7

Risk Assessment On-Scene

Eivind L. Rake
Fire Department of South Rogaland/
Stavanger University Hospital, RAKOS
Norway

1. Introduction

The modern community is complex with tight couplings between infrastructures, systems and geographical areas (Perrow, 1999). Accidents and disasters are becoming increasingly global, human made and less observable (nuclear, chemical, and biological etc.)(Beck, 1992). New kinds of crises (Roshental *et al*, 2001) are always upcoming, e.g. Mad Cow disease, viral pandemics, Tsunami and new forms of terrorist attacks. A typical example of the latter is the killing of 69 youths at Utøya, Norway, July 22, 2011. New type of crises, unprecedented, will be seen in the future and challenge the abilities of the societies and communities to cope successfully. Crises rarely correspond with the jurisdictional boundaries of organisation or government (Boin *et al*, 2005) or boundaries of countries. These crises demand considerations other than the preparations common to well – known crises.

Disasters can be described as the ultimate test of plans, preparedness, the emergency management and emergency response capability of a society. The ability to effectively deal with disasters is becoming more relevant because of factors that tend to increase risk and an increased attention and demand from society. The effort to build defences against unconventional threats has not kept pace with the rapid rate of development of new kind of crises. The need for better ways to deal with the potential for catastrophic loss inherent in emergencies and rescue operations has been widely recognised and accepted by government, industry and response units, especially in the aftermath of 9/11, the Tsunami and during the rise of terrorism as witnessed in the bombings in Madrid and London in 2004 and 2005.

To a certain extent we can reduce the numbers of crises that hit, even if we cannot nullify them. Despite the best efforts of society crises will occur and have to be dealt with. The post – event actions, as emergency responses, seek quick and efficient ways to minimize impacts when an accident occurs. The incident, especially in dynamic complex situations, may escalate to a major emergency and even disaster if not handled correctly. The possibility of severe detrimental effect during emergencies is closely tied to the authorities' and response units' opportunity, ability and modus of management, which in turn can act as constraints on subsequent decisions and coping. However, we *can* prepare. If we take the time to make the right preparation now, we may be able to reduce the unwanted consequences a disaster can wreak. Standard procedures and prepared plans act sufficiently in predictable, well – known and routine accidents. The demands of a crisis tend to make specific detailed emergency plans of limited use. A conclusion from the Swedish Tsunami Report (SOUS, 2005) describes the incompleteness of plans;

- A crisis will occur that is new and not predicted and detailed emergency plans don't exist.
- A plan will never give us instructions for every situation that occurs during an unfolding emergency.

New problems must be faced through openness, cooperation and flexibility. The bomb attack in Oslo, July 22, and the following mass execution at Utøya, surprised the response units. They had no sufficient plans but had to deal with the attacks and the following massive need of emergency assistance. Risk management was a vital part of the crises management.

This chapter describe the assessments on-scene, the arena where the crisis take place, especially assessment carried out by incident commanders and other professional leaders of emergency response units; the police, paramedics and fire brigade. The chapter intend to give insight of how risk assessment on-scene is coped with and how effective risk assessment can be carried out in real time while the crisis unfolds on-scene. Initially the command system, the commanders' tasks, and the inherent uncertainty on-scene an accident/crisis is described. It is followed by a description of how decision making on-scene normally is carried out. The challenges of decision making and some basic principles of effective decision making are given. To reduce uncertainty it is important to make satisfying decisions and satisfying risk assessments. A review of risk and risk assessment on-scene ends with a proposal of successful risk management and risk assessment on-scene. By being prepared for unique and sudden scenarios, including the vast number of variables involved, and unprecedented emergencies, we can reduce the uncertainty and thereby the extent of the damage, and increase the probability of a successful crisis management. Proper risk management is the core.

The reminder of the chapter is organised into 5 sections, starting with Section 2 that provides an overview of crises and crisis management. Then, in Section 3 we describe the incident command system on-scene and the need of an incident commander and his responsibility. The following Section 4 discusses uncertainty, a major obstacle to proper decision making, which is presented in Section 5. This section explains some principles of decision making and how effective decision making can be conducted by the incident commander. In Section 6 systematic ways of dealing with risk are pointed out and ideas of successful risk management are presented. Finally, in the last Section 7, we highlight the need of adequate situational awareness and extensive training of risk assessment and do more research to cope successfully with the risks in future incidents and crisis.

2. Crises and crisis management

Boin *et al.* (2005) defines crisis in terms of a discontinuity which usually causes authorities to engage decision making under conditions of uncertainty and time pressure. According to (Rosenthal *et al.* 2001) a crisis can be understood as a period with increasing stress, disturbing society and threatening values and structures in unexpected and unthinkable ways. Crisis management must therefore deal with present risks and avoid risks that can, or will arise. In the experience of the author, crisis management is the continuous process by which all those involved, from an incident commander to groups such as an incident response team and even entire communities, manage hazards in an effort to avoid or

ameliorate the impact of disasters resulting from these hazards. The management must also cope with non-routine phenomena and developments during emergencies. We use the word "crisis", but other words are often used to describe unexpected and unintentional occurrences resulting in an immediate threat to human life, or serious damage to property or environment.

Despite the best efforts of society, crises will occur and have to be dealt with. Post-event actions, such as emergency responses, seek quick and efficient ways to minimise impacts when a crisis occurs. An emergency response consists of immediate, time-sensitive actions to be taken during and after the impact to reduce casualties and damage and to respond immediately to the victims to avoid any threatening situations. Quick, appropriate and sufficient relief efforts are typical activity. Response measures include identifying and disseminating the threats and the impact, alerting the responders, searching for and rescuing any trapped victims and providing the necessary care. The response phase includes mobilisation of the necessary emergency services and first responders. The police, the ambulance service and the fire department are typical first responders.

