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Survival through coping strategies for resilience following a ship accident in polar waters

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ABSTRACT

On 19 June 1989, the cruise liner Maksim Gorkiy hit an ice floe southwest of Svalbard. The passengers and parts of her crew abandoned the ship. In a massive rescue operation 953 crew and passengers were rescued, in addition to the ship. This is only one of several examples of serious ship accidents in polar waters.

The aim of the article is to study coping strategies for resilience among a group of crew members and passengers taking part in the SARex2 exercise, coping strategies that may contribute to a group's survival following a ship accident and the subsequent evacuation of the ship.

The empirical findings stem from participant observation during SARex2 in Svalbard in 2017, a review of the requirements specified in the International Code for Ships Operating in Polar Waters (IMO, 2014) and a literature review on the special challenges of operating in these waters. The theoretical lenses are teamwork, sense making and resilience.

The article starts with a presentation of the challenges of operating in polar waters, as well as some relevant parts of the Polar Code. Then the conceptual framework of the study is presented, followed by information on the SARex2 exercise and methodology. Then follows a discussion of coping strategies for resilience following a ship accident in these waters. Finally, some concluding remarks are presented, on how to transfer a group of crew members and passengers into a team required for survival after a ship accident and the subsequent evacuation of the ship in polar waters.

1. Introduction

On 19 June 1989, the cruise liner Maksim Gorkiy hit an ice floe southwest of Svalbard. She rapidly began to take in water. The passengers and parts of her crew abandoned the ship, in lifeboats and rafts. Some of them were instructed to climb onto the sea ice, due to a fear that lifeboats would be crushed down by the ice. In a joint rescue operation, including the Norwegian Coast Guard vessel KV Senja, 953 crew and passengers were rescued, in addition to the ship. Some research and presentations on the Maksim Gorkiy accident reveal shortcomings in distress signal or alarm routines (Andreassen et al., 2015; Kvamstad et al., 2009; Schmied et al., 2017), crew inexperience with Arctic conditions (Marchenko 2015), high speed voyage in sea ice waters (Andreassen et al., 2015; Kleiven, 2012), organised rescue assistance far away (Kvamstad et al., 2009), but also inadequate information available on sea ice conditions (Fjørtoft and Berge 2019). Another accident took place in the Antarctic Ocean in 2007, when MV Explorer reportedly struck a submerged iceberg and sank, also this time with organised rescue assistance far away (Kvamstad et al., 2009). Both the Maksim Gorkiy and the MV Explorer accidents proved to be challenging not only for crew and passengers but also for rescue operations. They also revealed shortcomings on available preparedness equipment and competence level among ship crews in evacuation procedures (Bignell, 2009; Commissioner of Maritime Affairs, 2009; Hovden, 2014; Kleiven, 2012; Lohr, 1989). However, there are also other examples of maritime incidents and accidents in polar waters (e.g. MS Malmø and Sjøveien in 2019, Northguider, Academic Loffe and Aurora Explorer in 2018, Nordic Barents and UNIS Polaris in 2017, Ortelius and Excursion Vessel with passengers from L'Austral in 2016). We are experiencing an increase in maritime traffic in polar waters, and particularly in the Arctic. Climate change and the melting of sea ice are opening up Arctic sea routes. The result may be more accidents such as those mentioned above.

Surviving a major ship accident with evacuation to a life raft in these harsh climate conditions is difficult and would require a lot of effort from rescue organizations but also from the survivors themselves. Team effort is a central part of crisis preparedness and response. Teamwork may be understood as 'activities that serve to strengthen the quality of functional interactions, relationships, cooperation, communication and

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coordination of team members' (McIntyre and Salas, 1995: 27). In this way, teamwork may enable, and will be crucial for, effective team decision-making (Lipshitz et al., 2001) as well as a team's ability to adapt to, and find solutions for, a wide variety of conditions (Klein and Pierce, 2001). There is extensive literature on organized and trained teams: effective team decision-making (Orasanu 1997; Volpe et al. 1996), professional teams (Flin et al., 2002; Zsambok and Klein, 1997), adaptive organizational teams (Klein and Pierce, 2001), from a team of experts to an expert team (Salas et al., 1997), training professional teams (team of teams) for emergency management (Schaafstala et al., 2001), team situational awareness (Salas et al., 1995), shared problem assessment (Orasanu, 1997), team mind (Klein, 1998), etc. However, there seems to be less research on survival through the formation of a group of crew members and passengers into a team as part of the emergency response.

