Received: 6 February 2022 | Revised: 3 October 2023 | Accepted: 1 November 2023

DOI: 10.1111/1468-5973.12517

ORIGINAL ARTICLE

WILEY

Exercise design for interagency collaboration training: The case of maritime nuclear emergency management tabletop exercises

Rune Elvegård | Natalia Andreassen

Centre for Crisis Management and Collaboration, Nord University Business School, Bodø, Norway

Correspondence
Rune Elvegård
Email: rune.elvegard@nord.no

Natalia Andreassen
Email: natalia.andreassen@nord.no

Funding information
Norges Forskningsråd, Grant/Award Number: 336285

Abstract

In this paper, we explore a concept of exercise design within emergency management competence development. The paper presents recommendations for exercise design aspects that may be suitable for gaining collaboration skills and knowledge that responders need in unknown events of high complexity. This study explores the practice of tabletop exercises with complex scenarios that engage participants to discover organizational roles and responsibility division in collaborative action. Empirically, we base our analysis on maritime search and rescue nuclear preparedness exercises in the Arctic seas. We focus on elements that are essential for learners to increase their knowledge of operational complexity and collaborative performance, including understanding one's own and others' roles and responsibilities, formation of interagency teams, their boundaries and interaction between authorities and levels, mutual recognition of risks and learning about resource capacities and their limitations. The study draws conclusions on aspects that are critical for designing emergency management tabletop exercises, in particularly discussions in mixed groups for interpretative learning; own practice reflection for integrative learning; formulating general collaborative competence objectives, and complexity and realism of scenarios.

KEYWORDS
Arctic, collaboration, complexity, exercise design, radiological and nuclear search and rescue

1 | INTRODUCTION

Collaboration in emergency response is crucial in situations wherein the involved response authorities have to work closely together to solve tasks in a better way. Several critical tasks in complex emergency response cannot be solved within an individual organization but must be handled through interaction with all actors whose combined resources are being utilized efficiently (Abdeen et al., 2021). Collaboration is a central process used in coordinating the preparedness resources of different actors to ensure the best possible situational awareness and control. The essence of collaboration means that several organizations exert joint actions in favour of the public interest rather than working separately (Bardach, 1998).

Scenario-based learning within emergency management is usually based on facts and details of historical events. Crisis scenarios are, in many ways, effective tools for both organizational and individual learning (Borodzicz & Van Haperen, 2002). However,

treading the same path in preparation for an incident of high complexity with potentially unpredictable consequences is not always efficient. Several factors, such as geographical position, weather, lack of preparedness and infrastructure, may be completely different in new events. Organizational complexity with various command structures, challenges in information flow, uncertainties in operational patterns of the involved response agencies, as well as uncertainty in dividing roles and responsibilities among the involved parties may pose challenges to collaboration (Moynihan, 2008).

The crisis leadership literature acknowledges that it is impossible to prepare for all types of crisis events and calls for brainstorming and preparing for less likely large-scale incidents with demanding efforts from a broad range of emergency response actors (Mitroff et al., 1987). When an outcome and operational pattern are not yet certain, it is possible, based on risk and vulnerability analyses and commercial activity patterns, to imagine future catastrophic events and simulate and discuss complex scenarios to discover plans for collaboration. Mendonça et al. (2006) claimed that when no standard operating procedure is appropriate, an approach to emergency management exercise design should be supporting managers to deal with an uncertainty and changing environment. Exercising a complex scenario with unknown consequences may be a way to prepare for future emergency response operations and acquire a new understanding of the knowledge needed for collaborative actions.

Paton and Jackson (2002) explained that training might compensate for the limited opportunities available for acquiring actual disaster response experience; thus, it is fundamental in disaster readiness planning and competence development. Sinclair et al. (2012) claimed that emergency management training is intended to develop people's capacity to respond to new and atypical demands engendered by emergencies. Several studies uncovered that collaboration exercises contribute to learning that can be useful in actual emergency work of professional emergency personnel (Borodzicz & Van Haperen, 2002; Perry, 2004; Roud et al., 2020; Tena-Chollet et al., 2017). However, more studies are called for examining the collaborative elements of an exercise design and learning environment (Berlin & Carlström, 2015; Tena-Chollet et al., 2017).