The terror attack in Oslo, Norway, including a bomb explosion and the massacre at Utøya killing 77 persons, pinpoints what crises are about and what we are concerned with: threats (unknown and unforeseen), and undesirable outcomes (injuries, fatalities, depression, political changes etc.). A crisis is an unexpected event that threatens values, such as health, environment or society in general, possibly resulting in undesired outcomes, e.g. causing death. Typically, it is the moment at which a threat is transformed into actual fatalities or other substantial loss. The people affected expect the local authority, and if the local authority fails, the government to avert the threat or at least minimise the damage of the crisis at hand. The authority is normally represented by the emergency services. Crises can be described as the ultimate test of plans, preparedness and the management and emergency response capability of a society. The ability to deal effectively with crises is becoming increasingly relevant because of factors now tending to exacerbate risk and the increased focus on these, with demands for urgent action, especially from the media, the politicians and the population at large. The statement of (Boin *et al.* 2005) "*Crisis management bears directly upon lives of citizens and the well-being of societies*" (p.1), emphasises why crises have to be coped with effectively. Actions by the authorities, the response units, involved persons and organisations need to result in mitigation and success.

For many years, rescue operations have been organised in accordance with strictly hierarchical management structures. There seem to be only minor differences between emergency response units within and between countries with respect to formalised routines. A typical management structure has manuals describing the organisation, leadership and the responsibilities of each of the emergency services at a major incident. LESLP (2008) and (Bigley and Roberts 2001) include manuals and procedures from different management structures. These manuals and procedures intended to gather, coordinate and control the temporary systems of managing personnel and equipment at a wide range of emergencies. The procedures describe the management system and responsibilities and set out the tasks and duties of the commander of the operation, the incident commander.

Crises management is the shorthand phrase for management and coping with non – routine phenomena and development during emergencies. Emergency management on accident scenes is complicated. The consequences may be severe for many people, implying

competing and frequently ill-defined goals for the rescue operation. Uncertainties, both in situation assessment and outcome predictions are large, that is; data is missing; information is fragmented and unreliable; the mass of non-relevant data interrupts the focus; and occasionally lack of expertise in vital areas, and lack of resources are problematic. The situations and the risks are constantly changing, with the potential of sudden dramatic occurrences that require an entire rethinking of the rescue operation. There are multiple individuals involved in the emergency organisations and the teams involved are not static; they change from incident to incident. The work domain changes for each emergency situation. Each scenario and the inherent risk are unique and will only in broad general features be known to the combating actors. Crises management and the following operational command and decision making is in general complex, due to the causes above and the high number of feasible courses of action and their implicit representations. Distributed decision making is even more complex, and in a commanding situation, and with multiple actors, even more demanding and exacting.

3. Incident commanding

A crisis calls for management and leadership. On-scene at the emergency, the incident commander is the predetermined manager and leader. He is ultimately responsible for all activities that take place at the incident ground (Bigley and Roberts, 2001). His responders and superiors expect the incident commander to have command and control. His aim is to reduce uncertainty, provide an authoritative account of what is going on, why it is happening, and what has to be done to minimise risks and the following impact. Leadership can be seen as the interaction between the leader and the leadership situation. Fiedler (1996) claims that the most important leadership lesson to be learned so far is that the leadership of groups is a highly complex interaction between an individual and the social and task environment.

The on-scene commanding structure and the incident commander (IC) in particular play an important role in fighting emerging crises. Formal leaders carry a special responsibility for making sure that the tasks of leadership are properly addressed and executed (Boin *et al.*, 2005). In general, the leader affects responders' performances and the outcome. Fiedler (1996) states that how well the leader's particular style, abilities, and background, i.e. experience, contribute to performance is largely contingent on the control and influence the leadership the situation provides for.

A classic example is the Piper Alpha disaster in 1988 (Flin, 2001). A major explosion on an oil and gas production platform resulted in the loss of 165 crewmembers. Lord Cullen concluded, in his public inquiry report (Cullen, 1990), that the number of fatalities was substantially greater than it would have been if the offshore installation manager (the IC on the platform) had taken initiatives to save life. The IC failed, and demonstrated inadequate leadership during the crisis. According to (Fredholm 2006) every response operation needs leadership. The more complex situation and less routine, the more need for coordination, strategic planning, prioritising and decisions to cope with the problems and risks at hand. He calls for distinct and explicit leadership in demanding situations.

The IC's responsibility is to be the commanding officer and have overall management on scene. Overall management includes determining incident objectives and strategy, setting

immediate priorities and assigning subsequent priorities, working out an action plan, approving requests for additional resources or for the release of resources, informing agencies and organisations of the incident status and demobilising when appropriate. The IC must establish an appropriate organisation and coordinate the activities for all emergency units. Figure 1 shows an example of such an organisation.

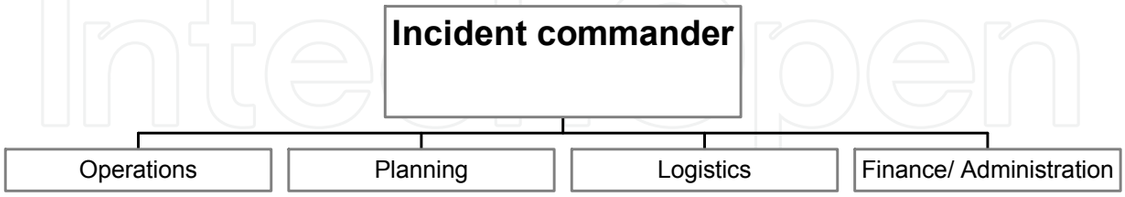


Fig. 1. US Incident Command System (ICS): Basic Functional Structure (FEMA, 2012)

The ICS structure establishes five functional areas: (1) Command, (2) Operations, (3) Planning, (4) Logistics, and (5) Finance/administration for management of all major incidents.

