNOWING-THAT KNOWLEDGE

Conceptual knowledge or knowing-that knowledge can be modeled as proposition[2]. An example of a proposition: “A *fire worker* (subject) *drives* (predicate) a *fire truck* (object)”. Propositions give meaning to a subject by relating it with help of a predicates to objects. An object may in another proposition fulfill the role of

[1] Ontology: A strict and complete overview of a subject or domain, usually with a hierarchical structure, containing all the relevant variables and their relations, including requirements and rules that apply to these variables and relations within the specific domain.

[2] Proposition: a statement that relates a subject by means of a predicate with an object.

subject, and vice versa. In this way networks of propositions are formed which as such provide a knowledge base[3].

Human activities or knowing-how knowledge

Knowing-how knowledge is situational defined: what may be effective in one situation does not necessarily apply to another situation. Also, humans have different views on situations. The interaction of actors can modeled by constructing a system of situations. Different situations are defined by a context in which they occur.

[3] The semantic web (known as web 3.0) is constructed as a networks of propositions using subject–predicate–object relations.

2 EXPERTISE MANAGEMENT ONTOLOGY (EMONT) STEP–BY–STEP

In this chapter basic elements of modeling with EM_{ont} are introduced by focusing on the **knowing-how** knowledge associated with (human) activities, and in particular on modeling worldviews. The most elements of EM_{ont} will be explained with help of a fictitious and simplified situation of counteracting a flooding disaster.

2.1 APPLYING THE PQR FORMULA TO DESCRIBE HUMAN BEHAVIOR (EXPERTISE)

In the Expertise Management Method (see Appendix §3.2) human behavior is defined as 'a human activity system'. The human activity system as well as other types of actors (e.g. machinery) are modeled by applying the PQR formula[4]. The PQR formula is pivotal to EM_{ont} as it concisely captures the notion of nested patterns of human behavior: activities executed for dealing with particular circumstances, which is motivated by someone's worldview. The PQR formula reads like a sentence:

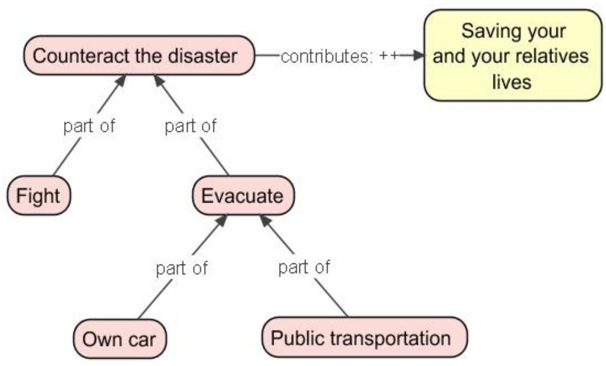
***Do* P *by* a Q in order *to achieve* R.**

The letters P, Q and R do not resemble anything, except for being subsequent letters in the alphabet. A specific meaning, however, is attached to these letters:

PQR	Meaning	
P	What?	What *activity* are we going to do, perform, execute or what *process* is going to happen?
Q	How?	By which *means* or *in what way* are we going to do it?
R	Why?	What *goal* do we want to achieve?

Applying the PQR formula touches upon **expertise** or **know-how** knowledge in the sense that an expert can apply the right patterns almost without consciously thinking. Based on his experience, an expert knows intuitively what to do in specific situations.

Example 1: Application of the PQR formula: Counteracting a disaster.



If a disaster strikes, then you should *counteract* (P - **What**) to *save yourself and your relatives' lives* (R - **Why**). Then the question becomes: **How** (Q) do we save lives? Usually, there are several options, that is, particular ways to achieve the desired goal. One option is to *fight* (Q_1) the disaster, another one is to *evacuate* (Q_2) the endangered area. Which one to choose depends on the circumstances, but both can contribute positively to achieving the desired *goal of saving lives* (R).

4 The PQR formula originates from the Soft Systems Methodology (see §3.1) where it is applied as a root definition: a statement written in a few sentences capturing the intention of someone's worldview.