Therefore, this study aims to pay attention to exercise design and the aspects that may help the learners enhance collaboration knowledge and skills useful in dealing with complexity. This article focuses on providing recommendations for didactical planning of emergency management collaboration exercises. This study addresses the following research question: **How can an exercise in emergency management be designed to enhance skills and knowledge in collaboration in complexity?**

The article proceeds with an introduction of the context and empirical argument for the study. Subsequently, viewpoints of organizational studies on complexity and collaboration are presented, along with the theoretical perspectives of organizational learning and exercise design. We draw upon viewpoints on didactical planning and social cognitive theories, particularly with regard to the learning prerequisites of participants and the role of a complex scenario. We then proceed with presenting the data collection and analysis method. The data include both quantitative and qualitative sources obtained through exercise questionnaires and participant observations. The results include the description of the maritime search and rescue (SAR) preparedness system in case of radiological and nuclear emergencies in Norway, descriptions of the tabletop nuclear preparedness exercises, empirics on exercise design and learning outcomes in understanding roles and responsibilities. Finally, we discuss the results and draw some conclusions.

1.1 | Context of the maritime nuclear SAR preparedness system in Norway

A maritime nuclear preparedness system involves several organizations and experts. The most important consequence-reducing barrier in case of a nuclear accident is notification and rapid implementation of protective measures. Nuclear preparedness in Norway is organized through a Crisis Committee for Nuclear Preparedness under the leadership of the Norwegian Radiation and Nuclear Safety Authority. The Committee is responsible for and has the authority to implement measures to reduce the consequences of a nuclear accident. (DSB [Norwegian Directorate for Civil Protection], 2019). Norway currently has a permanent contingency plan against nuclear incidents. The objective of national nuclear preparedness is for all potential incidents to be handled regardless of the probability (DSB [Norwegian Directorate for Civil Protection], 2019).

The structure of the SAR system in most countries is divided into subfunctions and action sectors, for example, according to incident type, geographical area of responsibility and capacities within the different levels of coordination. For maritime SAR operations, the International Aeronautical and Maritime Search and Rescue (IAMSAR) manual serves as a platform for the tasks and roles (IMO, 2013). The Norwegian SAR system is organized with national and regional structures. The Joint Rescue Coordination Centre in Norway is responsible for SAR operations at the national strategic level. The rescue service in Norway is carried out as a collaboration between government agencies, nongovernmental organizations and private enterprises. The SAR mission coordinator (SMC) is in charge of the overall coordination of incidents and allocation of all necessary resources. SMCs constitute rescue controllers who work at the Joint Rescue Coordination Centre. The Joint Rescue Coordination Centre is responsible for the rescue operation in a nuclear event or other events involving radioactivity or radiation, while the Crisis Committee handles incidents beyond this scope.

Maritime nuclear safety preparedness is characterized by complexity, especially because multiple organizations and at least two emergency preparedness systems are involved—maritime SAR and nuclear preparedness. The lack of capacities within relevant authorities or countries may often cause higher dependency on international assistance and coordination of each other's resources and actions. In addition, there is a dearth of hands-on experience in dealing with SAR during radiological or nuclear emergencies and rapidly changing unpredicted situations. This requires the involved authorities and responding personnel to rely on each other's expertise and professional judgements. A harsh environment may hamper the conduct of an SAR operation. The operational conditions for radiological-nuclear

SAR in a cold climate may be unpredictable, which calls for shared knowledge and experiences on the operational conditions in the Arctic and lessons learned from prior accidents and exercises.

In this article, we focus on the empirical setting of maritime radiological-nuclear SAR operations. Such operations may be referred to as operations with high complexity that may require coordinated actions from a larger number of involved authorities and response organizations than a normal SAR operation. Decisions made in such incidents will potentially have not only short-term but also long-term influences on people, environments, economies, industries and so on. In addition, SAR responders lack hands-on experience in dealing with such incidents, yet they need to act in volatile, unexpectedly changing conditions. The traffic of nuclear-propelled vessels in the Norwegian sea areas and adjacent areas in the Arctic is noticeably increasing. Accidents involving such reactors near the coast can result in tremendous air and sea emissions, which will have serious consequences in Norway and neighbouring countries. In Norway, the risk of this type of event has been defined with medium probability (DSB Norwegian Directorate for Civil Protection, 2019). Therefore, using empirical data from Norway would allow us to discuss the case of a potential incident that may simultaneously have unpredictable consequences and collective action patterns based on activity patterns.

