

A Call for Sensemaking Support Systems in Crisis Management

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Abstract. In this chapter, we explore four information processing challenges commonly experienced in crisis situations, which form the basis of the design of information systems that should support actors in these situations. When we explore the difference between Sensemaking and decision making, two activities that are undertaken to cope with information processing challenges, we can understand the two types of information systems support that are needed. The first type—decision support systems—supports actors in dealing with information-related problems of uncertainty and complexity, and is the traditional focus of information systems design. The second type—sensemaking support systems—should support actors in dealing with problems of frames of reference, ambiguity, and equivocality, but is not commonplace yet. We conducted three case studies in different crisis situations to explore these information processing challenges: A case study of the sudden crisis of an airplane crash in the Barents Rescue Exercise, a case study of the yearly recurring forest fires crises in Portugal, and a case study of the post-conflict European Union Police Mission in Bosnia and Herzegovina. We discuss design premises for crisis management information systems and compare these to our findings, and observe that systems designed accordingly will provide for the necessary Sensemaking support.

1 Introduction

The term “crisis” derives from the ancient Greek word *κρῖσις* (krisis), meaning moment of decision, judgment, or choice. In Greek tragedies, for example, *κρῖσεις* (krisis) were turning points where human choice could make a fundamental

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difference to the future [25]. Nowadays, we use the term crisis for either “a crucial stage or turning point in the course of anything,” which reflects the original meaning of the word, or “a time of extreme trouble or danger” [9]. In this chapter, we use the term crisis to describe the latter type of events, when people are struck by disastrous circumstances. As a consequence of such events, however, people will inherently find themselves in a crucial stage or turning point in which they do not only need to make decisions on the course of action they will pursue, but also need to make judgments on what is happening around them and on what the decision context is. We use the theory of Sensemaking to study exactly this: how people make sense of their environment, and how they give meaning to what is happening. Sensemaking is a crucial process in crises, as the manner and thereby the success of how one deals with crucial events is determined by the grasp one has of a situation.

Crisis environments are characterized by various types of information problems that complicate the response, such as inaccurate, late, superficial, irrelevant, unreliable, and conflicting information [30, 32]. This poses difficulties for actors to make sense of what is going on and to take appropriate action. Such issues of information processing are a major challenge for the field of crisis management, both conceptually and empirically [19]. Commonly, research is aimed at how often, when and why process members use a certain technology. However, such research does not address the more fundamental and underlying question of what kind of processes take place when people make use of the information they retrieve. This involves less explicit information processing mechanisms that are considered a “black box” [23]. To design appropriate supporting systems, we need to know more about what is being supported [40], and that is what we want to investigate in this contribution.

We focus on how people cope with information processing challenges in crisis situations to better understand what type of Information Systems (IS) support people need in crisis management. More specifically, we examine how information processing challenges of ambiguity, uncertainty, equivocality, and complexity are related to Sensemaking and/or decision making, and observe through case study research how actors deal with these information processing challenges in three specific crisis situations: A case study of an aviation crash in the Barents Rescue Exercise, a case study on forest fires in Portugal, and a case study in Bosnia–Herzegovina of the European Union Police Mission (EUPM).

This chapter is outlined as follows: First, we discuss Sensemaking and the constructs that characterize Sensemaking. We then discuss several information processing challenges, how they relate to Sensemaking and decision making, and how IS can support them. Thereafter, we discuss the case studies we conducted, the methodology we used, the findings related to how actors deal with information processing challenges, and analyze the findings. Finally, we discuss implications for the design of crisis management IS and present our conclusions.

2 Sensemaking

Sensemaking literally means making sense of things, making things sensible [37, p. 16]. Organizational and management scholars have defined and used the concept

of Sensemaking in different ways. March and Olsen related Sensemaking to experiential learning [4, p. 77], as “individuals and organizations make sense of their experience and modify behavior in terms of their interpretations” [15, p. 56]. Huber and Daft talked about Sensemaking as the construction of sensible and sensible events [11, p. 154]. From Starbuck and Milliken’s perspective, “Sensemaking has many distinct aspects: comprehending, understanding, explaining, attributing, extrapolating, and predicting, at least. (...) What is common to these processes is that they involve placing stimuli into frameworks (or schemata) that make sense of the stimuli” [27, p. 51]. This broader notion of Sensemaking is also acknowledged by Thomas et al., who view information seeking, processing, creating, and using to be central activities of Sensemaking [28]. This means that Sensemaking is not a noun, but a verb; that it is a process, with sense as its product [19].

We heavily rely on Weick’s extensive work on Sensemaking [34–39]. He matured the concept of Sensemaking in organizations, among others by defining its underlying constructs. In the following section, we expound on these properties.

2.1 Sensemaking Constructs

Weick [37] distinguishes between seven properties of Sensemaking. Although they might not be fully exhaustive nor exclusive in the scientific sense, they still are a grand attempt to render the way people deal with interruptions more tangible [19]. The seven different properties of Sensemaking can be captured by the acronym SIR COPE: Social context, Identity construction, Retrospection, Cue extraction, Ongoing projects, Plausibility, and Enactment [17–21, 37–39].

Social context

“People learn about events when they compare what they see with what someone else sees and then negotiate some mutually acceptable version of what really happened” [34]. Cognitive and social aspects of Sensemaking are inextricably linked. People need social anchors and a form of social reality [38], because what we say or think or do is contingent on what others say and think and do. Sensemaking requires talking, interaction, conversation, argument, and dialogue with others [18].

Identity construction

Depending on who the Sensemaker is, the definition of what is happening will also change. What the situation means is defined by who one becomes while dealing with it or what and who one represents. “The Sensemaker is himself or herself an ongoing puzzle undergoing continual redefinition, coincident with presenting some self to others and trying to decide which self is appropriate” [37, p. 20]. An organization seeks to discover what it “thinks” and “knows” about itself and its environment, and this construction of identity is the basis for imparting meaning to information within the organization and, eventually, determining what problems must be solved.

Retrospection

“Sensemaking is influenced by what people notice in elapsed events, how far back they look, and how well they remember what they were doing” [38]. Weick, Sutcliffe, and Obstfeld [41] point out that answers to the question, “what’s the story?” emerge from retrospect, connections with past experience, and dialogue among people who act on behalf of larger social units. Answers to the question, “now what?” emerge from presumptions about the future, articulation concurrent with action, and projects that become increasingly clear as they unfold.

Cue extraction

Sensemaking is influenced by both individual preferences for certain cues as well as environmental conditions that make certain cues figural and salient [38]. We notice some things and not others. We pay attention and extract a particular cue and then link it with some other idea that clarifies the meaning of the cue, which then alters the more general idea to which we linked the cue, and on and on. Extracted cues enable us to act, which increases our confidence and confirms our faith in earlier cues [18].