For the purpose of this chapter we will focus only on the Incident commander and the Operations. See (FEMA, 2006) for information about the other 3 areas. Operations (2) manage tactical operations to implement the overall strategic plan. They are responsible for all activities on-scene and run the operational tasks such as life-saving, reducing risks from immediate hazards etc. Operations deals also with the risk and risk assessments on-scene. The IC must ensure the overall safety of the rescuers, the response units, the victims, and any threatened residents or inhabitants. This is a part of the risk management on-scene. The IC normally acts at tactical level and his subordinates, such as the medical officer, at operational level. On the operational level the IC is at the sharp end of the action, located at a command post, and directs the team performing the orders, the decided tasks. The IC's role at tactical level is to implement the plans and achieve the objectives set by the strategic level. The tactical level prioritises plans and coordinates actions on the operational level. The strategic level allocates resources and supports the tactical level just as the tactical level supports the operational level. At major responses and crises the strategic and tactical command is generally located away from the scene.

The major aim of a standardised and hierarchal command structure is to have an effective and predictable command system: a functional system well known to all the responders. Command and control (C2) is the shorthand phrase for the aim of incident management. Leadership is both a position and a process involving collaboration, teamwork, and cooperation. Leadership on-scene an accident can be described, as (Boin *et al.* 2005) do, as a set of strategic tasks that encompass the activities associated with the scenes/stages of management. The leadership function seems pivotal to coping and vital to how the incidents evolve and the risk is managed.

The structure of on-scene command is an "all hazard – all risk" approach to managing crisis response operations as well as non-crisis events. The commander is responsible for coping with all threats on-scene and minimising the risk and consequences. The structure in every western country and all emergency responses are broadly similar. The structure shown in

Figure 1 offers a good example of an effective system. A similar structure is used in Great Britain (bronze, silver and gold) and in the Scandinavian countries.

Flin and Arbuthnot (2002) provide 6 cases described by experienced incident commanders. They represent a variety of disciplines and study commanders from the police, the fire department, the Royal Navy and the Marines, on a passenger airline and from a prison. The commanders reflect (retrospectively) upon extraordinary episodes in which their command skills were tested in a variety of ways and presented as experience – based and the hands-on knowledge of skilled practitioners. These cases are narrative descriptions of past serious incidents. The commanders draw lessons for the future, either rule of thumb or as important lessons. Common conclusions were:

- The importance of being prepared (training, planning, understanding of techniques and staging, learning from earlier occurrences and knowing your team)
- Key personal activities are decision making, communication, information, comprehension of the situation and risk assessment

Flin and Arbuthnot (2002) reflects on issues concerning the training of commanders, identifying some of the key capabilities and skills, such as leadership and team coordination, stress management, situation (risk) management, and decision making. McLennan *et al.* (2003) studied effective incident management and team management during wildfires. They concluded that the incident commander, with his four staff functions, see Figure 1, must develop a common operational picture of the situation by concentrating on the threats and resources.

On call-out, the incident commanders construct their mental maps of the situations from a combination of information from the call centre, knowledge of standard procedures, their expectation of available resources, and personal knowledge of the site (Rake and Njå, 2009). Typical management strategies when reaching the scene involves incremental problem solving within narrow time horizons. The incident commanders pay attention to details rather than considering the overall situation. In general the commanders expect normal situations, i.e. typical accidents they were trained to cope with, and in responses to which their preparations and strategies were standard. A study of incident commanders in real time shows that these incident command strategies are more reactive than proactive, and that the commanders rarely command. Risk management is normally limited to evaluations of the response units' safety (*ibid.*). A risk approach, to be used by crisis managers, incident managers and in situation with important values at stake and different kind of uncertainty, is recommended.

4. Uncertainty

Uncertainty is defined as "*lack of knowledge about the performance of a system (the "world"), and observable quantities in particular*" (Aven, 2003, p. 178). This definition is supported by NATO (2002), describing uncertainty in situations needing command and control. NATO generally defines uncertainty as an "*inability to determine a variable value or system (or nature) or to predict its future evolution*" (p. 249). In the action context, such as on-scene a crisis, (Lipshitz and Strauss 1997) describe uncertainty as a sense of doubt that blocks or delays action. This description goes to the core of on-scene risk management: an action is a result of a decision and a decision is based upon the information and the following assessment.

A crisis, a disaster or an accident, minor or major, can be described as borderless threats, creeping and acute, contending reality claims (uncertainty/surprise), conflicting, they are unplanned, unscheduled, unprecedented and unpleasant to the victims and almost unmanageable events (Rosenthal *et al*. 1989, 2001). Three characteristics must be foremost, both during the preparation and the responses; *1) important values at stake, 2) limited time to deal with the situation, and 3) a great deal of uncertainty involved*. The need for prompt action, from various response units to handle the different tasks in an effective way is obvious. Actors in rescue operation operate within a short time horizon most of the time. They have limited and incomplete information to manage. Thus, it can be suggested that crisis management, preparations and plans, must include the terms: *severe threats*, *uncertainty* and the need for *prompt action*. Uncertainty constitutes a prominent characteristic, an inherent feature, and is the major obstacle to effective decision making, risk assessment and the overall emergency management, especially during the response period (Lewis, 1988). Hansson (1996) presents interesting considerations concerning severe uncertainty related to: the identity of the options not being well determined (*uncertainty of demarcation*), the consequences of at least some options are unknown (*uncertainty of consequences*), it is not clear whether information obtained from others, such as experts and informants, can be relied upon (*uncertainty of reliance*), and the values relevant for the decision are not determined with sufficient precision (*uncertainty of values*). This uncertainty must be dealt with, both during the preparations and the responses, especially when decisions are to be made and executed. Sometimes our uncertainty is regarded as too large and not conducive to making a decision. Decisions are made upon some information. We need more information, the information has to be interpreted, and the decision has to be made in real-time. The decisions must be made in accordance with the demands of the situation. If it is not possible to postpone the decision, the decision maker simply makes his decision. Such decisions have of course a greater uncertainty, in the sense that the background knowledge should have been better. We have to make trade–offs quickly, based on real-time constraints, in order to respond effectively in real-time.

Sometimes our uncertainty is regarded as too large and not conducive to making a proper decision. Klein (1989) lists four sources of uncertainty: (1) *Missing information*, (2) *Unreliable information*, (3) *Ambiguous or conflicting information*, and (4) *Complex information*. Uncertainty can also be described, according to Klein, as a sense of doubt that threatens to block or delay action. Note the distinction between (Klein 1989) and (Lipshitz and Strauss 1997) regarding the description of uncertainty. Klein uses the opening words *threats to block* (it might happen) whereas for Lipshits and Strauss the action verb *block* (it happens). The distinction stresses the importance of the threat, a consequence of the uncertainty.