2 | THEORY

Collaborative processes are essential in dealing with disasters, in which authority is shared, resources are scarce and responsibility is distributed (Waugh & Streib, 2006). Emergency management training is intended to develop people's capacity and competence to respond to emergencies, to act and to use resources collectively. This study's intended contribution is twofold. First, it contributes to the literature on collaboration in emergency management by discussing the prerequisites of group collaboration knowledge and skills in complexity. Second, a contribution is also made in the field of didactical planning of emergency management exercises.

2.1 | Collaboration in emergency management

Collaboration can be referred to as 'any joint activity by two or more agencies that is intended to increase public value by working together rather than separately' (Bardach, 1998, p. 8). The term may also be described as working together for a specific goal or purpose. Understanding the big picture is valuable; however, it is also crucial to focus on how to succeed in reaching the collaborative goal (Bardach, 1998, 2001). In large-scale emergency management, collaboration within and between emergency response agencies is essential to accomplish multiple challenging tasks.

Kapucu et al. (2010) claimed that collaborative processes in emergency management include sharing authority and leadership and achieving the efficient use of resources. Collaboration among all stakeholders may be characterized by a mutual understanding of people and the transfer of information within and among organizations, forming partnerships and mutual understanding of how different partners come together and use their resources together, how they work together and how they talk together (p. 463).

Other collaborative processes that are discussed in the literature are the formation or institutionalization of emergency management networks (Kapucu & Hu, 2014, p. 400), cognition, including common situation awareness and emerging risk recognition and comprehension (Comfort, 2007, p. 190), gaining interorganizational trust in the context of networks (Roud et al., 2020, p. 171) and achieving collective organizational improvisation capacity (Mendonça & Wallace, 2004). Collaboration processes may also include choosing strategies for collaboration, the modes of collaboration, initiating the process without an unnecessary waiting time and clear instructions for collaboration (Berlin & Carlström, 2015).

Collaboration refers to utilizing the competence and capacity of each other's team or agency. Paton and Jackson (2002) claimed that an initial prerequisite for participants to be able to utilize collective expertise effectively is a shared understanding of their roles. This requires clarified roles and responsibilities between the actors and their own and others' resources and capacities.

Roles are defined in organizational studies as a set of expectations in connection to a position or fulfillment of an assignment (Mintzberg, 1977). The involved coordinators are required to fulfill a wide range of roles and responsibilities related to information sharing, decision-making and coordination. If the teams understand each other's roles, collaboration problems that may arise can be eased (Flin, 1997; Musharraf et al., 2019; Crichton & Flin, 2004). During interagency collaborations, a crisis response unit may develop a new way of thinking and change the different roles and action options that can be included in the overall competence basis. Therefore, understanding their roles and shared expectations for their roles is essential for interagency collaboration.

2.2 | Complexity in emergency management

Complexity in emergency management often refers to different environmental attributes. One complexity perspective focuses on resources and unpredictable severe weather or climate that cause operational volatility (Lauta et al., 2018; Marchenko et al., 2018). In particular, scholars suggest a new dimension characterized by 'cold disasters' (Andreassen & Pincus, 2022; Dahlberg, 2015; Lauta et al., 2018). A cold disaster requires a broad range of efforts that are generally hindered by resource scarcity. A scarce preparedness resource infrastructure calls for cross-border support. The complex aspects of the Arctic region amplify and magnify the ramifications of a disaster, which also happens due to weather and climate operational conditions and limitations of resource functionality. The conceptual dimensions would then refer to both the lack of resources available to handle the unwanted event and the lack of understanding of how the consequences evolve (Andreassen & Pincus, 2022).