Ongoing projects

Sensemaking has neither a beginning nor a formal end. Instead, it “takes place in a continuing and dynamic fashion as events unfold and we continually seek to understand what events mean in relationship to our organizations” [21]. Most of us at any given time find ourselves “in the middle of something.” As we move from one situation to another, we make and revise assumptions and beliefs along the way. Once you cannot keep pace with the action, you lose context, information, situated cognition, and tools made meaningful by actual use [39].

Plausibility

“Sensemaking is about coherence, how events hang together, certainty that is sufficient for present purposes, and credibility” [38]. Looking for what is plausible is often of more practical help than finding accuracy [21]. Plausibility helps us explore what we see and energizes us to act; the search for accuracy can de-energize us as the search drags on and on.

Enactment

People often do not know what the “appropriate action” is until they take some action, guided by preconceptions, and see what happens. “Action is a means to gain some sense of what one is up against, as when one asks questions, tries a negotiating gambit, builds a prototype to evoke reactions, makes a declaration to see what response it pulls, or probes something to see how it reacts” [38]. Action determines the situation, as it creates an orderly, material, social construction that is subject to

multiple interpretations [35]. The basic premise is that there is no objective environment out there separate from one's interpretation of it. Thus, the organization creates or enacts parts of its environment through selective attention and interpretation.

Weick et al. [41, p. 419] formulate a gripping conclusion on what the seven Sensemaking properties are all about: "Taken together these properties suggest that increased skill at Sensemaking should occur when people are socialized to make do, be resilient, treat constraints as self-imposed, strive for plausibility, keep showing up, use retrospect to get a sense of direction, and articulate descriptions that energize. These are micro-level actions. They are small actions. But they are small actions with large consequences."

3 Information Processing Challenges and Support

Information-related problems cause people to have difficulties in processing information in crisis situations. Very often the terms uncertainty, complexity, ambiguity, and equivocality are used in an attempt to stress these "difficult circumstances" people have to cope with. However, these terms are mostly used interchangeably, without exactly describing what is meant. Zack [42] distinguished these four terms according to two dimensions: the nature of what is being processed and the constitution of the processing problem.

The nature of what is being processed is either information or frames of reference. With information, we mean "observations that have been cognitively processed and punctuated into coherent messages" [42]. Frames of reference [4, p. 108], on the other hand, are the interpretative frames which provide the context for creating and understanding information. There can be situations in which there is a lack of information or a frame of reference, or too much information or too many frames of reference to process.

Table 1 Information processing challenges (adapted from [42])

	Information	Frame(s) of reference
Lack of...	Uncertainty	Ambiguity
Variety/diversity of...	Complexity	Equivocality

As shown in Table 1, this breakdown into two dimensions leads to four different types of information processing challenges [42]: uncertainty, complexity, ambiguity, and equivocality.

Uncertainty is a situation in which there is not enough information already possessed by the organization to perform the task [5, 8]. *Complexity* is the second information-based challenge, and arises when there is more information than one can easily process [42]. Although information-related problems are not the only type of problems that lead to complexity, this narrow definition suffices for our present focus on information-related processing challenges. When there is a

situation in which one does not have a framework for interpreting information, there is *ambiguity* [42]. Finally, *equivocality*—or confusion—is a situation in which one has several competing or contradictory frameworks [6]. Ambiguity and equivocality may at first sight seem to be synonymous terms, but they are used throughout literature to distinguish between unclear meaning (ambiguity) and the confusion created by two or more meanings as in a pun or equivocal (equivocality) [37, p. 92].

The four information processing challenges are not mutually exclusive, but often exhibit a natural hierarchy of difficulty in practice. Ambiguity is the most difficult challenge to overcome, since it involves developing a frame of reference when none is available. When people negotiate their interpretations and share their understandings, a situation of equivocality can arise as there are multiple conflicting frames of reference. There is a balance needed for, on one side, creating new frames of references and reducing the frames on the other side. Once an appropriate frame is constructed, the situation may reveal itself to be uncertain, complex, or both. This will determine whether a strategy of information seeking or information reduction should be adapted.

In the following section, we will highlight the difference between Sensemaking and decision making, and discuss which information processing challenges they both are aimed at.

3.1 Sensemaking versus Decision Making

Decision making is traditionally viewed as a sequential process of problem classification and definition, alternative generation, alternative evaluation, and selection of the best course of action [26]. This process is about strategic rationality, aimed at reducing uncertainty [6, 36]. Uncertainty can be reduced through objective analysis because it consists of clear questions for which answers exist [5, 40]. Complexity can also be reduced by objective analysis, as it requires restricting or reducing factual information and associated linkages [42].

On the contrary, Sensemaking is about contextual rationality, built out of vague questions, muddy answers, and negotiated agreements that attempt to reduce ambiguity and equivocality. The genesis of Sensemaking is a lack of fit between what we expect and what we encounter [40]. With Sensemaking, one does not look at the question of “which course of action should we choose?”, but instead at an earlier point in time where users are unsure whether there is even a decision to be made, with questions such as “what is going on here, and should I even be asking this question just now?” [40]. This shows that Sensemaking is used to overcome situations of ambiguity. When there are too many interpretations of an event, people engage in Sensemaking too, to reduce equivocality.

Sensemaking is concerned with making things that have already happened meaningful [3] and is more than problem definition, as Weick and Meader [40] explain: “to label a small portion of the stream of experiences as a ‘problem’ is only one of many options. The stream could also be labeled a predicament, an enigma, a dilemma, or an opportunity. Each of these labels has a different implication for

action. If it is a problem, then solve it; but if it is a predicament, then accept it; if it is an enigma then ignore it; if it is a dilemma then define it anyway; and if it is an opportunity then exploit it. To call something a problem is the outcome of Sensemaking.”

People usually enhance their Sensemaking efforts after a sudden loss of meaning, when they experience a diffuse sense of unease that perhaps something needs to be done, although no one can say for sure. People then “must make sense of an uncertain situation that initially makes no sense” [24, p. 40], and try to shape and give definition to the decision context by processes of Sensemaking [40]. Sensemaking differs from interpretation as Sensemaking “is about the ways people generate what they interpret” [37, p. 13].

Just as the information processing challenges from Table 1 are not mutually exclusive, Sensemaking and decision making cannot be separated, but instead operate simultaneously. Meaning must be established and then sufficiently negotiated prior to acting on information [42]: Sensemaking shapes events into decisions, and decision making clarifies what is happening [40].

The previous discussion does not imply that dealing with information challenges is not important for Sensemaking. It is not possible to separate the two activities of coping with information challenges and interpretation challenges. However, the main activity of Sensemaking is ascribing meaning to what is really happening and not gathering information on a situation. More information does not automatically lead to better Sensemaking [12]. The central problem requiring Sensemaking is mostly that there are too many potential meanings, and so acquiring information can sometimes help but often is not needed. Instead, triangulating information [34], socializing and exchanging different points of view [20], and thinking back of previous experiences to place the current situation into context, as the retrospection property showed us, are a few strategies that are likely to be more successful for Sensemaking.