The International Code for Ships Operating in Polar Waters (the Polar Code) was developed by the International Maritime Organisation (IMO) to increase the safety of ships' operations and mitigate the impact on the people of the environment in the remote, vulnerable and potentially harsh polar waters (IMO, 2014). According to the Polar Code, ships operating in these waters are required to prepare for their own rescue for a period of up to five days following a ship accident. However, representatives of the Norwegian Coast Guard and researchers from the University of Stavanger question the degree to which a ship's crew and passengers possess the required skills and equipment to do that (Solberg et al., 2016). The equipment and skills we experience among professional rescue agencies, such as search and rescue helicopter crews and Coast Guard vessel crews, are unlikely to be found among passengers and crew members of merchant ships and cruise liners in polar waters. We need therefore to bridge the gap between the knowledge required for survival and the knowledge possessed by crew and passengers. Thus, the aim of this article is to study coping strategies for resilience among a group of crew members and passengers taking part in the Search and Rescue exercise 2 (SARex2) in 2017, coping strategies that may contribute to a group's survival following a ship accident and the subsequent evacuation of the ship in polar waters. Three issues seem relevant in this respect: (1) the specific challenges survivors face following a major ship accident in these waters, (2) the specific expectations concerning survivors' own responsibilities for taking care of themselves in the evacuation and survival phases after a ship accident, and (3) how survivors can cope with these challenges while waiting for the professional agencies to come to their rescue.

The empirical findings stem from participant observations in a life raft in the SARex2-exercise in Svalbard in 2017 (see chapter 3 and 6), a literature review on the special challenges of operating in polar waters and the Polar Code. The theoretical lenses are teamwork, sense making and resilience.

The article starts with a presentation of challenges of operating in polar waters, as well as some relevant parts of the Polar Code (IMO, 2014). Then the conceptual framework of the study is presented before we move on to the research methods. The next chapter describes the SARex2 exercise, followed by a discussion of coping strategies for resilience in the evacuation and survival phases after a major ship accident in polar waters. Finally, some concluding remarks are presented, on how to transfer a group of crew members and passengers into a team required for survival. The article is inspired by Karl Weick's discussions of the collapse of sense making among firemen during the Mann Gulch fire and how organizations can be made more resilient (1993), along with an article by the present author, together with Professor Odd Einar Olsen, on reliability-seeking networks in complex emergencies (Kruke and Olsen, 2005).

2. Polar waters and the Polar Code

2.1. Polar waters

Polar waters are the oceans surrounding the polar areas, i.e. the Arctic and Antarctic waters, as illustrated in the Polar Code (IMO, 2014). Even though these waters have similarities, they also possess significant differences. However, ship operations in these waters have many of the same challenges' relater to sources of hazard (IMO, 2014), operations and preparedness. Hence, even though most of the empirical data stems from Arctic waters, we will also use the term polar waters in this article.

2.2. Sources of hazard

Maritime rescue operations in polar waters are challenging, calling for operational cooperation among response agencies (Sydnes et al., 2017). However, crew and passengers experiencing a ship accident must shoulder the responsibility for own rescue in the initial phase, and even longer. The physical environment has a potentially strong effect on human beings (Wærø et al., 2018) and on technical installations, making remoteness and climate conditions important for operations (see also IMO, 2014).

2.2.1. Remoteness

Svalbard is a remote archipelago located some 1300 km from the North Pole, 832 km from Greenland and 950 km from the Norwegian mainland. Remoteness is challenging for efficient rescue operations following a ship accident in polar waters (IMO, 2014), both due to the distances and the limited available infrastructure. Thus, following being rescued, the remoteness of the polar regions and less available infrastructure, may result in survivors being evacuated by search and rescue (SAR) helicopters to a temporary location on the closest shore, and not to a warm and safe haven. Search and rescue operations in remote regions, such as polar waters, may therefore entail an extra element of evacuation (SAR-E), an element that is not important to the same degree close to local communities. Survivors stranded on a beach was the exercise scenario during SARex3 in 2018 (Solberg et al., 2018).

The Polar Code further specifies that the high latitude affects navigation- and communication systems, and the quality of ice imagery information, and thus managers (maritime and search and rescue) capacities for navigation and for operational decisions (IMO, 2014). Cold climate conditions further complicate operations.

2.2.2. Climate conditions

The Arctic and Antarctic regions are characterized by rapidly changing and harsh weather conditions (IMO 2014), conditions that may cause impairment of technical installations and safety equipment and icing on radar- and communication antennas. Whereas the sea water temperature around Svalbard varies only a few degrees with some −2°C during the winter and up to +5 °C during the summer, the air temperature varies considerably all through the year. The mean temperature on Svalbard during the winter is some −15 °C and during the summer some +6 °C. However, the actual temperature may often be far colder, due to the wind-chill factor (Osczevski and Bluestein, 2005), dependent on air temperature, wind velocity and humidity. These cold climate conditions complicate operations (Ahmad, et al. 2016) through reduced physical and cognitive performance (Balindres et al., 2016; Mäkinen, 2007) of personnel, and with an impact on technical equipment, the outdoor working environment, human performance, maintenance, emergency preparedness, rescue operations and survival time (IMO, 2014). Finally, reduced visibility due to lack of daylight, white out and fog varies with the season. Both the polar night and the midnight sun may affect human performance through poor sleep quality (Palinkas and Suedfeld, 2008; Pattyn et al., 2017). Whereas white out is experienced when a white cloud layer appears to merge with the white snow surface, fog is often the result of heat exchange between the air and the sea, or between warm seawater and colder water from the glaciers (Wærø et al., 2018). Both fog and white out may affect helicopter search and rescue operations.

Other sources of hazards specified in the Polar Code are a potential lack of both ship crew experience in polar operations and suitable emergency response equipment.