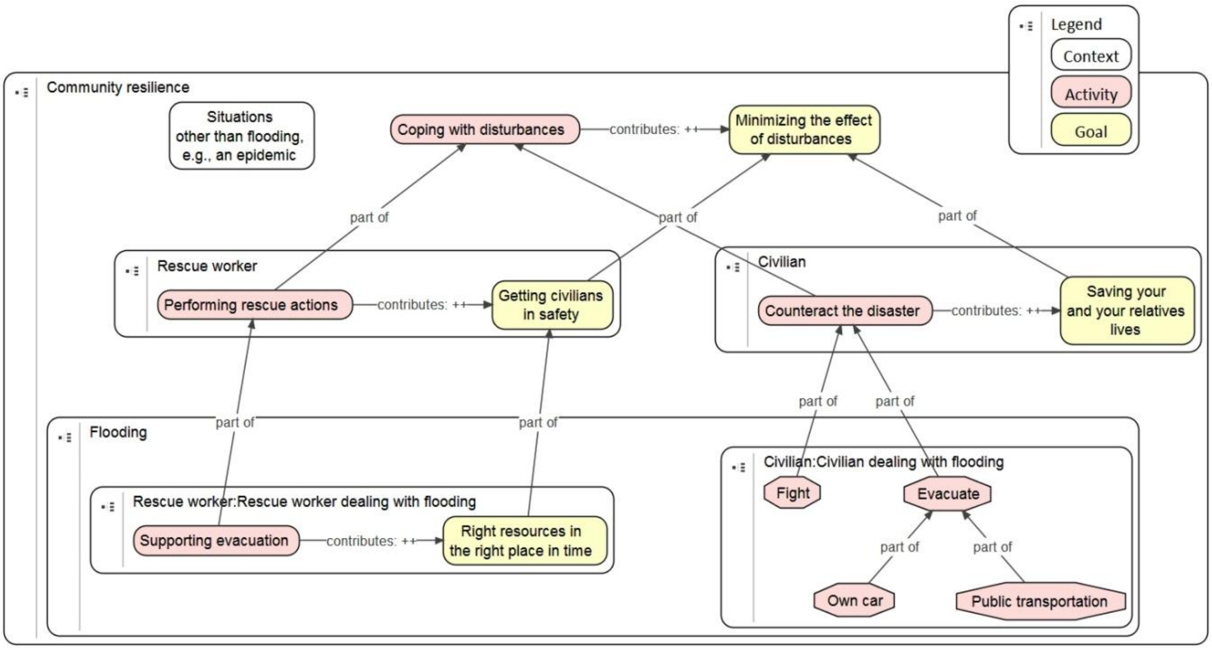
The PQR formula can be applied recursively. A Q (**How**) can be decomposed in more specific or diverse Q's (**How's**). Continuing example 1 about encountering a disaster: the evacuation activity can be subdivided in *evacuation by car* ($Q_{2,1}$) or by *public transport* ($Q_{2,2}$). Hence, evacuation activity Q_2 gets the status of the activity P (**What**) for its constituents.

Generalizing from example 1: by applying the PQR formula[5] recursively, we can model an experts' knowledge, that is, his behavioral patterns, at any desired level of detail. Just like activities (P), goals (R) can be decomposed in sub-goals as well.

2.2 Situations (PQR's in a particular context)

A *situation* is a network of actors, whether human or not, brought together to accomplish goals. Their goals may be shared or not shared. Technically, a *situation* is modeled as a *context* and the actors in the situation subsequently are modeled as *sub-contexts*.

Example 2: A situation consisting of contexts and sub-contexts.



The main *context*, i.e. *situation*, in example 2 is "Community resilience". Within this situation, the community as a whole tries to cope with disturbances (what) by minimizing the effect of disturbances (main *goal*). From this main goal sub-goals, such as "Saving your and your relatives lives", are derived. The overall goal can also be seen as a 'hook' to which more specific sub-goals can be attached. The same applies to the activity "Coping with disturbances": it is a hook to attach more specific activities which altogether contribute to the main goal. The main activity and main goal are addressing **what** should be done, not yet **how** it can be done.

Specific roles in specific situations

[5] Many practitioners find it hard to remember where the letters P, Q and R stand for. To reassure those practitioners, the way we are using the PQR formula, PQR could be remembered as the idea of recursively decomposing activities in what and how in order to be specific in how to achieve goals. In EM_{ont}, we make no distinction between what and how activities. The context makes clear the intention of a particular activity. So, it is really not important to remember where PQR stand for. The idea behind PQR, however, is key in modeling the behavior of actors. We refer to this idea by using PQR as a mnemonic.