The previous discussion enables us to make a clear distinction between decision making and Sensemaking: Decision making is about coping with information processing challenges of uncertainty and complexity by dealing with information, whereas Sensemaking is about coping with information processing challenges of ambiguity and equivocality by dealing with frames of reference. This information processing distinction between decision making and Sensemaking has not been made previously in literature. We will apply this dichotomy in the discussion of the case studies in Section 4.

3.2 Information Systems

Some interesting work has been done on the intersection between IS and crisis management, for example [10, 29], but recent research and practice have shown that current crisis management IS are long overdue [30]. Interesting and substantial research exists on Sensemaking and crises situations such as [36], but relatively few studies use Sensemaking as an analytical lens for the design of information

technology [40], and there is scarce research on how IS can support information processing challenges—specifically related to Sensemaking—in crisis management [14]. In the hectic circumstances of crises, people could benefit from IS support in making sense of what is going on. There are, however, many challenges to accomplish this, since data in IS “contain only what can be collected and processed through machines. That excludes sensory information, feelings, intuitions, and context — all of which are necessary for an accurate perception of what is happening. (...) To withhold these incompatible data is to handicap the observer. And therein lies the problem” [34].

The problems of managing information and managing frames of reference are “tightly linked in a mutually interacting loop” and require “managing information and the systems that provide it” [42]. IS have been generally designed to overcome the information problems from Table 1. Most IS are aimed at either storing and retrieving information to reduce uncertainty, such as database management systems and document repositories, or at analyzing and processing large amounts of information to reduce complexity, such as decision support systems [31]. However, as we have previously discussed, information related strategies are not always helpful in coping with a variety of potential meanings.

Problems of interpretation and the creation and management of frames of reference, which aids Sensemaking, have generally not been taken into account when designing IS. Most IS currently seem to intend the opposite because they aim at replacing or suppressing the possibility to make sense of situations. For example, heavily inspired by Herbert Simon’s work, IS research and practice use structured data as a substitute for information [2]. However, information is not a commodity; it is a skilled human accomplishment. Information is meaning resulting from a person’s engagement with data [7]. IS should thus be designed to take dialogue, interpretation, and an individual’s search for meaning as sacred [2]. We use the term “Sensemaking Support Systems” [18, 37, 40] to denote systems that should be designed in the future to support Sensemaking. “We need to understand more about Sensemaking Support Systems as well as Decision Support Systems, which means we need to know more about what is being supported” [37, p. 179]. In the following section we discuss three case studies we conducted in different crisis situations, in which we examined how people handle and process information in crises to understand how supporting IS should be designed.

4 Case Studies

In this chapter, we report on three case studies we conducted [16]: the sudden crisis of an airplane crash in the Barents Rescue Exercise, the yearly recurring crises of forest fires in Portugal, and the post-conflict state building EUPM in Bosnia and Herzegovina. We selected these case studies on grounds of their differing crisis characteristics, as we wanted to investigate how people handle and process information and make sense in a broad spectrum of crisis management situations. In Table 2,

Table 2 Taxonomy of crisis management case studies

-	Case study 1: Barents Rescue Exercise	Case study 2: Forest fires in Portugal	Case study 3: EUPM in Bosnia and Herzegovina
Crisis type	Accident	Natural disaster	Conflict
Timing and type of operations	In casu; dealing with the plane crash	Ex ante and in casu; preventing and dealing with forest fires	Ex post; state building
Level of management	Operational	Strategic	Operational
Time span	Short	Ongoing, long term	Medium term
Predictability	Sudden	Expected	Expected

we show how these case studies differ from each other on varying aspects of crisis management.

We first describe the common methodology used. After this, we describe the three case studies: an introduction on each case study, how we conducted it, the findings from the case study, and a discussion of the findings. The findings are for each case study organized according to the nature of the processing of information: the dealing with information to reduce uncertainty and complexity, and the dealing with frames of reference to reduce ambiguity and equivocality. Literal quotations from interviewees are indicated with quotation marks.

4.1 Methodology

For these three case studies, we used an interpretive approach and conducted in total 20 interviews with a common approach and research aim. Interpretive research attempts to understand phenomena through the meanings that people assign to them [22]. Interpretive methods of IS research take into account the context in which the information system is used with that particularity that it also acknowledges the mutual interaction between the system and its context. To succeed in the opening up of these mutual interactions, the researcher has to interact with the research participants. Klein and Myers [13] state that the “data are not just sitting there waiting to be gathered, like rocks on the seashore.” Data are produced in a social interaction of the researchers with the participants.

For our research design, we drew on Walsham [33] and Klein and Myers [13], who provide comprehensive guidelines on how to conduct interpretive case study research in the IS domain. On the practical level this shows itself throughout our research by means of a colorful interviewing style with which we stimulated our respondents to answer us difficult questions related to the Sensemaking constructs [19], among others by using statements, dichotomies, metaphors and dilemmas, relying heavily on examples and anecdotes, and calling upon their imagination to find out the bottom-line. In our interpretive case studies, we adjusted our style

to the respondent, such as to his/her language, world view, professional experience, and personality.

The interviews were semi-structured, in the sense that we knew which topics to touch upon and had a list of the general points we wanted to find out, related to the seven Sensemaking constructs, but adjusted the questions to how the interview was evolving. Permission for tape recording was granted for 19 interviews; only notes were taken at the interview in which the respondent was not comfortable with the use of a tape recorder. Confidentiality was guaranteed in all interviews.

We supplemented data and understanding of the case studies with other types of field data, such as reports, background stories on various websites, press articles, brochures, and informal interaction at the sites of the case studies.

4.2 Case Study 1: Barents Rescue Exercise

Barents Rescue is a series of field training exercises which are organized and conducted by the countries within the Barents Euro-Arctic Council (BEAC): Norway, Sweden, Finland, and Russia. The Barents Rescue 2007 Exercise was held in October 2007 in Saariselkä and Ivalo, located in the Northern part of Finland. The exercise aimed to facilitate communication, coordination, and cooperation between countries and civil–military services that may be involved in crises relevant to the Barents region. The project consisted of a series of planning conferences, training events, and exercises, of which the Barents Rescue Exercise in October 2007 was the final and main event.

There are several challenges to crisis response operations in the Barents region: The distances between cities are big, there is limited infrastructure, because of the scarce population there are limited resources for rescue operations, and the climate conditions are severe in winter. For this reason, it is important that the countries in the region plan on how to join forces when responding to a crisis. The Barents Rescue Exercise was aimed at training such cooperation and improving crisis preparedness.