Orasanu and Connolly (1993) describe uncertainty as incomplete, ambiguous and changing information. At the scene of the crisis the information is fragmented and ambiguous and it is difficult to assemble a clear picture of the dynamic situation. The decision maker can lose valuable information in a critical situation because of overload or deficiency of information. The lack of information, or the overwhelming amount of information, present at the scenes causes problems to the incident commander. This highlights at least two important elements of the information process: (1) *The need to search for meaningful information* and (2) *The processing of information*. According to (Rijpma and Van Duim 2001) crisis management demands rapid information processing to succeed.

Lipshitz and Strauss (1997) identified three forms of uncertainty when studying retrospective reports of decision making under uncertainty: (1) *Inadequate understanding of the situation*, (2) *Lack of information on which to base a decision*, and (3) *Conflict among decision alternatives*. They hypothesised RAWFS heuristics and proposed that decision makers cope with the uncertainty with a heuristic consisting of five strategies: (1) ***R**eduction* (collecting more information), (2) ***A**ssumption based reasoning* (use assumption to close information gaps), (3) ***W**eighing pros and cons* (of at least two alternatives), (4) ***F**orestalling* (generate options), and (5) ***S**uppression* (ignoring uncertainty by suppressing negative information). According to the RAWFS heuristic, the decision process begins with an attempt to understand the situation, recognise or make sense of it. If these tactics succeed, the decision maker initiates a mental process of serial option evaluation.

Lipshitz *et al.* (2007) followed up their hypothesis by studying the fire ground commander at ten incidents. The commander used a helmet-mounted video camera and microphone during the response. The commander reviewed the video and audio records and reported his associated thinking process. In total 150 uncertainties were mapped. They found that the commanders preferred to use reduction tactics, especially information search, and relied on information from other people, such as bystanders, subordinate fire fighters or from other emergency units. When such tactics were impractical, or failed, they switched to assumption-based reasoning. These findings are consistent with RAWFS heuristics. The use of "weighing pros and cons" and "suppression" was not confirmed. Lipshitz *et al.* (2007) explain the absence by the commander's high level of experience and the use of matching. The commander manages to overcome uncertainty and make a satisfactory decision without expending energy on the other two strategies.

These approaches to uncertainty, expressed by Klein (1989), (Lipshitz and Strauss 1997), and (Orasanu and Connolly 1993), have reasonable conformity: information is crucial to success, i.e. to reduce uncertainty to an "acceptable" risk level so that the decision maker can make his decision. There seems to be a general agreement by researchers to manage uncertainty consistently and use uncertainty explicitly as an assessment and decision tool. It is essential to include uncertainty when studying the incident commander in action dealing with multiple risks.

Next, we address how decision making takes place in times of crisis, especially on-scene, because it is vital for effective risk assessment and the overall risk management. It is, after all, no point having identified risks if we do nothing about it. Decisions have to be made and the following section describes how effective decision making could be carried out by the incident commander.

5. Decision making

Decision making during crises, or under disaster conditions, is a complex and multifarious project (Dror, 1988) and is a core part of risk management. Boin *et al.* (2005) see decision making as the critical task of crisis leadership. Wrong decisions, or decisions made too late, may lead to poor management, poor risk assessment, and loss of values. Decision making is described as a cognitive process leading to the selection of a course of action, among alternatives, at least to do or not to do. Every decision making process produces a final choice. It can be an action, immediately executed or intended to be accomplished in the

future. It can also be an opinion. Yates (2001) describes a decision as a commitment to an action that is intended to yield satisfying states and makes a distinction between the decision and the following action. Decision making may be described as a tool to help a decision maker, e.g. the commander on-scene a crisis, to reach successfully the goals of the response. The decision process begins when a person, i.e. the decision maker, needs to do something with a "problem" at hand, but he still does not know what. Therefore, decision making is a reasoning process and can be based on explicit or tacit assumptions. Decision making is said to be a psychological construct. This means that we can never "see" a decision, but we can infer from observable behaviour, such as the implementation of the decided action, that a decision has been made. We may then conclude that a psychological event, which we call "decision making", has occurred.

Decision making in the on-scene context can be described as dynamic and may often be a compromise between a good strategy for controlling the decision task, the problem at hand or the event, and a strategy that enables the decision maker to exert some measure of control over the rate at which he/she has to make decisions (Brehmer, 1992). The latter strategy may be useful when important information is missing and the decision ought to be postponed, if possible, to enable the acquisition of more information to improve the decision basis.

Edwards (1962) gives some characteristics of dynamic decision making. Firstly, *a series of decisions is required to reach the goal*, a successful outcome. Secondly, *the decisions are not independent*. One decision leads to a later decision. Thirdly, *the state of the decision problem changes*, both autonomously and as a consequence of the decisions already made. Brehmer (1992) adds a fourth characteristic: *the decision has to be made in real time*, which means that the decision maker is not free to make decisions when he himself wants to. The decision maker is the "owner of the problem" and no one else can make the decision.

To describe effective decision making, a necessity of excellent incident performance, (Cannon-Bowers *et al.* 1996, 1997) identified six attributes of effective decision making that are important to the incident commander:

1. *Flexible*

If possible the decision ought to be an evolving decision, which means that it can be improved by later decisions if it is not sufficient to cope with the situation. Alternative courses of action should as far as possible not be limited

2. *Quick*

On the incident ground, problems often demand rapid responses. The decision must be taken "now"

3. *Resilient*

The decision should bear challenges. The situation offers resistance and must be overcome

4. *Adaptive*

The decision is not singular or independent of earlier or subsequent decisions or the situation at hand

5. *Risk taking*

On-scene it is impossible to avoid all threats and hazards to the emergency units if the response is to be successful

6. *Accurate*

The input of efforts and units to solve the problem should be sufficient and appropriate. If not, the incident commander may run out of resources before it is necessary. These attributes are logical because an incident commander acts in situations characterised by uncertainty, severe threats and the need for prompt action. The work of Cannon-Bowers *et al*. suffers so far from a lack of empirical background and they define these attributes on the basis of hypotheses.