Depending on the situation, humans perform specific actions to achieve the required goals. This notion is modeled as sub-roles in situations. By exploring example 2 on the situation of Community resilience a few *sub-contexts* were added, e.g. representing roles (sub-contexts) of Rescue worker and Civilian. From example 2 you can see how these two roles can be expressed in specific sub-situations, and in this particular example: in the situation of “Flooding”. In the situation “Flooding”, a Civilian has to deal with flooding. This may sound obvious, and it is, but something interesting is going on. The sub-context “Civilian:Civilian dealing with flooding” means that “Civilian dealing with flooding” is a sub-context of “Civilian”. At the same time, the sub-context “Civilian dealing with flooding” is also a sub-context of “Flooding”. This is just as the Civilian is contained in the sub-situation “Flooding” (see illustration of example 2). Thus, a sub-context may be captured in more than one context. This reflects the notion that humans play specific roles in specific situations.

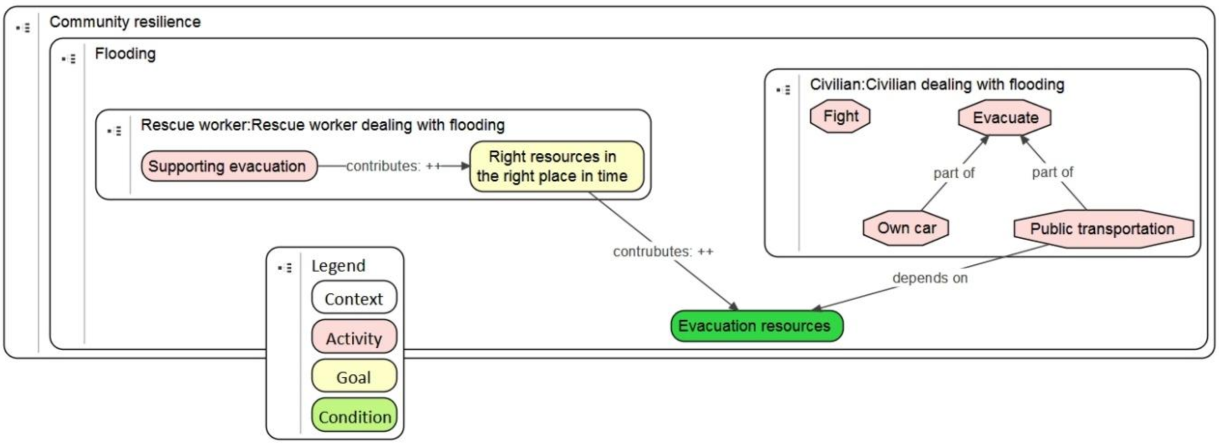
To conclude, it can be observed that a context is used to model situations comprising of sub-situations and roles. A role in its turn may be a situation for its constituents. That is, a role can be seen as a situation made up of sub-roles and sub-situations. A typical example is an organization which has employees engaged in specific activities. For an employee, the organization may appear as a situation rather than a role. So it is all a matter of perspective from which we can abstract away by using the general concept of nested contexts.

2.3 INTERDEPENDENCIES (CONDITIONS)

Actors are not acting alone, they *interact* with each other. How and how well they interact is determined by the *conditions* present in the situation in which the actors are interacting. A condition describes a state of a situation, which may be influenced by the behavior of an actor. A condition is often defined in a qualified way, e.g. “the availability of rescue workers”, or “a sufficient supply of evacuation resources”. As such, a condition can also be regarded as an internal system indicator. It can be said that a collection of conditions characterizes a system.

Typically, a goal is related to a condition: a goal “contributes to” to the condition. “Contributes to” is an expression of the type of *relation / interdependency* the goal and condition have. In example 3, the goal “Right resources in the right place in time” contributes positively to the condition “Evacuation resources”. In other words, the condition is an indication of the extent to which the goal has been achieved.
Note that a goal and a condition have deliberately been modeled as separate concepts. It is quite well possible, and in real situations frequently the case, that one actor achieving a goal contributing to a particular condition is undermined by another actor achieving another goal contributing (negatively) to the same condition.

Example 3: Goals contributing to conditions.