The scenario for the exercise was an aviation accident. A British aircraft executed an emergency landing in the uninhabited areas of the Inari municipality. The more than 200 passengers were mainly tourists from the United Kingdom. The reason for the crash was not immediately clear, but it was very likely that many passengers were injured or deceased. The scenario involved different stakeholders from the BEAC countries, such as alarm centers, national rescue services, hospitals, the military, private companies, and voluntary organizations.

The exercise included three phases with different approaches to crisis management. The first phase, the alarm exercise, was aimed at exercising the alarming and gathering of possible resources in the Barents region in case of a major crisis. The second phase, the table top exercise, was aimed at exercising the practical response in the crisis area, consisting of a command post exercise, table top exercise, and

exercise with utilizing virtual tools. The third and final phase, the field training exercise, was aimed at training the capabilities of organizations and agencies involved in the direct response to a crisis, both on the operational level and on the strategic level.

4.2.1 Case Study Implementation

In October 2007, we traveled to the Northern part of Finland for the Barents Rescue Exercise. We conducted four interviews with key people involved in the crisis response operation: One person working at the On Site Operations Coordination Center (OSOCC), one person working at the Local Emergency Management Authority (LEMA), one person working at the On Site Command Center (OSC), and one person in charge of leading the medical team.

Besides these interviews, we got a good overview of how the actors handle and process information in the exercise through observations [1]. As the table top exercise and the field training exercise were each organized on one location, we could observe how all the actors dealt with the crisis. These observations were used for the interviews, as we could ask specific questions on the actions of the observed people and what had happened in the exercise. The Barents Rescue Exercise provided a good opportunity for us to observe a crisis on the operational level, as it is difficult to observe a crisis in a real-life situation.

4.2.2 Case Study Findings on Dealing with Information

We observed several information problems in the exercise. There were problems of conflicting information when air traffic control and the rescue services labeled the accident site with two different geographical coordinates. Information often arrived late in the alarm exercise, as the primary communication technology that was used was the fax, the most commonly used tool at the time the procedures were put in place. Other unnecessary delays were caused in the field because it was not clear which organization was in charge of the rescue operation. Moreover, not all actors were informed about the Emergency Rescue Center in Tromsø as a contact point for the response operation. Another factor delaying the response was the information provision to the medical team. After the initial alarm, it took 90 minutes before the medical team received the first information about the victims. The medical team was only able to determine the kind of assistance that was needed after this information was received.

Actors dealt with these information problems in different ways. People indicated to have preferences concerning the level of detail of information that is useful to have. Although most interviewees clearly stated that more detail was better for them, there were also cases in which actors argued that anything more than essential information was not needed and in fact distracted them from their job.

People also had different ways for making sure they were communicating as effectively as possible. For example, one actor started handling the crisis by listing

his key contact persons and phone numbers to prepare himself for information exchanges in the upcoming hectic circumstances.

What happened in practice when people communicated in the crisis was that messages were double-checked to make sure that they arrived properly, for example, in radio communications by the recipient repeating the main words.

The interviewee who was working in the OSC said that “you are forced to trust the people with whom you are exchanging information, no matter who is on the other side” when responding to a crisis. He felt that there is not much time to think about whether the information received from others is right or wrong, and one therefore has to act on the information that is available.

For the people in the OSOCC, it was important to receive information on what is happening on a continuous basis: “We need to get the key cards, to keep being informed”. The OSOCC and LEMA were operating in two separate but adjacent rooms. A liaison officer of LEMA was appointed to regularly brief the people in the OSOCC on what was happening. This briefing was, however, not frequent enough, especially since LEMA was very busy. Moreover, the people in the OSOCC did not use any system to receive information and communicate with the LEMA.

4.2.3 Case Study Findings on Dealing with Frames of Reference

Some people identified experience to be a helpful resource for crisis response while others felt it to be essential: “From your experience you cannot remember everything, but many things stay in the back of your head and become a routine.”

For one key actor it was important to create time to think about the situation: “I read the documents and think about what’s next. And if there is too much noise, I go perhaps out, take a cup of coffee, and smoke a cigarette. Because when it’s so hectic, you have to clear your mind and think about what’s going on.”

Most of the interviewees indicated that they value effectiveness over efficiency when responding to a crisis. For example, they would request more resources than deemed absolutely necessary, just to be sure to have enough.

In the alarm exercise, actors had different expectations of each other. For example, regarding the procedure to follow, Finland expected a very fast response from other countries, while Norwegian actors took their time to find out how many resources were needed and available.

The comparison of frames of reference on the strategic level by exchanging points of view and understanding of the crisis was hampered because the OSOCC and LEMA worked more or less independently.

Language was an issue of concern in this international exercise. As responders cannot use their native language when cooperating with responders from other countries, it was difficult for them to choose the right words to use. Culture is also important, as an interviewee emphasized: “We [Finnish people], together with the Swedes and Norwegians, think in the same way and have the same kind of picture in mind all the time. We have the same kind of systems [structures] in place, and we understand each other. But with the Russians it’s a bit harder.”

4.2.4 Discussion of the Findings

The initial response to an airplane crash should be a rapid response, as surviving passengers need immediate medical aid. Problems of uncertainty—a lack of information—delayed the response: the alarm center could not inform actors swiftly due to an outdated alarm procedure by fax, the contact point and focal point for the response operation was unknown to many actors, and the medical team received information on the victims far too late. Moreover, the information exchange between LEMA and OSOCC was not good. In the future this can be avoided by having LEMA and OSOCC in the same location, or by using shared IS. Then, the people in the OSOCC are not dependent on briefings but can actively follow what is going on. Problems of complexity showed up, for example, when determining the accident site, as the IS that were used by various actors were not interoperable.

People try to cope with uncertainty and complexity in different ways. Interviewees indicated to have different preferences concerning the level of detail of information, and, consequently, either seek more detailed information or refrain from this level of detail. Actors take precautionary measures against complexity by organizing information in certain ways, double checking information they receive to avoid having conflicting information, and acting on uncertain information as it is the only information they have.

Situations of ambiguity and equivocality are more difficult to observe, but revealed themselves in the interviews. Interviewees indicated that when they have no accurate frame of reference, they rely on their experience, take time to think about the situation, and act according to the (inaccurate) frame of reference they have. It was difficult for the actors to cope with equivocality. Communication and information exchange between actors was not sufficient, due to physical separation and lack of appropriate systems to support this. Also, the international context of response hampered the discussion and exchange of frames of reference, as actors had different cultural backgrounds and were speaking different languages.

4.3 Case Study 2: Forest Fires in Portugal

Forest fires are a great concern for Portugal, as more than a quarter of the country is covered by forests, and droughts in summertime increase the likelihood of such natural disasters. In recent years, Portugal has been facing extremely hot and dry summers, with highest peaks in 2003 and 2005. The fire risk in Portugal has been increased by changes in land use practices. Rural exodus has left a large area of land uncultivated, where combustible materials can now unnoted trigger big fires when droughts occur.