Another view on emergency management complexity developed in organizational studies is related to a range of organizational

elements, given the increasing number of interdependencies of heterogeneous elements such as teams in organizations, jurisdictions and management levels (Czarniawska, 2004; Shuffler et al., 2015; Weick & Sutcliffe, 2011). Wolbers et al. (2017) regarded coordination as an emergent process in which different interdependent action trajectories are synchronized. Complexity in crisis and emergency operations may also be related to responsive processes that connect people's interactions and behaviours with the change and unpredictability of social realities (Johannessen, 2018). It may be defined by the potentially incomplete or uncertain cues–outcomes relationship the decision-makers need to base their judgements (Kahneman & Klein, 2009; Steigenberger et al., 2017; Tversky & Kahneman, 1974). The overall emergency preparedness picture is often characterized by a diversity of actors who take care of different parts of emergency preparedness (Moynihan, 2008). When organizations collaborate in a response operation, they must coordinate actions across established operational patterns and organizational boundaries. Complexity creates challenges for situation awareness, management and coordination (Andreassen et al., 2020). Therefore, it requires an understanding of the information flow and communication lines between the involved organizations and key sectors.

Organizations and agencies may be turning into larger systems comprising teams or multiteam systems (Shuffler et al., 2015, p. 660). Such systems may also be described as networks of teams working toward shared goals. As teams across emergency management agencies collaborate, the systems often necessitate the skills, competencies and expertise within the boundaries of individual teams to be brought together in new ways to tackle challenges.

In the case of multiteam collaboration, organizational complexity may be discussed in relation to a number of interdependent authorities and levels. Organizations may build multiple types of connections with other organizations. Such collaboration is difficult due to not only the complexity of incidents but also the diverse composition of people and agencies working together (Kapucu & Hu, 2014). However, the composition of the connected teams may change in incidents of high complexity and difficult environmental conditions, wherein both teams and systems with previously established routines, knowledge and procedures must readjust their methods for exchanging information across the teams and again determine their shared understanding to utilize their collective expertise and resources (Paton & Jackson, 2002; Shuffler et al., 2015). Emergency response in high complexity is characterized by its uniqueness and unpredictable outcomes.

2.3 | Exercise design and group learning

Designing an effective emergency management exercise requires taking into account both exercise purposes, namely, systematic didactical planning of all the activities connected to an exercise and maximization of the participants' learning during an exercise event (Wilson, 2000). Exercise design is about which choices to make when planning the content of the exercise, methods and learning strategies for the participants. To investigate the usefulness of emergency management exercise design, understanding of group learning process seems crucial (Borodzicz & Van Haperen, 2002).

Collaboration exercises are activities that different organizations may run to improve collaboration and deal with serious incidents in an optimal manner (Berlin & Carlström, 2015). Emergency management exercises are defined as activities that provide experience for participants with defined roles in dealing with high-pressure situations in a safe and supportive environment (Paton et al., 1999). Learning from the exercises is a crucial outcome to make organizational collaboration more efficient. Organizational learning theories provide useful frameworks for understanding the way multiteam systems learn from their experiences and exercises. In the overview of the organizational learning frameworks, Crossan et al. (1999, p. 525) explained that learning processes emerge in sequence through the levels—individual, group and organization. In particular, interpreting and integrating processes occur when it comes to group learning. Interpreting and integrating processes are crucial for developing learning processes at the next level, that is, the level of organizations.

Interpreting is a social activity that creates shared meaning and understanding and results in the development of a common language. Social constructivism explains that knowledge is constructed and added to the existing part of the knowledge and focuses on the value of discussions and learning through sharing reflections and interpretations (Nyborg, 1985; Vygotsky, 1978). Thus, it is important to recognize various learning prerequisites, including the background of the training audience, experience and competence. The concept of exercise design also means setting up certain learning strategies for participants with various practice backgrounds, individual learning styles and professional roles.

Integrating is the next step to developing a shared understanding among individuals about how coordinated action can be taken and effectively repeated in future operations (Crossan et al., 1999). Adult learners usually bring different competencies and skills into learning activities (Thomas, 2018). Dewey (1938) emphasized the necessity of a connection between learning and personal experience and explained that experiences should be linked cumulatively with one another. Learning outcomes become meaningful when they are connected to an understanding of their role in practice.

Didactical planning is said to be the fundamental support for facilitating the pedagogical use of learning for those who will be called upon to respond to disasters (Paton & Jackson, 2002). Designing exercises include the systematic planning of all the activities connected to an exercise. It often refers to the basic steps required for the process of planning an exercise, namely, identifying who needs to be trained, which kind of knowledge, skills and attitudes should be instilled in people and groups, and the exercise, scenario and evaluation types (Wilson, 2000). People learn through different methods of knowledge acquisition, and different learning processes would ensure maximizing the learning potential and developing competencies necessary for effective performance.