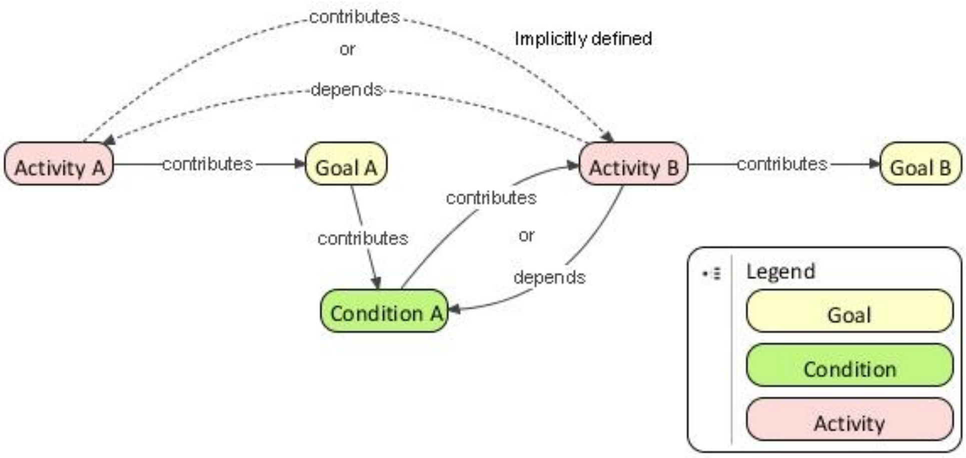


Type and quality of relations

Examples 3 and 4 are used to describe the type and quality of relations between activities, goals and conditions.

- **Dependency**: Activities may depend on a condition, as is the case in example 3: evacuation with public transport. Dependency between an activity and condition states the extent to which an activity can be performed depending on how well this activity is facilitated by other activities expressed in terms of one or more conditions.
- **Contribution**: A *goal* contributes to a *condition*. The relation "contributes to" is not as strong as the relation "depends on". A dependency can be expressed as "contributes to" for modeling situations in which the relation between an activity and a condition is weaker.

Example 4: General pattern of relations between activities, goals and conditions.



Note regarding the general pattern of relations (example 4): by applying a condition a relation is established between Activity A and Activity B. This is an implicit relation, as by means of the condition the relation between Activity A and B is (already) established. There is no need to make the relation between A and B (as indicated by the dotted lines in example 4) explicit.

2.4 Worldviews and beliefs

Up to now we have focused on a single person who, depending on the situation, carried out certain activities. However, not everyone will carry out this particular activity in the same way. These different approaches originate from the different **worldviews** people have. Also, the worldview of a single person may vary depending on the situation he is engaged in. Therefore, different worldviews will have to be considered, which can be included in the model similarly to how contexts were used to model roles in specific situations (§2.2). Example 5 illustrates different worldviews: a Civilian can deal with flooding by helping his neighbors or deal with the disaster on his own.

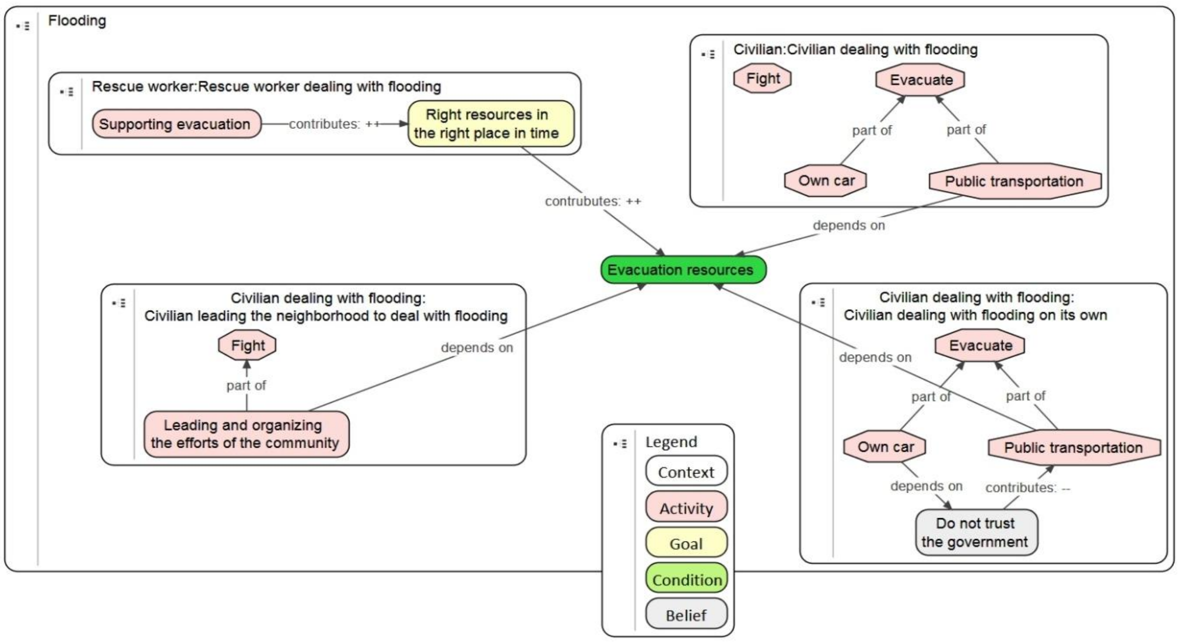
A **belief** is considered a fixed idea, which defines a worldview. A belief is similar to a condition, but in contrast, a belief cannot be changed within the system itself. In example 5 the context "Civilian dealing with flooding on its own" includes the belief "Do not trust the government": this particular civilian does not expect anything positive from the government, no matter how hard the government tries.