The National Authority for Civil Protection (Portuguese acronym ANPC) has the primary role in planning, coordinating, and implementing the Civil Protection policy. The ANPC is a central operational service under the direct administration of the Ministry of Interior. The ANPC maintains its own operational structure, the National Command for Relief Operations that ensures the operational command in terms of relief operations and the integrated operational command of all the fire

brigades in accordance with the legal system. The Integrated System for Relief and Protection Operations is a set of structures, norms, and procedures which ensures that all civil protection agents act under a sole command. This integrated system aims at responding to (imminent) crisis situations.

The Portuguese State does not have its own fire brigades. The great majority of the fire brigades are volunteer fire fighter associations; others belong to the city councils and private companies. The Portuguese Forest Services play an important role in the management of the forests in Portugal, especially in mapping the risks of hazards and in educating people on how to prevent forest fires.

In 2003, 2004, and 2005, Portugal could not cope with the forest fires themselves and, therefore, requested outside assistance through the European Commission (EC)'s Community Civil Protection Mechanism. The Community Civil Protection Mechanism was established in October 2001 and is an operational instrument designed to enhance preparedness and to mobilize immediate civil protection assistance in the event of disasters. It can be activated in case of natural and man-made disasters by any country in the world, after which one or more of the 30 participating states—the European Union (EU) member states as well as Liechtenstein, Norway, and Iceland—will try to offer their assistance. The mechanism is coordinated by the Monitoring and Information Center (MIC) of the EC in Brussels.

4.3.1 Case Study Implementation

For the Portuguese forest fires case study, we conducted interviews using the previously discussed interpretive approach, interviewing six people who are both involved in managing and preventing forest fires in Portugal, and who are involved in coordinating the international response to the Portuguese forest fires through the Community Civil Protection Mechanism. The interviews were aimed at finding out how these actors handle and process information related to the Portuguese forest fires.

In December 2007, the first author traveled to Lisbon to interview two people working at the ANPC and two people at the Portuguese Forest Services, and got a chance to observe the operations center of the ANPC. Two follow-up interviews were conducted in February 2008 in Brussels: One interview with a person working at the EC, Directorate-General for the Environment, who also demonstrated the MIC, and an interview with a person working at the Civil Protection Unit of the EU's Council Secretariat.

4.3.2 Case Study Findings on Dealing with Information

The Portuguese Forest Services are mainly focused on preventing forest fires. They produce two kinds of fire hazard maps and share these with the district level and the ANPC: One structural, not very detailed map with a large pixel size, and one map with a smaller pixel size. The latter is better suited for teams on the ground and indicates the hazards in summer; in winter, it is used to find areas where the authorities can conduct "prescribed firing," which are techniques to manage fuel.

Historical information on where the forest fires took place is important information for producing these maps. Depending on the tree species, it takes on average 5 years for a forest to become a potential “problem situation” when forest fires are a substantial risk, but it takes many more years for a forest to return to their pre-fire state. The Portuguese Forest Services experience problems of acquiring up-to-date information for producing the fire hazard maps, as these often have to be bought and land-use data is very expensive.

Both detection of forest fires and first response to forest fires are very important, as the difficulty of fighting such fires increases nearly exponentially in time. Forest fires can be detected in three ways: by somebody from the population calling 117 (the dedicated forest fire emergency phone number) or 112 (the normal emergency phone number), by a surveillance post, or by a surveillance brigade. The ANPC is responsible for informing the population, the people who work for civil protection, the media, and the national and district level command structure. The district command for relief operations is responsible for the deployment of means, both terrestrial and aerial, and conducting the first intervention. If they do not succeed, or if the fire crosses the district level, the ANPC is responsible for the enlarged combat situation. The ANPC then sends more resources to the field, which can be requested from other districts.

When the crisis is overwhelming and national resources are insufficient, the minister—advised by the national commander—can activate the Community Civil Protection Mechanism by sending a message to the MIC in Brussels. The ANPC is permanently connected to the Common Emergency Communication and Information System (CECIS) of the MIC. CECIS allows for sharing of current information on the situation as well as identification of what is needed. Countries can also indicate whether they can provide assistance or not.

Daily briefings take place at the ANPC in summer on the general hazard situation of the country with representatives from the major players. The National Guard and the armed forces have permanent liaison officers stationed at the ANPC. In the case of a severe crisis, liaison officers from other civil protection agencies are present at the ANPC, such as officers from the forest department, the maritime authority, the police, the medical services, and the meteorological institute: “In the daily briefings we bring information from all the agents who share responsibility in terms of civil protection.” At the end of these briefings, the ANPC provides all actors with a summary of these briefings in writing. The national commander takes decisions according to the information shared and the analysis conducted in the meeting, for example, on whether to increase the readiness level or to pre-mobilize resources.

The ANPC mainly uses the media to communicate with the population and other external parties. When a threatening situation arises, the ANPC sends out an alert and the key players from the media come to the office where they are briefed. The media outlets then disseminate the message to the citizens, including any measures that should be taken. The ANPC also organizes a press conference every week on what is happening and what the expectations are for the following week. In severe crisis situations there is a daily press conference.

The ANPC also displays information for the citizens on their website, such as information on where current fires are located and how many fire fighters are working in the area. The website also advises people on what to do for each level of forest fire risk. The people at the ANPC realize that it is important to provide accurate information: "We cannot always tell people that tomorrow will be the worst day."

There is a lot of redundancy in the sharing of information. When civil protection actors send a message, they make sure it arrives by using as many means as possible. At the ANPC, people are updated on the situation by text messages, and senders usually immediately call to check whether the message has been received and read. When the Community Mechanism for Civil Protection is activated, fax messages are sent and phone calls are made to other countries besides the formal request through CECIS: "In a crisis situation this is quite normal as you want to make sure the message gets to the person."

4.3.3 Case Study Findings on Dealing with Frames of Reference

Forest fires in Portugal do not only happen during the summer, they also occur in wintertime. Winter fires are good if they are controlled, since what burns at that time cannot burn in summer when the fires are mostly not controllable. However, the concept of "good fires" is new and generally unknown by the population. It therefore is important to inform the people that fires during winter are not bad if they are managed appropriately. The Portuguese Forest Services promote this idea on their website and have launched a campaign on television, radio, and in newspapers. Another campaign highlighted that people should not light fires near forests during summer, and that they should clear all combustible materials. Besides these nation-wide campaigns, the Portuguese Forest Services have engaged in direct contact with local shepherds, farmers, and forest owners to try to change their behavior and spread the word that not all fires are bad.

The ANPC's main target is currently to educate people. They do this together with big companies such as supermarket chains. One initiative included printing the phrases "Portugal without fires depends on everyone" and "You should not use fire on a hot day" on the supermarket's plastic bags. The ANPC has also been advertising in football stadiums and on football shirts, and has broadcasted their campaigns on television and advertised in newspapers. "You have to give good and correct information to your population, otherwise you can have situations as in 2003, 2004 and 2005", one interviewee said. It has been successful until now: the number of ignitions has been reduced since the start of these campaigns.