Torgersen and Saeverot (2016) posited that there are didactical challenges in training for unforeseen events. These challenges lay in

the strategies to develop skills to cope with the unforeseen. Normative practice is not established or apparent during unpredicted or complex events. A prediction may be made based on existing guidelines and experiences, but they may not be feasible in a new situation. Therefore, learning outcomes that may be useful for unknown future conditions have to be replaced by more generic competence objectives aimed at developing skills to cope with the unforeseen.

For exercises on unpredictable situations and response challenges that cannot be completely solved, one should plan the exercise based on known or hypothetical scenarios. Choosing a scenario is another important step in didactical planning. Rolfe et al. (1998) claimed that a scenario should be realistic enough to provide settings that participants can recognize and connect to their experience, knowledge or their usual functions and get to experience what could have happened at an actual event. Partly realistic scenarios may give the actors an incorrect perception of their ability to deal with incidents and crises. In designing a scenario, all details are necessary to create realism for the participants, even during a discussion-based tabletop exercise.

Practicing a worst-case scenario may be a good way of imagining a situation of high complexity that requires collaboration. In complex scenarios, it is important to encourage and facilitate a clearly stated collaborative purpose (Andersson et al., 2014). It is essential to engage learners by providing a motivating, challenging environment that becomes meaningful to the chosen scenario and the real work tasks afterward (Lukosch et al., 2012). A worst-case scenario may provide the experiential means by which to train people in an environment that is as realistic as possible for an as-yet-unknown crisis (Borodzicz & Van Haperen, 2002). Understanding the situation, making decisions in complexity and utilizing the competencies and capacities of other organizations are all dependent on certain competencies and skills. A harmonious collaboration is crucial for emergency response performance in high-complexity events and an important skill to gain through exercises to prepare for future events.

3 | METHOD

3.1 | Design

This study used a concurrent explanatory mixed-method design. The study comprised two steps: (1) observing the participants in the three tabletop exercises and (2) routinely collecting quantitative and qualitative data through questionnaires to evaluate the effectiveness of the tabletop exercises. This research design approach was chosen to offer explanations and reflections on the tabletop exercise as a learning method in a detailed manner (Brunero et al., 2021). The advantage of the concurrent research strategy is method triangulation, which is used to combine qualitative and quantitative data, thereby improving validity and reliability (Creswell & Clark, 2017). The weakness of the method is that the effectiveness of the changes among the three exercises was not captured by this mainly qualitative study. The dependency of the intervening variables in exercise design that influenced the group learning processes may be tested in a quantitative study. However, the current study dealt with this challenge by studying the three data samples in both steps consequently, which provided an opportunity to investigate the implemented strategies of exercise design in the observed exercises for interagency collaboration in complexity and make general conclusions on their effectiveness.

The qualitative data were collected to explain in depth the effectiveness of the group learning processes, namely, interpreting and integrating. The quantitative data were collected to confirm the effectiveness of the exercises and reach the exercise objective of mutual understanding and knowledge-of-the-scenario problem. Participants can rate the perceived learning and effectiveness of the exercise design. The different intervening variables include the participants' backgrounds, varied expertise in the given scenario, group and cohort structures, exercise objectives, scenario complexity and realism.

The tabletop exercise is one of a variety of exercise forms within emergency management training. It is a traditional tool for conducting collaborative competence development efforts, where the focus is based on dialogue and discussion. Tabletop exercises address the need for the coordinated responses of multiple agencies (High et al., 2010). The team (players) sits around a table (or in digital breakout rooms) and discusses the handling of an imaginary scenario. The participants present solutions and share knowledge through discussion and dialogue. New issues may be continuously presented to maintain the event's progress. This type of exercise is widely used at strategic, operational and tactical emergency management levels to discuss collaboration practices between different organizations. Tena-Chollet et al. (2017) claimed that advantage of tabletop exercises is soliciting cooperation skills in a stress-free environment. The advantage of choosing the tabletop exercise type for this study is the possibility of focusing on group learning processes. Through dialogue and discussion, the group can develop interpretations of newly shared understandings. This shared meaning can be learned and adjusted toward the needs and skills of the participants, causing integration processes. The observation and data for the study were collected in Norway. The benefit of this choice lies in the urgency and realism of the scenarios. The exercise in another country can be different at the on-scene detailed level of resources and locations. The study omitted this disadvantage by focusing on the operational and strategic levels, where participants discuss the challenges of the collaboration of two systems and the possible ways to respond effectively.