These hazards, and the potential impact on organizational-, technical- and human performance may expose ships and personnel to particular challenges following accidents in these waters. They are also dimensioning factors for ships' survival equipment and preparedness activities.

2.3. International code for ships operating in polar waters (IMO Polar Code)

The most relevant parts of the Polar Code (IMO, 2014) for this study are, in addition to the hazards mentioned above, expected time of rescue, life-saving appliances and arrangements, and manning and training.

The maximum expected time of rescue (Chapter 1, para 1.2.7), specified as the time adopted for the design of equipment and system that provide survival support, shall never be less than 5 days. This is both the standard that equipment and rescue resources and arrangements have to meet and the dimensioning requirement for individual survival after a major ship accident, that is to say the period in which survival is down to the activities of the survivors themselves, prior to the arrival of rescuers coming to their aid.

All life-saving appliances and arrangements (Chapter 8, para 8.2.3) shall be operational at the required level to support survival following abandoning ship under extreme conditions during the maximum expected time of rescue. Thus, in addition to equipment, manning and training (Chapter 12) of crews and personnel in lifeboat- and life raft operations are required. Ships operating in polar waters are to be appropriately manned by qualified, trained and experienced personnel capable to manage the evacuation process and take command of the lifeboats and the life rafts.

3. The search and rescue exercise 2 (SARex2)

The SARex2 exercise was part of a one-week expedition on board the Norwegian Coast Guard Vessel (KV) Svalbard for testing of equipment related to the survival following an emergency evacuation of ships in polar waters. The objectives of the actual exercise (3–4 May 2017) were to investigate the functional requirements as defined in the International Code for Ships Operating in Polar Waters (IMO Polar Code), in particular concerning the adequacy of the modified lifeboat and life raft, and Personal Protective Equipment (PPE) for use in cold climate conditions (Solberg et al., 2017). The planned exercise area was northeast of Spitsbergen, the largest island on Svalbard. Unfortunately, that area was not accessible due to sea ice. We then deviated from our initial plan and changed exercise area to Krossfjorden, on the west coast of Spitsbergen. The SARex2 was a survival exercise in which a group of civilian exercise staff and crew members from KV Svalbard were evacuated from the ship to a lifeboat and a life raft. A main part of the exercise was then to study the impact of harsh climate conditions on the exercise participants. The exercise participants did not receive pre-exercise training and preparation instructions. However, they were asked to bring their own personal protective equipment, i.e. two layers of woollen underwear, a hat/cap and gloves/mittens. The participants were then provided with survival suits of varying quality and transported by MOB boats to the lifeboat or the life raft. The exercise participants conducted a dry evacuation. The weather conditions were rather rough and varied between −4°C and gale force when the exercise started May 3rd to −9°C and full gale to storm force when the exercise was terminated May 4th.

The overall management of the exercise was conducted by the Captain Endre Barane and crew on board KV Svalbard. The scientific part of the exercise was managed by Professor Ove Tobias Gudmestad, University of Stavanger. A team of medical doctors monitored the physical well-being of the participants and conducted cognitive and physical tests at regular intervals during the exercise.

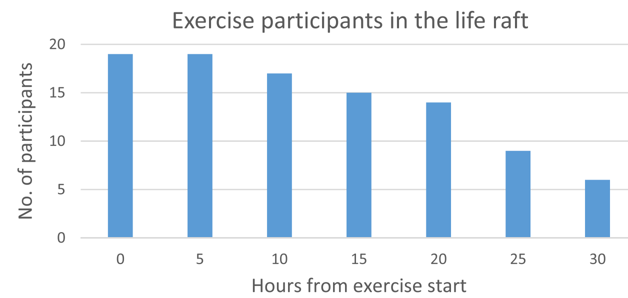

Fig. 1. Number of exercise participants in the raft during the exercise.

Nineteen participants started the exercise in the life raft. When the exercise was terminated 30 h later, only six participants remained. The others were pulled out of the exercise by the medical doctors, due to hypothermia (see Fig. 1).

We experienced only a slight drop in the number of exercise participants during the first 20 h. The steeper drop after 20 h may be the result of deteriorating weather conditions, with colder air temperatures and increasing wind, resulting in hypothermia. A contributing factor to exercise participants being pulled out could have been visits by medical doctors at regular intervals, and the sight of KV Svalbard in close proximity (Solberg et al., 2017). KV Svalbard was a safe, and warn, haven and thus an option to abort the exercise. It is possible to assume that this also could have an impact on the will to engage in life maintaining activities on board the raft. For the remaining exercise participants, the air temperature decreased as participants were pulled out of the exercise. A learning point was that a relatively full life raft was able to stay warmer than a half-full raft (Solberg et al., 2017).

For more detailed information about the exercise, see Solberg et al. 2017.

4. The methodology

I was among the exercise participants in the life raft in the SARex2. My goal was to study what it may take to transfer a group of crew members and passengers into a team necessary for survival. Personal experience from this exercise forms the main part of the data collected for this study. Before taking part in SARex2, I conducted a literature study on polar expeditions, the Polar Code, the SARex1-report (Solberg et al., 2016) and a review of the literature on teams, team building, sense making and resilience.