There have been instances in which the forest fire situation was under control, but people started to panic as images of the fire were aired on television. One interviewee stated that the best way to prevent these kinds of situations is to actively cooperate with the media.

To aid interpreting new information on the hazard situation, the ANPC visualizes information about the major incidents that are occurring in the country on a geographical IS-based map. There is a special screen on which the forest fire situation is projected.

After each big crisis in Portugal, the ANPC invites all the actors that were involved in the response to discuss the process, what was done and what worked or did not work. These lessons learned are then incorporated into their procedures.

The MIC has the overall European perspective on civil protection. The mechanism can facilitate and give an “educated hint” as to which country to help, but in the end the countries themselves decide on where they want to provide or accept assistance. Countries do not always accept assistance, because the help that is offered may not be exactly what they wanted, or it comes with a price tag they are not willing to pay.

Notably, the use of language in CECIS is not standardized. This sometimes causes problems in interpreting what is meant by a request or an offer, and has resulted in countries bringing resources that were not of use in that crisis situation.

“Nothing helps more in emergency situations than people knowing each other,” many interviewees mentioned. The Community Mechanism for Civil Protection and the MIC bring together people from all 30 countries for events like training sessions, workshops, common exercises, and meetings. Through these types of interaction people become more familiar with the realities of the other countries: “The more you exchange information, the more you know where and how to target your request for assistance. And the better you make your request, the better you get answered.”

4.3.4 Discussion of the Findings

In summer, the ANPC needs to get accurate and timely information on the actual situation of the forest fires, and needs to provide the actors on the ground and the citizens with information concerning the forest fires. As forest fires pose a continuous threat to the country, there are good systems in place for obtaining and providing this information, such as the different ways a forest fire can be reported, daily briefings with all key response actors, and good cooperation with the media.

The importance of timely and accurate information is evident in the behavior of actors when communicating through the Community Mechanism for Civil Protection, as redundant information exchanges take place to make sure that recipients have read a message and understood it correctly. This, however, might lead to a situation of complexity, as people receive many notifications on different communication media and might lose track of which message is new for them and which message is part of a “reminder.”

With such yearly recurring crises, the actors have chosen for a strategy of prevention rather than only response. The Portuguese Forest Services play a leading role in this by mapping the risk of forest fires in the different areas. They, however, experience problems of uncertainty as they have difficulties in obtaining all relevant information for such maps.

Informing citizens is important in Portugal’s crisis situation. The Portuguese Forest Services cooperate with the ANPC for prevention campaigns, the ANPC provides information on forest fires on their website, and there are press conferences in summertime. All these activities are aimed at removing uncertainty that citizens face.

Some campaigns are also aimed at removing ambiguity by providing a frame of reference for citizens to make sense of what is happening. For example, the concept of “good fires” was unknown to the majority of people, but after the campaign citizens would better understand the fires that occur in wintertime. Such educational campaigns could also prevent interpretation problems leading to panic, such as the broadcast of fires on television at a time when fires are under control.

The main strategy to cope with equivocality is to socially mix and engage in discussion. After a crisis, the key actors discuss their understanding of what happened and what went wrong, and try to create a common frame of reference which is then incorporated into their procedures and used to deal with the next crisis. Moreover, one interviewee mentioned the importance for actors to socially mix between different country representatives, as it helps civil protection actors to understand the other countries’ frames of reference: the situation in their respective country, how they respond, their concerns, etc. This is very useful for future collaboration and assistance, as the other actors’ frames of reference are then better understood.

4.4 Case Study 3: European Union Police Mission in Bosnia and Herzegovina

Since 1991, the EC has set aside more than 2.5 billion euros to support Bosnia and Herzegovina with public administration reform, justice and home affairs-related issues, and improvement of the investment climate as key target areas. Police reform has been one of the main obstacles to Bosnia and Herzegovina’s integration in the EU. On July 1, 2005, the EC concluded that police reform was the single remaining obstacle to the Stabilization and Association Agreement.

International efforts to reform the Bosnian police force started immediately after the peace agreement when the United Nations led International Police Task Force (IPTF) was deployed. The IPTF comprised more than 2,000 international police officers from 43 countries.

On January 1, 2003, the EU launched the EUPM in Bosnia and Herzegovina. It was the first mission initiated under the European Security and Defense Policy (ESDP), initially intended to cover a three-year period and included around 500 police officers from more than 30 countries. Following an invitation by the Bosnian authorities, the EU decided to establish a continued and refocused EUPM of 200 international staff members and a mandate of 2 years, until the end of 2008. The EUPM supports the police reform process and continues to develop and consolidate local capacity and regional cooperation in the fight against organized crime.

In addition to the EUPM, the EU has an European Union Special Representative (EUSR) and a military crisis management mission, European Union Force (EUFOR) Althea, in Bosnia and Herzegovina. The EUSR is in charge of assuring the coherence of the ESDP activities. The EUSR can offer political advice to the EUFOR among others regarding organized crime, and facilitates coordination between Brussels and Sarajevo. The EUFOR also has a paramilitary police force

under its command. The EUPM, however, is the lead in the coordination of policing aspects of the ESDP efforts in the fight against organized crime.

4.4.1 Case Study Implementation

In April 2008, we traveled to Sarajevo and conducted a total of 12 interviews using the interpretive approach. We conducted interviews with EUPM people from the general management, EU Coordination Office, Security Department, and Press and Public Information Department. Moreover, we conducted interviews with people who are directly or indirectly involved in the EUPM: representatives of the EC Department Police Projects, EUFOR, EUSR, Canton Sarajevo Police Department, Organization for Security and Co-operation in Europe, and the Popolari think-tank.

4.4.2 Case Study Findings on Dealing with Information

To support the local police in fighting organized crime, it is important for EUPM to collect criminal intelligence from everywhere in Bosnia and Herzegovina and analyze it to create a good situational overview. The main sources of information for EUPM's headquarters are the local police, the daily reports from EUPM's field offices, and the security awareness working group. EUPM follows the general statistics of everyday crime in the country to notice crime trends that could be part of a bigger picture. Information that relates to police crime and police corruption is also important. The main source of such information is not the local police, but the local community. EUPM has informants who have high positions in society.

EUPM tries to obtain local information on the overall security situation together with EUFOR through EUFOR's Liaison Observation Team (LOT) house concept. These are small groups of military people living in normal houses and liaising with the local population. Because people from LOTs are military peacekeepers, they are sometimes not very good at collecting criminal intelligence for EUPM.

The local police are an important source of information for EUPM, but EUPM often needs to "press out" information from them. This goes back to the time of the former Yugoslavia when having information implied having power and information would not be shared unless ordered. This culture of not sharing information with internationals was partially enforced during the IPTF time.