2.5 Refining and creating clarity in the complex model

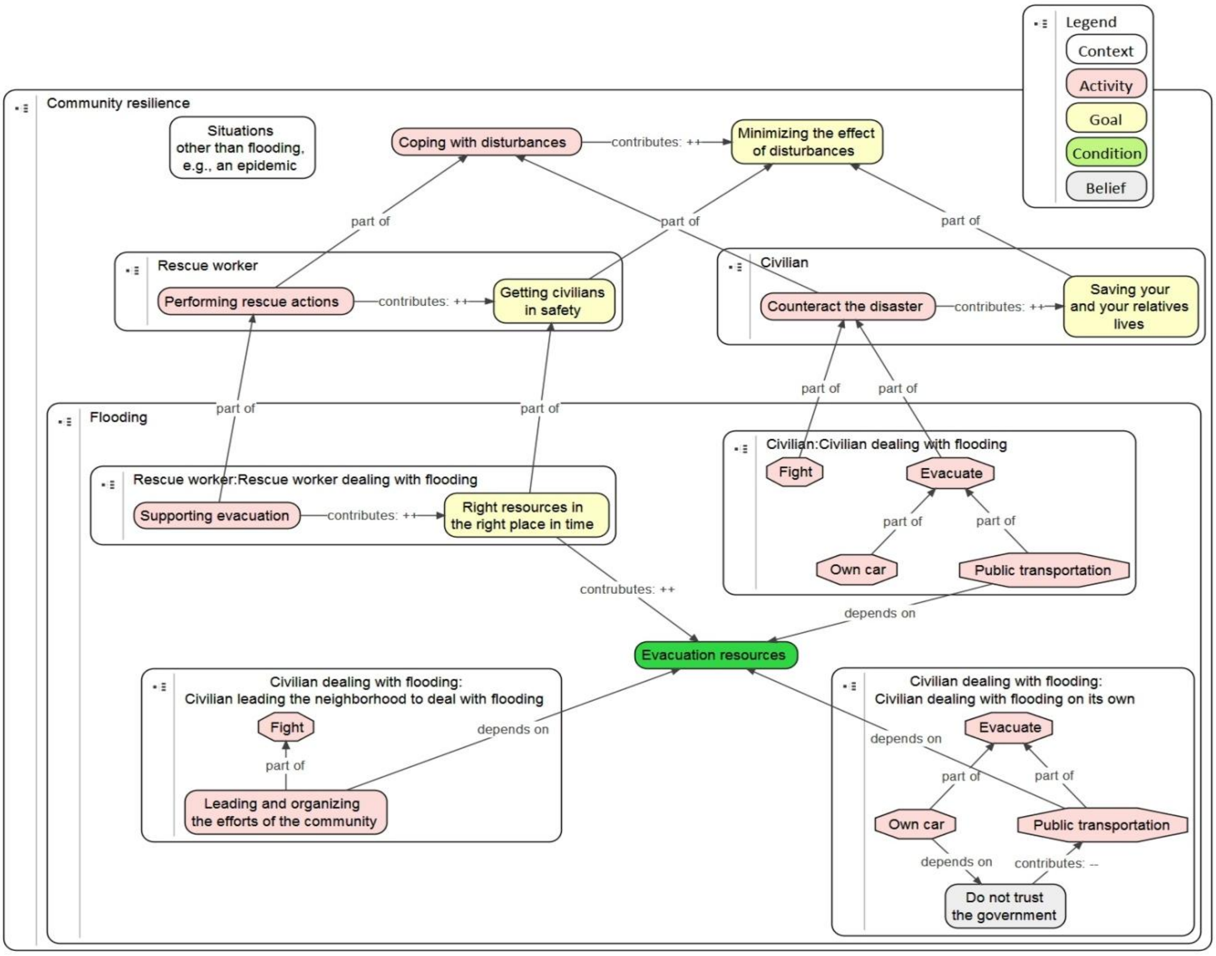
Creating clarity in a complex model can be done firstly by developing a *main scheme* presenting the big picture which includes only the most important situations (sub-contexts). Details of the different situations are provided only when “zooming in” to these, thus by developing separate schemes that only describe the situation selected. The main scheme therefore provides a more generic basis (or the so-called ‘hooks’) for deriving sub-contexts to which, depending on the type of situation you are interested to have a detailed look at, information can be added.