Conducting an exercise in these rough conditions may be problematic from an ethical point of view. However, with a team of medical doctors overseeing the exercise, and the most advanced search and rescue vessel in the region, the KV Svalbard, it was possible to conduct the exercise within acceptable exercise and research ethical and safety standards.

The findings and discussions in this article are founded on empirical data collected in the Svalbard waters. However, the article may also have some external validity regarding the relevance of the findings compared to other remote cold climate regions with similar conditions and challenges, especially the Antarctic region, even though Arctic and Antarctic waters also have significant differences (IMO, 2014), such as geographical distances to the rest of the world, travel restrictions, etc.

5. The cosmology episodes, sense making, déjà vu and resilience

Crises, also at sea, are events we seldom or never experience, events that may impose severe demands on sense making (Weick, 1993). In general, people normally act according to an understanding of events cohering in time and space (Weick, 1985), giving a feeling of *déjà vu* – I have seen or experienced this before – with an expectation that disruptions or changes happen in an orderly manner. Weick calls this 'everyday cosmologies' (1993), as events it is possible to make sense of. Sense making means that 'reality is an ongoing accomplishment that emerges from efforts to create order and make retrospective sense of what occurs' (Weick, 1993: 635). However, accidents are often severe, with unexpected disruptions, characterised by a higher degree of uncertainty, disruptions that may be termed 'cosmology episodes' (Weick, 1985: 51-52). 'A cosmology episode occurs when people suddenly and deeply feel that the universe is no longer a rational, orderly system' (Weick, 1993: 633), episodes giving a feeling of *vu jàdé* – I have never experienced something like this before. This experience is in anthropology understood as liminality, i.e. the space between the world of status that the person is leaving and the world of status into which the person is being inducted (Van Gennep, 1961).

A major ship accident may be characterized as a cosmology episode or a liminal experience. Ships do usually not sink and we do have faith in their seaworthiness. We would probably not have conducted many sea voyages if ships sank on a regular basis. However, in his book on the Mann Gulch disaster, Norman Maclean presents his first principle of reality on how fast things may turn from everyday cosmologies to a cosmology episode: 'Little things suddenly and literally can become big as hell, the ordinary can suddenly become monstrous' (1992: 217). Thus, when experiencing a major ship accident, giving us a feeling of being in a cosmology episode, we need quickly to turn our focus towards looking for signs of recognition (Klein, 1989) or sense making (Weick, 1993) and towards decision making (Boin et al., 2005; Klein, 1989), to cope with the situation at hand. This shift in focus may be crucial for survival.

A number of potential sources of resilience that make groups less vulnerable to disruptions of sense making are proposed by Karl Weick in his article on the Mann Gulch disaster: improvisation or bricolage, virtual role systems, the attitude of wisdom, and norms of respectful interaction (1993). In the following, I will discuss more coping strategies for resilience, based primarily on empirical findings from the SARex2-exercise but also on research into safety, preparedness and disaster response. But before starting, we need to clarify our understanding of resilience. Wildavsky defines resilience as 'the capacity to cope with unanticipated dangers after they have become manifest, learning to bounce back' (1991: 77). The ability to bounce back when confronted by a crisis, i.e. responding to the crisis, is a long-lasting understanding of resilience (Comfort et al., 2010; Kruke and Olsen, 2005; Tveiten et al., 2012; Woods, 2015). It is also a main characteristic in the United Nations International Strategy for Disaster Reduction (UNISDR) definition of resilience: 'The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions' (UNISDR, 2009). In the high reliability literature, commitment to resilience is a strategy of looking for the fallibility of existing knowledge, the ability to bounce back from errors, flexibility in management and operations, and the capacity to handle surprises in the moment (Kruke and Olsen, 2005; Vogus and Welbourne, 2003; Weick et al., 1999). Resilience may also be understood as the ability to adapt when confronted with an unexpected situation and with inadequate routines and procedures on how to act, a form of precursor resilience (Pettersen and Schulman, 2016), or as the community's ability to learn and to overcome accidents and catastrophes: learning and adaptation (Edwards 2009). This is a reactive form of resilience: recovery resilience (Comfort et al., 2010). Resilience may also be the result of utilising the requisite variety or divergent viewpoints of the group. Schulman defines requisite variety as "conceptual slack" by which he means 'a divergence in analytical perspectives among members of an organization over theories, models, or causal assumptions pertaining to its technology or production processes' (Schulman, 1993: 364). Furthermore, resilience may be understood as a coping strategy of improvisation or bricolage in contingencies where existing knowledge, strategies and routines fall short in handling the situation at hand (Comfort et al. 2010; Kendra and Wachtendorf, 2003; Kruke and Olsen, 2005; Weick, 1993). Hollnagel emphasises that resilience is about sustaining required operations through the adjustment of a system functioning under both expected and unexpected conditions (2011). Thus, adaptation to the situation at hand is a required strategy (Hollnagel, 2014) in contingencies. Anticipation may increase the capacity for resilient handling of both expected and unexpected contingencies (Kruke and Olsen, 2005). Thus, resilience will be more effective during contingencies if it is organized for. Wildavsky defines anticipation as 'prediction and prevention of potential dangers before damage is done' (1991: 77).