3.2 | Tabletop exercises and setting

Three tabletop exercises called 'nuclear exercises' related to radiological-nuclear SAR were carried out in 2019, 2020 and 2021 at Nord University. In 2020, the exercise was run digitally using Zoom. The purpose of the exercises was to give the participants a

better understanding of the Norwegian nuclear preparedness organization and discuss the roles, responsibilities and interactions of various agencies in the acute handling of a nuclear incident. The exercise design was developed by Nord University, Centre for Crisis Management and Collaboration (NORDLAB) in cooperation with Norwegian Radiation and Nuclear Safety Authority and Joint Rescue Coordination Centre Norway.

The intended learning outcomes setting the design and structure of the discussions in the exercise were, among others, that (1) the participants shall gain knowledge about the roles and organization of the emergency preparedness system for maritime SAR in a radiological/nuclear emergency at the central, regional and local levels and (2) the participants shall gain insight into the division of the roles and responsibilities between the nuclear preparedness organization and the actors involved in the SAR.

The starting point of the scenario was a Russian nuclear-powered icebreaker, NS EXERCISE, that was on route from Murmansk to the Gulf of Finland. It followed the established traffic separation zones along the coast of Northern Norway. At 1300 CET, a mayday was transmitted from NS EXERCISE with the following content.

'We are in position 68°50′11.9″ N 11°46′03.4″ E. We are a nuclear-powered icebreaker, 152 m in length, 20,000-tons displacement, and 120 crew. We are currently fighting a fire and have two severely injured crew with life-threatening injuries. We are in danger of losing all power'.

At 1700 CET, the NS EXERCISE communicated to the Joint Rescue Coordination Centre Norway that the fire had severely damaged multiple systems onboard, including those of the nuclear reactor. At 1900 CET, NS EXERCISE reported to the Joint Rescue Coordination Centre Norway: 'We are loosing coolant in the nuclear reactor. This has resulted in damage to the reactor's core fuel elements. We are unable to stop the release of fission products into the environment. We have an additional critical casualty who is contaminated. He must be evacuated immediately'.

The scenario was developed based on the RADEX 2019 international exercise, which described a worst-case scenario with a reactor accident onboard a nuclear-powered icebreaker that allowed for a discussion of responding to an SAR operation in a radiologically hazardous environment and some of the most significant aspects of nuclear emergency response in an Arctic environment (EPPR Emergency Prevention Preparedness and Response Working Group of Arctic Council, 2019).

To achieve a credible and realistic worst-case scenario for the tabletop exercise at the Centre for Crisis Management and Collaboration at Nord University (NORDLAB), knowledge of SMCs and experts from the Norwegian Authority for Nuclear and Safety Preparedness was used. The planning of the tabletop exercises is time-consuming. Creating a credible and realistic scenario with an uncertain outcome, creating a storyboard and designing various information and learning methods are challenging tasks.

The logistics of several parties cooperating were comprehensive. The participants received background materials and introduction lectures before the exercise. All participants were divided into groups to discuss the situation from the perspective of the most important organizations involved in the incident response. The groups were designated in advance, with mixed backgrounds in each group. All participants received their roles in advance and prepared to discuss a particular role. After a series of discussions, all students shared their viewpoints with each other and discussed their roles.

In the plenary, the participants provided a more detailed description of their perception of their own role in the incident. The groups presented their limitations and opportunities in relation to their own area of responsibility and authority in a radiological-nuclear SAR incident. Furthermore, they talked about their scope of application and how to perform the tasks in a radiological-nuclear SAR event.

3.3 | Participants

The exercises were conducted for master's degree students at a practice-based programme in preparedness and emergency management at Nord University. The number of participants was 36 in 2019, 56 in 2020 and 33 in 2021. The diversity of the students' backgrounds and employment over 3 years is illustrated in Figure 1. Approximately half of the participants had experience or prior training in radiological-nuclear SAR.