Traditionally, as effective tools were missing, the writing of many reports was the main means of analysis for the police after information was gathered, and these reports were stored in nationwide data systems. After the war there was no money to maintain these systems, and they were cut into smaller elements. Nowadays, the police have to be aware of the fact that informants from different political parties and criminal groups could reside in their units. That is why the police do not document much anymore, but rather "store" important information in the heads of some trusted members of the police agency.

EUPM does not have a central database to retrieve important information from. All information is stored on local hard drives. There is a need for some kind of web-based application, but nobody thought of this when EUPM was deployed and

now it is too late to implement something like this. EUPM does have an archive of aggregated reports that are sent on a weekly basis to the headquarters in Brussels, but these only indicate trends and no detailed information, as they are intended for member states representatives and other people in Brussels who “are not interested in details, but that is exactly what we need here.”

EUPM has experienced difficulties in distributing its message to the citizens: “With normal press work you fail to communicate with the public.” The local media in the country are biased, and citizens tend to watch and read their own particular news and media. Whenever EUPM issues a press release it is reported in three different ways: from Serb, Croat, and Bosnian angles. This means that it is not easy to properly reach out to the public. Bosnia and Herzegovina’s television networks are still underdeveloped and underfunded but constitute the most unbiased media in the country. However, the ratings are not very high. It is also difficult for EUPM to trust local journalists. This is why EUPM has set up their own relatively large media department, used to distribute their message to the citizens. EUPM launches their own television programs, does public information campaigns, organizes round-table discussions, and produces their own radio programs. An example of a newly set-up television program is the Bosnian version of “America’s most wanted.” This is a tool for EUPM to distribute police-related or EUPM-related topics. In addition, EUPM is producing a print supplement, called “Kronika 112” (112 is the Bosnian emergency phone number).

EUPM has introduced public complaint bureaus throughout the country, where citizens can report bribe demands or any other suspicious police activities. Once a year EUPM conducts comprehensive public opinion surveys in which they test the messages that have been sent out. EUPM also trained press officers of local police forces and police chiefs in media management.

Within the European community in Bosnia and Herzegovina, there is a system of liaison officers to communicate and share information between the different EU organizations. There is a liaison officer dedicated to EUPM in each EU organization. There are bi-weekly meetings to share security information between all the international organizations in the so-called “security awareness working group,” which is one of the most relevant tools or systems to share information regarding the security and safety situation.

Some interviewees complained that very few people understand that information sharing and coordination takes a lot of time: “Sometimes you have some things which cannot be e-mailed, or which have to be encrypted. All these kind of things take time and have to be organized.”

4.4.3 Case Study Findings on Dealing with Frames of Reference

In a complex country such as Bosnia and Herzegovina, EUPM needs information to be able to put police information and crime security information in the right context, interpret it in the right way, and identify the ways to proceed based on those interpretations. That is why EUPM collects a lot of political information. And

not only is the local and national Bosnian political information important but so too is international political information such as that related to the situation in Kosovo.

The Bosnia and Herzegovina authorities carried out an organized crime overview and analysis, but this did not result in an accurate picture of the situation. There are many reliability problems regarding the information that is gathered and put together by the public administration because of different legislations, different practices, and often an unwillingness to give out information. This is not necessarily because of corruption, but mostly caused by political preferences. The kind of information the political decision makers are giving out depends on which view of the security situation they want to show. Every now and then there are some situations that are politically fueled, and people are manipulated.

Other doubts were raised as to whether the international community in Bosnia and Herzegovina is basing its analysis on the right information. One interviewee was very critical of the international community, arguing that they do not conduct enough field-based research. The failure of the international community to get information from local people in multi-ethnic areas has led to “a gap between the Bosnian reality and the way it is presented by the media and policy makers.”

There is a problem within EUPM concerning their institutional memory because of the high turnover of staff. EUPM does not have information sharing tools within the mission, causing internal information management to be based on daily, weekly, and monthly incident reports and the institutional memory to be situated in the heads of “veterans.”

4.4.4 Discussion of the Findings

To cope with uncertainty, EUPM engages in different information gathering activities. First, they communicate with the local police, but as they do not have any system in place to store information and there are cultural differences in sharing information, it is difficult to obtain information from them. Second, EUPM is very active in media outreach to the citizens, for which they created a big media department, and has installed public complaint bureaus. Finally, EUPM has informants and liaising teams in place in the local community.

It is difficult for EUPM to deal with complexity as their institutional memory is not sufficient. EUPM also lacks an IS with a repository function to compensate for this, which should store all information they receive. This not only leads to loss of details but also to problems in interpreting what is going on in Bosnia and Herzegovina. EUPM tries to gather all kinds of contextual information, such as political information, to create a frame of reference and thereby to cope with ambiguity. But the question is how effective they can be at doing this, if there is no appropriate system in place.

The doubts that were raised about whether the analysis of the situation is based on the right information is a question concerning equivocality: there are several competing or contradictory frames of reference, and there is confusion on the appropriate frame for this situation.

5 Design of Crisis Management Information Systems

The three case studies gave us insight into how actors cope with information processing challenges in various crisis situations. But what can we learn from this for the design of IS for crisis management? To answer this question, we examined IS design guidelines for crisis management as developed for a Dynamic Emergency Response Management Information System (DERMIS) to support the response to crises, and compared these guidelines to our findings. In the work on DERMIS [29], which is based on extensive practical experiences in the field of crisis management and academic literature study, a set of nine design premises is introduced to guide the future design of crisis management IS. Because we focus on the information, information processing, decision making, and Sensemaking aspects of crisis management, we use the six design premises shown in Table 3 on page 447 for this discussion. We do not include the other three DERMIS design premises in our analysis, as they are more about the organizational aspects of crisis management, such as coordination, roles, and training.

DERMIS' first design premise clearly focuses on dealing with information, especially on dealing with complexity. In the Barents Rescue Exercise, some actors argued that they need a lot of detailed information, while others just wanted the most relevant information. The premise on information focus is about filtering out information so actors work with the level of information that is most suitable and/or preferable to them. The people working for EUPM experienced the problem that there is a lot of information "out there," but that there are no systems in place to make use of that information and analyze it. Design premise 1 also focuses on the importance of creating a good picture of what is going on by giving actors access to all contextual information. This overview will aid in creating a suitable frame of reference, as we saw at EUPM where police information, criminal intelligence, and political information is collected from all around the country and is used as contextual information to construct good frames of reference for their operations.

The design premise of "crisis memory" only supports dealing with frames of reference: By having access to historical information on the situation, actors will have the foundation for establishing a suitable frame of reference. In the Barents Rescue Exercise, respondents have explicitly mentioned the importance of experience in crisis situations. EUPM also acknowledges that experience is important, but faces problems of crisis memory due to high staff turnover. The ANPC in Portugal makes sure that the lessons learned from a crisis are incorporated into their procedures, to improve their response to following crises.