6. Coping strategies for resilience

How can we then learn to bounce back (Wildavsky, 1991), adapt to the situation at hand (Hollnagel, 2014), or resist, absorb, accommodate and recover (UNISDR, 2009) from the effects of a major ship accident? The following discussion is divided into six coping strategies for resilience: sense making, team building, familiarization, requisite variety, physical training, and resilience through deviation, improvisation and adaptation.

6.1. Resilience through the transition from cosmology episodes to sense making, déjà vu and decision-making

Even though we were "evacuated" from KV Svalbard to the life raft in an orderly manner and arrived dry and warm in our survival suits, it is fair to argue that many of the exercise participants were out of their comfort zone. For most people, a real ship accident is a cosmology episode, a feeling among survivors that the universe is no longer a rational, orderly system (Weick, 1993). Making sense of the situation is of the utmost importance for proper management, especially in such a dynamic and possibly dangerous situation. This is the initial stage, where people find themselves in an unexpected situation, difficult to understand, in a 'what the hell is going on?' situation (Boin et al., 2005), or the milling phase (Schneider, 1995). This initial phase is often characterized by a high degree of uncertainty, with some degree of chaos, followed by a search for an understanding of what is happening, to create some sort of sense of what is occurring (Weick, 1993). Thus, our first activities in the life raft were about clarifying the situation, trying to make sense of the situation in which we found ourselves and agreeing on the initial activities to manage the situation at hand, turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action (Weick et al., 2005: 409).

An often-cited definition of a crisis is 'a serious threat to the basic structures or the fundamental values and norms of a social system, which – under time pressure and highly uncertain circumstances – necessitates making critical decisions (Rosenthal 1986). People use their experiences for sense making, to make decisions in acute situations (Boin et al., 2005; Klein, 1989). Recognition-primed decision-making is reliance on past experience, based on features of sense making (Klein, 1989). Sense making is also about understanding and relating to the contextual rationality (Weick, 1993). People organize to make sense of the unexpected, to make sense of equivocal inputs and enact this sense back into the world to make that world more orderly (Weick et al., 2005: 410), turning from a cosmology episode to everyday cosmologies. A comforting thought when faced with a cosmology episode, such as a ship accident, is any sign of faint familiarity (Weick, 1993). Several researchers have presented strategies for utilizing signs of familiarity, such as *déjà vu* (Kruke, 2015; Weick et al., 1999), recognition-primed decision-making (Klein 1989), adaptive decision-making (Klein, 2011; Kruke, 2012), naturalistic decision-making (Lipshitz et al., 2001) and keynoting (Schneider, 1995). Common to all these strategies is how to move away from the feeling that the world is no longer a rational, orderly system (Weick, 1993), to start finding signs of a strategy to cope with the situation. Mapping of experiences among the group of people in the life raft is a step in that direction, making teambuilding important for resilience.

6.2. Resilience through team building

Team building is a process or series of activities undertaken to bring a desirable change in a group of people, or to increase the overall performance of the group. The American Anthropologist, Margaret Mead, said ‘Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has’. Lack of team building may have the opposite effect. This is exemplified by the British author, William Golding, in *Lord of the Flies*. In this bestseller, Golding describes how a group of well-educated boys stranded on an isolated island descend into savagery.

The exercise participants came from the crew on board KV Svalbard and from a group of the scientific staff. It is fair to assume that management of an existing trained team may prove easier for the officer in charge of the life raft than management of a loosely composed group of crew members and passengers, such as the scientific party taking part in the exercise or a group of tourists on board a cruise liner. As specified in the introduction chapter, research on team building is mostly related to existing professional teams. A loosely composed group of crew members and passengers will, by definition, experience initial challenges in working together towards a common goal. In addition, coordination, understood as ‘management of dependencies’ (Malone and Crowston, 1994), implies a realization that we are dependent on each other. This is a first step towards a common goal of survival. This dependency was reflected in an initial organization of the group in the life raft:

Command structure: The captain of the raft, an officer from KV Svalbard, chose a second in command among the passengers, a person with previous experience from the life raft during SARex1 in 2016. This initial organization was followed by organizing of some core activities.

The presentations: Everyone was asked to present himself/herself and include knowledge they thought could be relevant for the situation in which we found ourselves. A second presentation of first names was conducted later in the exercise. During this presentation, passengers were asked to mention an animal with the same first letter as their name. This formed a lighter mood among the passengers and made it easier to remember the names and thereby to communicate.

The buddy system: People were paired up as buddies and tasked to look after and take care of their buddy. The buddy system was in place throughout the exercise, at least for me and my buddy. The buddy system made us both feel a mutual dependency but also an altruistic feeling of the need to take care of each other.