We can describe the decision process as a longitudinal time process. Time is running, and it is impossible to stop or take time out. In addition, the goal of a successful outcome is not straightforward in a crisis. The decision making is often incremental, in which it is difficult to relate sub-goals to the ultimate one. This is emphasised by (Klein *et al.* 1993), who describe on-scene command situations with ill-defined goals and ill-structured tasks. In order to cope with the event, the on-scene commander has to perceive the real-time situation and its dynamics. The workload on the on-scene commander can be extreme, compounded by *ill-structured problem*, *critical values at stake*, *multiple players involved*, *time constraints* and *competing goals* (Orasanu and Conolly, 1993). The decisions made in the first minutes and hours are crucial to successful mitigation and the overall conclusion of the crisis (Flin, 2001, Kowalski and Vaught, 2001). Weingart and Wyer (2006) describe emergency medicine decision making as critical choices in chaotic environments. In short: on-scene an incident the activities are complex, the stakes are high and the effects on lives potentially significant. There has been a shift towards attempting to understand how decisions are made in the real world. Cannon-Bower *et al.* (1996), describe the development of the Naturalistic Decision Making (NDM) perspective as a paradigm shift. NDM became more influential in explaining management and decision making in command and control situations. Klein (1989) studied experienced fire ground commanders and during his findings and conclusion, introduced NDM. NDM differs clearly from the classic analytical approach, with respect to experience and field settings. NDM is concerned with experienced personnel operating in real life settings rather than studying naive participants, such as students, in a laboratory setting. NDM research studies seek to describe what is already happening in its natural context, as opposed to the traditional approach of prescribing an ideal way of finding the best option or an improvement to the existing strategy on hand.

The essentials of the approach have remained the same since it emerged in the 1980s and consist of three basic principles (Bryant, 2002):

1. Decisions are made by sequential, holistic evaluation of the action against some criterion of acceptability, rather than by comparison of multiple alternatives along multiple dimensions
2. The decision maker relies primarily on recognition-based processes to generate options and compares them to previous personal experiences. On-scene an accident the incident commander identifies a potential course of action by assessing the situation, then recognising past situations that are similar and determining their acceptability to the current situation

3. Mental evaluation is used to evaluate the course. A satisfactory solution is more important than finding an optimal solution (Simon, 1955). If the course is acceptable, the decision will be accomplished. Emergencies and rescue operations demand very rapid responses, and the rescuers accept a solution that merely works without considering whether a better solution exists.

In general, NDM models do not discuss the technological aspects of complex systems and the influence they have on decision making. The decision maker bases much of what is decided on what is perceived and the following cognition. Much of what is perceived is influenced by the design of the technologies, i.e. communication systems, digital maps and GPS, in the system. Technology can aid or impede decision making by representing the environment more or less accurately. Managers may be passive recipients of data presented by the technology or they may be in a position to shape and direct the technology (Shattuk and Miller, 2006).

So far we have discussed how crisis management, and incident commanding, deals with present risk or avoiding risk that might or will arise, during the crisis. We have also looked at uncertainty and its impact on the decision making on-scene. Next, we tie it all together in the risk management process during crisis.

6. Risk and risk assessment

Risk is traditionally understood as the potential negative impact of an activity and some characteristics of value that may arise from some present process or future event. There are many definitions of risk, depending on the specific application and situational context. Generally, risk is related to the expected losses which can be caused by a risky event, and to the probability of this event. The higher the loss and the more likely the event is, the worse the risk. In everyday usage, risk is often used synonymously with the probability or possibility of a loss or threat or suffering harm. Risk is a threat to a successful outcome.

Aven *et al.* (2004) describe the risk as the *combination* of possible consequences of a certain activity and the uncertainty of the consequences – the outcomes. The probability is a subjective measure of uncertainty. The term risk is related to future outcomes and related probabilities. The use of risk analysis and/or risk management offers an interesting approach to dealing with crises and incidents. Comfort (1988) describes analysis of risk as a rational process that results in a powerful goal for action of emergency operations. The dominant concept of risk, applied to safety and emergency management, can be described as *the engineer perspective*. The engineer perspective views risk as an inherent property of the system, in this case the accident scene, and the purpose of a study of the risk is to reveal the true risk. Thus, a sharp distinction is made between the real objective risk and the perceived risk. The focus is on the risk figure, which is an unobservable unknown quantity and thereby difficult to use in decision making on- scene. The engineer perspective is not practically applicable to incident commanders because it is too extensive and time demanding when the situations need rapid decisions. The engineer perspective is described in several textbooks and papers. See for example (Henley and Kumamoto 1981), (Modarres 1993) and (Vose 2000). The fundamental issues of risk are discussed for example in (Apostolakis and Wu 1993), (Hoffman and Kaplan 1999), and (Aven 2003).

An alternative risk perspective focuses on observable quantities, such as (Aven 2003, 2007), and can be described as knowledge and decision oriented analysis. Aven is inspired by *the classic analytic decision perspective*. This perspective searches for methods and models to apply in the case of multiple alternatives, to analyse, compare and choose the "best" solutions or decision. Aven emphasises the uncertainty element and implies that the risks are characterised by the combination of possible consequences with an activity, and the related uncertainties of the future consequences or outcomes. In relation to on-scene activities, such quantities could be the number of victims trapped in an earthquake, volume of gas from a gas leak, diffusion of an ammonia cloud, location of children caught in a fire scenario, materials exposed to fire, occurrence of structure breakage during fire fighting, time and capacity to carry out rescue operations, the number of dead and injured, injury categories and so on. Such quantities are of interest to the incident commander in the real time of the emergency. These quantities are called observables, because we will observe these quantities when the activity has ended. However, they are uncertain during the response activity. The risk and inherent uncertainty is quantitatively expressed by probabilities and the associated predictions of the observables. The uncertainties are assessed and the probabilities assigned. In this sense, the risk is purely epistemic. In other words we are uncertain because we lack sufficient knowledge. Aven (2003) denotes this concept of risk the predictive Bayesian approach to risk. See also (Njå and Rake, 2003).