Design premise 3 also only deals with managing frames of reference, as it refers to the fact that there cannot be one frame of reference for a crisis situation. You cannot know in advance what will happen in a crisis and how it will evolve over time. Instead, flexible systems are needed that support changing frames of reference. Planning for a crisis is therefore difficult, and expectations of other actors—perhaps guided by previous experiences, agreements, or "common sense" as perceived by one side—are not always met, as Norwegian and Finnish actors experienced in the Barents Rescue Exercise.

Table 3 DERMIS design premises [29]

DERMIS design premise	Explanation of the design premise
Design premise 1: Information focus	During a crisis, those who are dealing with the emergency risk are flooded by information. Therefore, the support system should carefully filter information that is directed toward actors. However, they must still be able to access all (contextual) information related to the crisis as information elements that are filtered out by the system may still be of vital importance.
Design premise 2: Crisis memory	It is important that the system is able to log the chain of events during a crisis without imposing an extra workload on those involved in the crisis response. This information can be used to improve the system for use in future crises, but it can also be used to analyze the crisis itself.
Design premise 3: Exceptions as norms	Due to the uniqueness of most crises, usually a planned response to the crisis cannot be followed in detail. Most actions are exceptions to the earlier defined norms. This implies that the support system must be flexible enough to allow reconfiguring and reallocation of resources during a crisis response.
Design premise 4: Scope and nature of crisis	Depending on the scope and nature of the crisis, several response teams may have to be assembled with members providing the necessary knowledge and experience for the teams' tasks. Special care should also be given to the fact that teams may operate only for a limited amount of time and then transfer their tasks to other teams or actors. The same goes for individual team members who may, for example, become exhausted after an amount of time.
Design premise 5: Information validity and timeliness	As actions undertaken during crises are always based on incomplete information, it is of paramount importance that the emergency response system makes an effort to store all available information in a centralized database. Thus, those involved in the crisis response can rely on a broad base of information, helping them making decision that are more effective and efficient in handling the crisis.
Design premise 6: Free exchange of information	During crisis response, it is important that a great amount of information can be exchanged among stakeholders so that they can delegate authority and conduct oversight. This, however, induces a risk of information overload, which, in turn, can be a risk to the crisis response effort. The response system should somehow protect participants from information overload.

The fourth design premise is overarching for our case studies, and is reflected by the different types of management of the crises we saw in the case studies and the taxonomy shown in Table 2. Crises differ in their nature and their scope, and to counteract this, the associated management of the crisis—either it is prevention, response or recovery—must be adapted to that situation.

At first sight, the design premise on “information validity and timeliness” only seems to be about supporting the coping with uncertainty, as it describes the “usual” situation that there is incomplete information. This point was made by the people in the OSOCC at the Barents Rescue Exercise, as they stressed the importance of continuous up-to-date information on the situation. In the Portuguese case study, we saw that the Forest Services were continuously gathering information on fire risks and were making it available to everybody by means of fire hazard maps. The importance of information validity revealed itself in the observation of redundant information exchange behavior at the Community Mechanism for Civil Protection. However, design premise 5 is also about organizing all information available, enabling actors to construct the best possible frame of reference. In Portugal, we saw the example of the use of media to provide citizens with timely and good information that they should be careful with combustible materials and the use of fire, and the new concept that in winter fires can be good. In Bosnia and Herzegovina, actors have to be careful for manipulation of their frames of reference through other parties’ partial or biased information sharing, mostly caused by political preferences.

The last design premise, “free exchange of information,” is also intended to support dealing with both information and frames of reference. Design premise 6 is about the importance of the social context that is used to gather and exchange information. In the Barents Rescue Exercise, there was no free exchange of information between the important actors, such as between the OSOCC and LEMA. In Portugal, the Forest Services experienced problems of acquiring up-to-date information for their fire hazard maps. Cultural differences, fear of political and criminal infiltration, and ethnical barriers made free exchange of information nearly impossible in the post-conflict setting of EUPM. But we also saw good examples of free exchange of information, such as CECIS which allows actors to share information on the crisis situation and ANPC’s use of the media to quickly reach out to the citizens. The social context is also used to compare frames of reference. Free exchange of information for this purpose was hampered in the Barents Rescue Exercise by physical separation of key actors without sufficient IS support to overcome this, and different languages and cultures. In the Portuguese case study, we saw interpretation problems arising from a lack of standardized language in CECIS. There was, however, an example of a good infrastructure for exchanging information in the Community Mechanism for Civil Protection that led to better familiarity of the other countries’ problems, resources, and capabilities.

6 Conclusion

In this contribution, we have explored four common information processing challenges in three different crisis situations. Although all information processing

challenges were present in all case studies, some challenges were more common in specific situations. At the airplane crash in the Barents Rescue Exercise, there were at first many uncertainty-related information problems. As this was a sudden crisis, actors obviously did not know what was happening in the first stages of the crisis. For an ongoing crisis situation as the forest fires in Portugal, we saw the importance of providing citizens with frames of reference. By supporting them in their situation of ambiguity, more severe forest fires can be prevented as people learn how to handle and prevent them, and people do not start to panic immediately when they see a fire. Finally, in the EUPM in Bosnia and Herzegovina, we saw the main problem of dealing with complexity, as a lot of information is gathered but cannot be analyzed and processed adequately due to a lack of systems and procedures.

We observed that the common trend in these three crisis situations was that actors at first focus on information-related problems, especially uncertainty problems of acquiring information, and then shift to strategies of coping with the complexity of too much information. This is an interesting finding and needs to be validated in future research. IS traditionally play a significant role in these areas of information-related problems, as they can support people in storing, retrieving, and analyzing huge amounts of data. This can be considered to be the realm of Decision Support Systems (DSS).

The challenges of ambiguity and equivocality, on the other hand, were mentioned less often and were not the specific aim of the actors, as they deal with them more implicitly. For these challenges, it is less important to search for more information. Rather people try to manage their frames of reference for interpreting the information by activities of Sensemaking. When we compared our findings to the DERMIS design premises, we found that all premises in some way contribute to the support of Sensemaking. If crisis management systems are designed to support access to all contextual information (design premise 1) and storage of historical information and incorporation of lessons learned (design premise 2), actors are supported to construct good frames of reference; if these systems are designed to be flexible during the response (design premise 3) and adaptable to the nature and scope of the crisis (design premise 4), actors are supported to update and change their frames of reference. Finally, as general requirements, if systems facilitate interaction and collaboration by supporting timely and valid information exchange (design premise 5) without any impediments (design premise 6), actors are supported to create, compare, update, and change their frames of reference. If crisis management IS are designed accordingly, they will become true Sensemaking Support Systems (SSS).

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