The duty roster: A duty roster was organized with shifts of three people on two-hour duty. The duty station was next to the main canvas opening. The duty tasks were related to:

- Wiping up water from the floor. This was a nonstop activity, since water came in through the vacuum valves and due to large waves and wind.
- Looking out for sea ice, polar bears, walruses, rescue vessels/helicopters, other life rafts/-boats, etc.
- Controlling the ventilation and thereby the temperature level and the CO^2 concentration.
- Radio communication.

Even though the duty roster structured the activities in the raft, we experienced a variation in the degree to which the people on board adhered to the roster. This might be due to exercise artificialities (see chapters 3 and 4). However, the duty roster, and crew abiding to the system, is of the utmost importance in order to maintain good living conditions on board the raft, and to maintain a lookout for hazards and approaching vessels, aircrafts and helicopters.

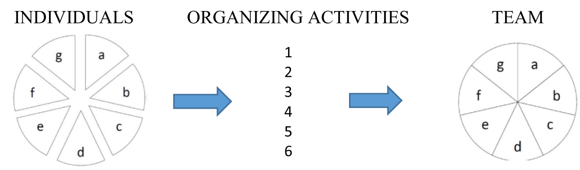

Fig. 2. From a group of individuals, via organizing activities, to a team.

Medical responsibility: A first aid trained passenger was given the responsibility for medical issues. He distributed seasickness tablets every 12 h. He also distributed paracetamol if required. The captain logged all distributed medication (the time and person receiving medication).

Food and water responsibility: The captain distributed water and food at regular intervals. Being a welcome break in the monotony, the actual distribution worked well. However, some participants did not eat the biscuits and drink the water during the “meals”. Some ended up close to dehydration, others became apathetic. This might be one reason for some passengers not adhering to the roster system, and also for hypothermia. Drinking and eating the rations may be crucial for the passengers' cognitive and physical ability to take part in the various activities on board the life raft, and thus for the team survival over a longer period of time. This will be discussed in the sub chapter on requisite variety.

Garbage collection responsibility: A tidy raft is important to maintain good living conditions, and thereby to keep up morale. Therefore, one exercise participant was chosen to be responsible for garbage collection. Much garbage was collected, but not all.

Entertainment responsible: We did not have a dedicated person responsible for entertainment. However, we did have some quizzes and jokes.

To sum up, most research into teams and crisis response focuses on existing response teams. Following a major ship accident, team building may be crucial for team survival. Fig. 2 summarizes this process.

6.3. Resilience through familiarization

Familiarization is mainly related to the situation in which we found ourselves after being evacuated onto the life raft, but also familiarization with the emergency equipment at our disposal. Training and exercises are important parts of the preparedness in the pre-crisis phase (see Fig. 3), and also for response, recognition-primed decision-making (Klein, 1989) and our ability to ‘bounce back’ (Wildavsky, 1991) in the acute phase.

This means that passengers and crew members should be engaged in preparedness activities prior to embarking on a voyage. What is to be included in these preparedness activities are specified in for instance the Polar Code (IMO, 2014). However, accumulated knowledge from previous voyages, including ship accidents, are also important to include.

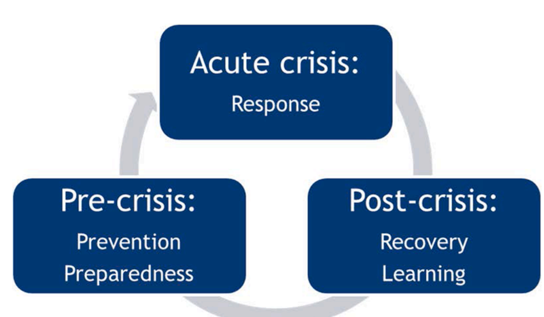

Fig. 3. Crisis phases (Kruke, 2012).

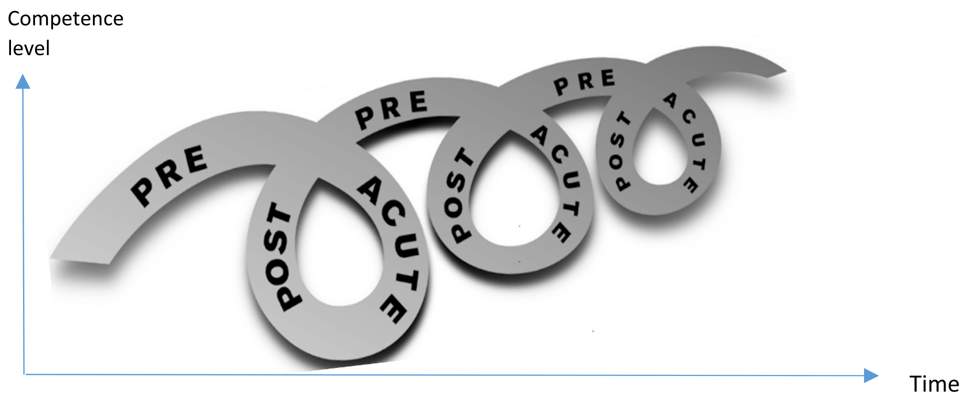

Fig. 4. Crisis phases as a spiral in relation to time and competence level (The figure is designed together with Marie Nilsen, NTNU).