We need to emphasise that risk analysis is an analytic decision support that describes the risk. Risk analysis results alone cannot be used to make a decision in action. Risk analysis is a decision tool. The frequency of rare failures can be hard to estimate and loss of human life is generally considered unacceptable and these considerations hamper the use of risk analysis on-scene an accident. It is imperative that risk assessment must be a part of the decision process for engendering effective decisions. Even so, a study including real time observations of experienced incident commanders from the police, the ambulance service and the fire department, could not identify any systematic risk management strategies in the observed accident cases, neither by the individual incident commanders nor by rescue teams (Rake and Njå, 2009). Risk as a concept important for on-scene activity was strongly connected with the responders' safety. The responses were mainly reactive, comprising direct action to deal with the visible hazard and the problem at hand. Pro-active strategies aimed at revealing and tackling uncertain events and risks were rarely seen (Rake and Njå, 2009).

How can focus on risk be useful on- scene? By using risk analysis as a decision support in his decision making process the commander can, firstly, *decide what kind of information is needed within specific time frames*, and, secondly, *decide which strategies and measures are to be applied in real-time*. Some systematic ways of dealing with risk are:

1. Risk prevention – strategies to reduce the probability of occurrence of a risk
2. Risk mitigation – strategies to reduce the impact of an occurring risk. For example, fail safe mechanisms in systems are designed for this purpose.
3. Insurance – transfer the risk to a third party.
4. Accept – simply do nothing about the risks. Typically applied to either very small risks or low probability, high impact events for which humans are powerless.

5. Reduce the uncertainties surrounding the situations in order to improve the quality of the decision – this will apply to all four generic strategies listed above.

In addition, it should be stressed the importance of effective communication of the involved risks with other actors. This communication results in attentive responders and managers and this reduces the uncertainties inherent in the situation. Therefore the risk is reduced.

There are few empirical evaluations of the actual influence of risk assessments on the decision making of first responders and incident commanders (Braut *et al*, 2012). This limitation restricts our ability to make broad generalisations. In addition, the complex situation on scene, with multiple actors, critical values at stake, need for prompt action, the dynamic situation, the vast numbers of variables involved and the inherent uncertainty, makes use of the risk concept demanding. However, by reducing uncertainty, and highlighting alternative decision options, the performance on scene will improve and risk reduced. In particular, accident situations regarded as abnormal to the incident manager, or the decision maker on-scene, would benefit from this way of thinking.

Identification of the observable quantities, which are critical values at stake, e.g. number of trapped persons inside a burning building, is a key principle to identify the risks which must be dealt with. This information is the basis for the decision maker's representation of the actions, contingency and outcomes that seem relevant to managing the incident. The decision prospects are assessed in relation to possible outcomes and the assigned probabilities. These assessments form the basis for the final decision, followed by an ongoing feedback process throughout the response. This approach involves and affects the risk and risk assessment.

The rescue operations are normally carried out by conscientious managers, commanders, and rescuers, doing their best to optimize the consequences and mitigate losses. However, the performance of the operations rest on standard procedures and experiences from "normal" responses. Despite the broad spectrum of incident types and conditions, a management has to take charge of the site, assess the situation and implement a plan of action to bring events under control. In familiar action, i.e. well known types of rescue operations, operational decisions are not based on rational situation analysis, only on the information, which in the given context is necessary to distinguish among the perceived alternatives for action. In such actions the experienced manager or decision maker makes his decisions upon recognition of the situation. Is the situation familiar? If so the decision maker selects an action, which he/she "knows" will cope with the urgent situation. In general, a pro – active mental analytic risk approach to the problem at hand will be effective when the situation is unclear and unknown. If the manager or decision maker systematically focuses on *Threats and what's at stake, Decision alternatives, Uncertainty* and *Consequences* it's possible to work pro – active and to cope both with well – known and uncommon situations during the emergencies (Rake, 2004). Even when decision makers have the necessary information and competence their emergency management will not be effective if they are not aware of the need to consider the potential risk involved in the situation and in their decisions. A risk approach is essential.

A core of successful risk assessment and decision making is to map the most likely threats to the future and analyze the subsequent impacts (from the threats) we have to cope with. Concentrate on threats and what's on stake before the incident commander, or decision maker on scene, lists the most relevant decision alternatives to solve the problem at hand or reduce the threats. To analyze the inherent uncertainty and consequences of the alternatives is the final step before the decision is made (Rake, 2004).

At the incident the information is fragmented and ambiguous thus making it difficult, and sometimes impossible, to assemble a complete or clear picture of the hazardous situation and the risks. Further observations, i.e. more information, are not always relevant. They only have value for the managerial problem at hand when the result of an observation could lead the crisis management to make a new or different decision. In a dynamic situation continuous/ persistent observation and information is necessary and a part of the described risk approach. Vital information can also fall victim to the situation and never reach the commander on-scene, or even more often, the emergency management remote from the arena, even if the situation changes relative slowly as in the Asian flow disaster– the tsunami – 2004.12.26 and the following days (Evaluation Norway, 2005).

The expert must recognize the problem/risk/threat even when an explanation is not available. This suggests that tacit knowledge (e.g. knowledge not easily verbalised) may play an important role in effective risk management. Training together with experienced managers and decision makers, followed by evaluation, can be suitable to unmask and transfer such competence.

7. Closure

Even the best management, decision or response may be overwhelmed by the situation over which the decision makers have no control, resulting in an undesirable outcome. However, if the understanding of the situation is impaired, then the ability to predict outcomes of actions is more flawed, and due to this, risks of an accident occurring are increased, independent of the plan or approach to problem solving. The problem is not the faults, errors or omissions made by the decision maker or the management, but to recognise/perceive the faults, and adjust the implementation of the decisions in time to avoid negative consequences, and make new and better decisions.