To the sub-contexts generated in examples 2 and 3 information can be added and removed (see example 5). For instance: specialized roles, such as “Civilian dealing with flooding on its own” and “Civilian leading the neighborhood to deal with flooding” are derived from the role “Civilian dealing with flooding”. Modeling elements can be discarded when they are not of use or add value to a particular sub-context. For instance, the context “Civilian dealing with flooding on its own”, the activity “Fight” has been removed.
The octagonal shape indicates that this modeling element happens to be used in other contexts too. In example 5 “Evacuate” is an activity occurring elsewhere in het context “Flooding” as well.

Example 5: Adding and removing information.



All EM_{ont} modeling elements, as discussed in the previous paragraphs, brought together in one scheme:



2.6 CONCLUDING REMARKS

The strength of modeling complex situations with EM_{ont} lies in putting patterns of human/non-human (actors) behavior (PQR's) in a context and applying these recursively. A context or situation is key to modeling roles and interactions of actors, including their different worldviews, in that particular context. The example of a flooding disaster is a simplified and incomplete illustration of a real situation. Modeling real situations can reflect reality in a comprehensive manner, but the models can also become very large. Applying contexts supports separating the main situation or processes from more detailed descriptions of the individual situations.

Subjects not discussed in this introduction to modeling with EM_{ont} include documenting good and bad practices, a sequence of activities ('composed activities'), and modeling conceptual knowledge and its connection to PQR's in a context. These subjects makes modeling with EM_{ont} more comprehensive, yet does not imply the introduction of significantly different elements to EM_{ont}.

3 APPENDIX: RESEARCH METHODS FOR DEALING WITH COMPLEX SITUATIONS

3.1 SOFT SYSTEMS METHODOLOGY (SSM)

SSM is used to address complex situations. SSM is based on systems theory and is action-oriented. SSM can be regarded as a collective learning process to systematically finding actions that bring about arguably desirable and culturally feasible changes in a situation. SSM has a lot in common with grounded theory, but emphasizes participants worldviews rather than putting the researcher at center stage.

Soft Systems Methodology (SSM): a very, very short tour

- We are living in a complex society with "messy" situations that can be improved somehow.
- SSM is an organized way to tackle problematic situations; it is action-oriented.
- The complexity of situations is caused by different worldviews, which are often taken for granted.
- People want to act purposefully, with intention.
- SSM approach:
  - Finding out;
  - Model building: purposeful activity models;
  - Discussing and debating;
  - Taking action: arguably desirable and culturally feasible.
- These four steps constitute a learning cycle. SSM is group learning.
- Taking action implies changing a situation in which we can find new opportunities to improve. In short, SSM is a never-ending story.

3.2 EXPERTISE MANAGEMENT METHOD (EMM)

SSM is a methodology rather than a step by step research method, therefore it is possible to tailor SSM to one's needs by including specific methods and techniques. This is precisely what we have done with developing the Expertise Management Method (EMM), where we have extended SSM with methods for accurately capturing human activities. Pivotal to EMM is the Expertise Management ontology (EM_{ont}), a model of human knowledge in the form of **knowing-that** and **knowing-how** knowledge.

Key to EMM is the situation: a situation composed of humans trying to achieve goals. These goals may be shared or not. Different humans have different worldviews on particular situations, stemming from diverse beliefs and experiences. Different – and often conflicting – worldviews are combined with the EM_{ont}. An EM_{ont} model also shows the interdependencies between humans and means. These interdependencies are stated in the form of conditions, which can be regarded as system states or internal system indicators.

Like in grounded theory, EMM favors a cyclic process of deduction and induction. With EMM specific cases are investigated for gaining insight into particular situations. These insights are generalized for explaining how to act in other but similar situations in order to achieving desired goala. As such, these insights provide clues for subsequent research about problems in actual situations. By continuously switching between cases and general insights universally applicable models are refined during the research process. Based on this cyclic research process theory can be developed.

EMM focuses on defining theories to explain why things occur as they occur in specific situations. With EMM these theories are used as a guidance to act in similar situations yet to be encountered. Since EMM is based on SSM, it is open to embrace specific research methods and techniques, including quantitative approaches.