The circle in Fig. 3 gives an indication of some sort of status quo, where we move on from the last crisis to the next pre-crisis phase, as an endless circle characterized by inadequate learning. However, prior experiences are all learning opportunities. The learning aspects of the post-crisis phase therefore give the opportunity to reach a new and more robust pre-crisis level. This process is displayed in Fig. 4.

Most of the exercise participants did not go through extensive preparations prior to SARex2. Some had their training as crew members on board KV Svalbard, some participated in SARex1, and others underwent training as part of their ordinary job in the marine industry. The rest of the exercise participants were fairly unfamiliar with maritime emergency equipment and operations.

The life raft came with two big sacks, filled with standard equipment, food and water. After the initial organizing of responsibilities and activities, the captain distributed the raft equipment to the passengers, gave them a few minutes to become familiar with it, and then asked everyone to present the item, what it is for, and how to use it. That gave us an opportunity to familiarize ourselves with the emergency equipment on board but also with the other passengers. This familiarization activity later proved to be very valuable, since we needed some of the equipment for various activities on board, and we learned that some of the passengers possessed skills that could be useful.

Handling technical equipment, such as radio equipment, medical equipment, pyrotechnical equipment, the life raft, etc., requires skills. However, to my surprise, technical skills and knowledge are also important for the proper use of a "simple" item such as a survival suit. It is a standard suit, with boots and a hood and gloves attached to it. However, during my 30 h' stay in a survival suit in a cold and wet life raft, I experienced that there are some important issues that need attention. The survival suit is waterproof. That means that water is not supposed to penetrate from outside and into the suit. The same is the case in the opposite direction. Thus, there is a need to ventilate the suit at regular intervals to remove condensation on the inside of the suit. This is crucial knowledge to stay dry, and thereby to reduce heat loss.

6.4. *Resilience through requisite variety*

As mentioned above, familiarization with each and everyone on board the life raft formed an important part of the initial team building and our ability to utilize the collective knowledge base, requisite variety or divergent viewpoints (Weick et al., 1999) on board. Of particular relevance for this section is that the people in the raft came forward with information they thought could be relevant for the situation in which we found ourselves. Two issues stand out as particularly relevant. The first is that some passengers may have concerns that need particular attention, such as medical issues. The second is to map the collective knowledge base in the life raft on issues like maritime experience, knowledge about the particular geographical area, technical knowledge relevant for the raft and for the emergency equipment, experience with radio communications, first aid knowledge, polar and cold climate experience, skills related to diet, digestion, language skills, physical training, etc. It is fair to say that utilizing the knowledge, expertise and capacities among the passengers may be crucial for survival in a real ship accident and subsequent evacuation to life rafts.

6.5. *Resilience through physical training*

Our life raft was a 9–10 square meters VIKING Life raft (throw overboard (self-righting), 25 pers.). Even with only 19 passengers, the raft was crowded. Despite that we conducted a dry evacuation during SARex2, it soon became evident for everyone that we needed to regain body temperature. It is likely, following a major ship accident, that some survivors will be boarding the lifeboats and life rafts from the sea. In cold climate conditions, wet evacuation is life threatening. 13 passengers aborted the exercise prior to the end of the exercise due to hypothermia. Thus, a main concern on board was to regain and maintain body temperature.

Luckily, in SARex2, the life raft was equipped with sidewalls it was possible to sit on (Solberg et al., 2017). We could therefore variate seating positions between the floor and the sidewalls. This change in seating arrangements gave the opportunity to conduct some physical exercise to reduce heat loss and to regain body temperature. Without these sidewalls physical training would have been more difficult, but still equally important.

6.6. *Resilience through deviation, adaptation and improvisation*

Safety management in stable conditions are much about reliability, understood as 'the unusual capacity to produce collective outcomes of a certain minimum quality repeatedly' (Hannan and Freeman, 1984: 154). However, this understanding of reliability is not suitable for understanding reliable operations in shifting climate conditions in polar waters, and management of dynamic and unexpected crises, situations that are unwanted, unanticipated and maybe also unexplainable in the initial phase (Hollnagel, 1993: 51). Our team structure changed several times during the exercise because people were pulled out due to hypothermia. This is a likely scenario also in a real situation where passengers may die due to hypothermia. In crises, variations in performance are expected (Weick et al., 1999), variations that may necessitate a different strategy, a strategy of deviation and improvisation. Reliability may also be a result of 'a continuous management of fluctuations both in job performance and in overall departmental interaction' (Schulman, 1993: 369), fluctuations as a natural response to a dynamic operating environment. In this understanding, reliability is transient in the sense that it is situation-specific, a localized accomplishment (Kruke and Olsen, 2005; Weick et al., 1999), and based on adaptive decision-making (Klein, 2011). Just as finding a proper exercise area during SARex2, the ending of the exercise may serve as a good example of the need for deviation, adaptation and improvisation.