We suggest that extensive training of risk assessment and problem solving will be valuable and may lead to better risk management on-scene and less undesirable outcomes. We would also emphasize the need for more and focused research. Especially important are the connection between situation assessment and inherent uncertainty, decision making and the risk assessment process.

Research in different settings, as in real time, is also necessary (Rake, 2003). The research should focus on the decisions maker. Normally we investigate incidents when the leaders fails, as in the Piper Alpha disasters (Cullen, 1990). An alternative meaningful approach could be to study successful risk managers.

One interesting research and development project is the BRIDGE project (BRIDGE, 2012) within the EU Seventh Framework Programme. BRIDGE intend to build a system to support interoperability – both technical and social – in large-scale emergency management. The system plans to serve as a bridge between first responder organisations, contributing to an effective and efficient response to natural catastrophes, technological disasters, and large-scale terrorist attacks. Important parts of the project are technical solutions and procedures to avoid risk and cope with the risk on-scene.

8. References

Apostolakis, G. and Wu, J. S. (1993). The interpretation of probability, De Finetti's representation theorem, and their implications to the use of expert opinions in safety assessment. In Barlow, R. E. and Clarotti, C. A. (eds.), *Reliability and Decision Making*, Chapman & Hill, London, pp. 311-322.

Aven, T. (2003). *Foundations of Risk Analysis. A knowledge and Decision-oriented Perspective.*John Wiley & Sons Ltd, Chichester, England

Aven, T. (2007). *A unified framework for risk and vulnerability analysis covering both safety and security*. Reliability Engineering & System Safety 92, pp. 745-754

Aven, T, Boyesen, M., Njå, O., Olsen, K.H. and Sandved, K. (2004). *Societal safety,*Universitetsforlaget, Oslo, Norway. (in Norwegian)

Beck, U. (1992). *Risk society: towards a new modernity*. London: Sage

Bigley, G.A. and Roberts, K.H. (2001). *The Incident Command System: High - Reliability Organizing For Complex and Volatile Task Environments*. Academy of Management Journal, vol 44, pp. 1281-1300

Brehmer, B. (1992). Dynamic decision making: Human control of complex systems. *Acta Psychologica, 81*, 211-241

BRIDGE (2012). http://www.bridgeproject.eu/en

Braut, G.S., Rake, E.L., Aanestad, R. and Njå, O. (2012). *Risk images as a basis for decisions related to provision of public services.* Risk Management, 14 (1) pp. 60-76

Bryant, D. J.(2002). *Making Naturalistic Decision making "Fast and Frugal".* Proceedings of the 7th International Command and Control Research Program. Defence Research Development Canada, Toronto, Canada. http://www.dodccrp.org/

Boin, A., 't Hart, P., Stern, E. and Sundelius, B. (2005). *The Politics of Crisis Management. Public leadership under Pressure.* Cambridge University Press, Cambridge, UK.

Cannon - Bowers, J.A., Salas, E. and Pruitt, J.S. (1996). *Establishing the boundaries of a paradigm for decision making research*. Human Factors, 38(2) pp. 193-205

Cannon - Bowers, J.A. and Bell, H.H. (1997). Training Decision Makers for Complex Environments: Implications of the Naturalistic Decision Making Perspective. In Zsambok, C.E. and Klein, G. (eds.): *Naturalistic Decision Making*. Lawrence Erlbaum Associates, Publishers, Mahwah, New Jersey, USA. pp. 99-110

Comfort, L.K. (ed.) (1988). *Managing Disaster. Strategies and Policy Perspectives.* Duke University Press, Durham, USA

Cullen, Lord (1990). *The public inquiry into the Piper Alpha Disasters*. Vol. I and II, HMSO, London, UK

Dror, Y. (1988). Decisionmaking under disaster conditions. In Comfort, L.K. (ed.). *Managing Disaster. Strategies and Policy Perspectives.* Duke University Press, Durham, USA

Edwards, W. (1962). *Dynamic decision theory and probabilistic information processing*. Human Factors, 4, pp. 59-73

Evaluation Norway (2005). *26:12 Rapport fra Evalueringsutvalget for Flodbølgekatastrofen i Sør Asia.* Statens Forvaltningstjeneste, Oslo, Norway

FEMA (2012). Federal Emergency Management Agency. http://www.fema.gov/pdf/emergency/nims/ NIMS_core.pdf, p. 53

Fiedler, F. (1996). *Research on leadership selection and training: One view of the future.* Administrative Quarterly, Vol. 41, pp. 241-251

Flin, R. and Arbuthnot, K. (eds.) (2002). *Incident command: tales from the hot seat*. Ashgate Publishing Limited, Aldershot

Flin, R. (2001). "Decision Making in Crises: The Piper Alpha Disaster. In Rosenthal, U., Boin, A and Comfort, L.K. (eds.). *Managing crises; Threats, dilemmas opportunities.* Charles C Thomas, Springfield, Ill. USA. pp. 103-119.

Fredholm, L. (2006). Coping of small and major societal crisis. (in Swedish). In Fredholm, L. and Göranson, A-L (eds.). *Management of rescue operations in the complex society*. Rädningsverket, Karlstad, Sweden, pp. 15-30. (in Swedish)

Hansson, S. O., (1996). *Decision Making Under Great Uncertainty*. Philosophy of the Social Sciences, 26 (3), pp. 369-386

Henley, E. J. and Kumamoto, H. (1981). *Reliability Engineering and Risk Assessment.* Prentice-Hall, N.J., USA

Hoffman, F. O. and Kaplan, S. (1999). *Beyond the domain of direct observations: how to specify a probability distribution that represents the state of knowledge about uncertain inputs*. Risk analysis, 19, pp. 131-134

Klein, G. (1989). Recognition – Primed Decisions. *Advances in Man-Machine Systems Research, 5*, 47-92.