The operating environment in polar waters is challenging in many ways. The need for deviation, adaptation and improvisation was experienced both during the voyage with KV Svalbard and the stay in the raft. Under no circumstances could KV Svalbard reach the planned exercise area, due to sea ice. Thus, an adaptation to the circumstances was in order, e.g. a deviation from the planned exercise took place, moving the exercise southward to a more suitable exercise area. This is just one example of required adaptations in these waters. Another example is how evacuees in lifeboats and life rafts need to deviate, adapt and improvise when facing sea ice. Life raft exercises are extremely dangerous in sea ice areas. In fact, the evacuees from the Maksim Gorkiy abandoned lifeboats and rafts to safer locations on the sea ice. The SARex2 exercise ended after approximately 30 h. The wind increased to gusts of up to 50 knots, the temperature dropped to approximately −9 °C and we had big chunks of sea ice around the raft. Thus, a decision to decommission the exercise was made by the captain on board KV Svalbard. The remaining six participants on board the life raft had the opportunity to listen in on the radio (VHF) communication between the captain on KV Svalbard and the officers in charge of the lifeboat and the life raft. The actual plan to end the exercise was adjusted several times, due to changes in the weather conditions. In the final stages of the exercise, both wind and some sea ice made it more challenging to maintain control, especially of the life raft.

In addition to deviation, adaptation may also be seen as bricolage or improvisation. Being in a life raft, with only a limited amount of equipment, may require bricolage or improvisation, to make the most out of the situation and of the tools and equipment at our disposal. Bricoleurs remain creative under pressure (Weick, 1993) because they are able to pull some sort of order out of chaotic conditions through a capacity to utilize whatever materials they have at their disposal. This may prove a crucial capacity, to be able to recover from the effects of a hazard in a timely and efficient manner (UNISDR, 2009), in an operating area in which survival may be based on one's own capacities for a period of up to five days (ref. the Polar Code).

6.7. *Figure – Coping strategies for resilience*

The discussion above is summarized in Fig. 5. These coping strategies for resilience are all strategies that may prove vital for survival following a major ship accident in Arctic waters.

These coping strategies for resilience are all parts of bringing a group of crew members and passengers together towards a common goal of survival. As individuals, they may struggle to survive only a couple of days. Their survival may depend on networking and coordination, on 'management of dependencies' (Malone and Crowston, 1994). In this respect it is fair to argue that teambuilding may be of particular importance, since teambuilding may imply familiarization, utilizing requisite variety, and lay the foundation for sense making, deviation, adaptation and improvisation.

Fig. 5. Coping strategies for resilience.

7. Concluding remarks

The experiences from the life raft in the SARex2 exercise reveal some coping strategies for resilience that may be crucial for a group's survival following a ship accident and the subsequent rescue, evacuation and survival phases. Processes of sense making, teambuilding, familiarization, requisite variety, physical training and deviation adaptation and improvisation are all coping strategies for resilience, not only for professional teams, but also for a group of people who suddenly and unexpectedly find themselves in a life raft after a major ship accident.

Polar hazards may expose ships and personnel to particular challenges following accidents in these waters. Consequently, they are dimensioning factors for survival equipment and for preparedness activities for ships operating in these waters. Thus, ships need to be appropriately manned by qualified, trained and experienced personnel capable of managing the evacuation process and take command of the lifeboats and the life rafts. With the current regime for preparedness and rescue operations, as specified in the Polar Code, much responsibility for the survival in the initial phase following a major ship accident rests on the shoulders of the ship crew and passengers. Thus, survival depends on relevant emergency equipment on board ships, on the knowledge and expertise among crew and passengers on how to handle the rescue, evacuation, and the period of up to five days in the raft, and, finally, on swift mobilization and deployment of search and rescue capacities. The findings from the SARex2-exercise indicate a knowledge gap on how to operate the survival equipment and how to utilise the full capacities of the "survivors" in the raft. It is hardly likely that passengers would survive for a period of up to five days in a raft in these waters. We therefore both need to bridge the gap between the knowledge required for survival and the knowledge possessed by crew and passengers, and to make sure that the survival equipment is of a standard making it possible to survive in these waters. This is also a concern specified in the Polar Code. Consequently, it is a need for a reliable regime to make sure that ships operating in these waters do have the proper equipment and knowledge for own rescue, evacuation and survival for a period of up to five days, and that proper exercises for the crew and passengers are conducted. Some concrete recommendations coming out of this research are:

- Passengers need thorough training, also because trained crew members might not be available to man all the life boats and rafts if a major accident occurs.
- The technical equipment (e.g. the survival suits, life boats, rafts, radios) must be of a standard making survival in polar waters possible and the equipment need detailed and easy to read instructions for reliable use by less experienced passengers.
- Coping strategies for resilience must be a part of the instructions.

It is fair to say that an exercise of 30 h' stay in a life raft is not adequate to fully test the feasibility of the Polar Code regarding preparedness. However, the exercise proved to be a good test of how to cope with some of the special challenges following a major ship accident in polar waters and to map relevant coping strategies for resilience.

Further research on maritime operations in polar waters, on the feasibility of preparedness equipment, on training of ship crews, on exercises involving passengers, on cross-border search and rescue capacities and operations are needed, particularly because of the increasing interest in polar waters. A particularly interesting research area is to study the evacuation element of search and rescue (SAR-E) operations in remote polar waters.

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