Klein, G., Orasanu, J., Calderwood, R., and Zsambok, C. E. (Eds.). (1993). *Decision Making in Action: Models and Methods*. Norwood, N.J.: Ablex Pub

Kowalski, K. M. and Vaught, C. (2001.). Judgement and Decision making under Stress: An Overview for Emergency Managers. In *8th Annual Conference Proceedings* (TIEMS 2001), Oslo, Norway

Lewis, R.G. (1988). Management Issues in Emergency Response. In Comfort, L.K. (ed.). *Managing Disaster. Strategies and Policy Perspectives*. Duke University Press, Durham, USA, pp. 163-179

LESLP (2008). *Major Incident - Procedure Manual*. 7th edition, London Emergency Services Liaison Panel, Metropolitan Police Service, London, UK. See also http://www.leslp.gov.uk/

Lipshitz, R., Omodei, M., McClellan, J and Wearing, A. (2007). What's burning? The RAWFS heuristics on the fire ground. In Hoffman, R. R. (ed) (2007). *Expertise out of context*. Lawrence Erlbaum Associates, New York, USA. pp. 97-111

Lipshitz, R., and Strauss, O. (1997). Coping with uncertainty: A naturalistic decision-making analysis. *Organizational Behavior and Human Decision Processes, 69*(2), 149-163.

McLennan, J., Omodei, M.M, Holgate, A.M., and Wearing, A.J. (2003). *Human Information Processing aspects of Effective Emergency Incident Management Decision Making*. The Human Factors of Decision Making in Complex system Conference, Dublane, Scotland

Modarres, M. (1993). *What every engineer should know about Reliability and Risk Analysis*. Marcel Dekker, N.Y., USA

NATO (2002). *NATO code of best practice for command and control assessment*, rev. ed., DoD Command and Control Research Program, Washington, D.C., USA

Njå, O., and Rake, E. L. (2003). *Risk Based Decision Making on Accident Scenes. In Emergency Management in a Changing World*. Paper presented at the The International Emergency Management Society 10th Annual Conference.

Orasanu, J., and Connolly, T. (1993). The Reinvention of Decision Making. In G. Klein, J. Orasanu, R. Calderwood & C. E. Zsambok (Eds.), *Decision Making in Action: Models and Methods*. Norwood, N.J.: Ablex Publishing Corporation.

Perrow, C. (1999). *Normal accidents: Living with high-risk technologies*. Princeton, N.J.: Princeton University Press.

Rake, E. L. (2003). Emergency management and decision making on accident scenes: taxonomy, models and future research. *International Journal of Emergency Management, 1*(4), 397-409

Rake, E. L. (2004). *A Risk-Informed Approach to Decision Making in Rescue Operations*. Paper presented at the International Conference on Probabilistic Safety Assessment and Management (PSAM7/ESREL04), Berlin

Rake, E.L. and Njå, O. (2009) Perceptions and performances of experienced incident commanders. *Journal of Risk Research*, 12(5), 665-685

Rijpma, J.A. and van Duim, M.J. (2001). The Response to the Hercules Crash. In Rosenthal, U., Boin, A. and Comfort, L.K. (eds.). *Managing crises; Threats, dilemmas opportunities.* Charles C Thomas, Springfield, Illinois, USA. pp 143-155

Rosenthal, U., Boin, R. A., and Comfort, L. K. (Eds.). (2001). *Managing crises: Threats, dilemmas, opportunities*. Springfield, Ill.: Charles C. Thomas.

Rosenthal, U., Hart, P. t., and Charles, M. T. (1989). The World of Crises and Crisis Management. In U. Rosenthal, M. T. Charles & P. t. Hart (Eds.), *Coping with Crises: The Management of Disasters, Riots, and Terrorism*. Springfield, Ill., U.S.A.: C.C. Thomas.

Shattuk, L.G and Miller, N.L. (2006). *Extending naturalistic decision making to complex organisation: A dynamic model of situated cognition*. Organization studies 27(7), pp. 989-1009

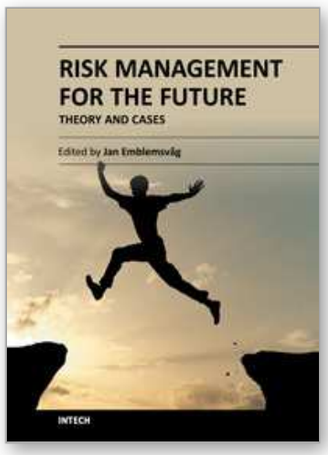
Simon, H. A. (1955). *A behavioural and organizational choice*. Quarterly Journal of Economics, 69, pp. 99-118

SOUS (2005). *Sverige och tsunami- granskning och förslag*. Statens Offentliga Utredningar, Stockholm, Sweden

Vose, D. (2000). *Risk Analysis*. John Wiley & Sons, LTD, New York, USA

Weingart, S. and Wyer, P. (2006). *Emergency medicine decision making: critical choices in chaotic environments*, McGraw-Hill, New York, USA

Yates, J. F. (2001). "Outsider:" Impressions of Naturalistic Decision making. In E. Salas & G. Klein (Eds.), *Linking Expertise and Naturalistic Decision Making*. Mahwah, NJ: Lawrence Erlbaum Associates.



Risk Management for the Future - Theory and Cases
Edited by Dr Jan Emblemsvåg

ISBN 978-953-51-0571-8
Hard cover, 496 pages
Publisher InTech
Published online 25, April, 2012
Published in print edition April, 2012

A large part of academic literature, business literature as well as practices in real life are resting on the assumption that uncertainty and risk does not exist. We all know that this is not true, yet, a whole variety of methods, tools and practices are not attuned to the fact that the future is uncertain and that risks are all around us. However, despite risk management entering the agenda some decades ago, it has introduced risks on its own as illustrated by the financial crisis. Here is a book that goes beyond risk management as it is today and tries to discuss what needs to be improved further. The book also offers some cases.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Eivind L. Rake (2012). Risk Assessment On-Scene, Risk Management for the Future - Theory and Cases, Dr Jan Emblemsvåg (Ed.), ISBN: 978-953-51-0571-8, InTech, Available from: http://www.intechopen.com/books/risk-management-for-the-future-theory-and-cases/risk-assessment-on-scene

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

IntechOpen