3.4 | Data collection

The participant observation lasted for 4 h per exercise, for a total of 12 h. Observation notes were taken by the exercise planners and discussed with mentors from the rescue service and radiation safety authorities who participated in the exercises. The notes were anonymized and transferred into MS Excel for further analysis.

A questionnaire was administered to each cohort. The participants were asked to rate their perceived improvement in understanding the roles and responsibilities of the emergency preparedness system in cases of maritime SAR during radiological nuclear

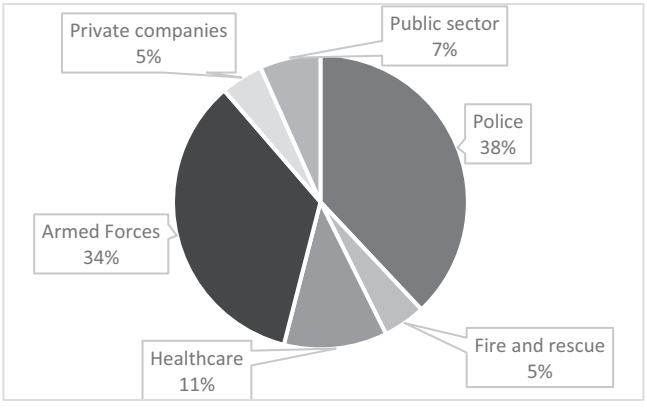

FIGURE 1 Participants' backgrounds.

emergencies, particularly in connection to collaborative action and their own background and practice. The participants were also asked to reflect on how the discussion of the roles and responsibilities contributes to the understanding of collaboration and complexity within radiological-nuclear SAR emergency management and how this type of exercise contributes to collaboration competence development. The answers were anonymized and transferred into MS Excel for further analysis.

3.5 | Quality of data and ethical issues

The reliability of the data, which is how accurately the data collection has been carried out, was assured on the basis of three exercises over 3 years with different participants and different backgrounds. The validity of data analysis and the interpretation of results were assured by connecting several exercise planners and mentors over several years. The observation notes were reviewed with mentors to validate the observation data.

Most of the quantitative questions in the questionnaire had four answer options. The answer options ranged from 'No' to 'To a small extent/uncertain', 'To a degree' and the highest score, which was 'Absolute'. It was important that none of the other answer options were crossed out. As Johannessen et al. (2011) pointed out, if the answer options are not included where applicable, there is a risk that the questions will remain unanswered without knowing the reason. Therefore, these evaluation questions were obligatory, and all participants answered all the questions.

The advantage of studying these participants is that they are professionals who work with emergency preparedness and response on a daily basis, including interagency emergency response and collaboration. Possible research ethical issues can arise when participants reflect on their own practice; however, no answers wherein organizations or persons are identifiable have been stored. The method preserved the privacy and anonymity of the participants and their answers during the data analysis. The participants gave informed consent to provide their answers for research purposes. They were also notified about confidentiality and which persons to contact if they had questions or wished to withdraw their consent.

3.6 | Data analysis

Creating meaning and making sense of the data are the main purposes of qualitative data analysis (Miles & Huberman, 1994). The literature review preidentified the main categories (i.e., collaboration and complexity) for the analysis of the observation notes and questionnaires. Both researchers read through the transcribed data files to obtain the overall perception impression of the main categories which are collaboration and complexity, and decide on the codes for the content analysis of the factors of an exercise design that led to learning about this category. 'Coding and categorization of the data material are core activities in the qualitative analysis process' (Nilssen, 2014, p. 78).

As illustrated in Figure 2, to analyse knowledge acquisition in complexity, we used two elements, namely, involved organizations and management levels. To analyse the skills for collaboration, two crucial codes were chosen for this analysis, namely, understanding the roles and responsibilities and knowledge of the resource capacities and limitations.

The coding process was conducted by two persons to make sure all the data were included. It was carried out in two phases. First, both files with participants' feedback and observation were analysed in connection to the following codes: 1.1 Collaboration-Roles; 1.2 Collaboration-Resources; 2.1 Complexity-Actors and 2.2 Complexity-Levels. In the second phase, there were assigned attributes on whether an element was present or lacking in the exercise design. This provides practical implications for developing exercises.

The process continued with the next steps of the qualitative analysis: condensation around the codes and summary (Johannessen et al., 2011, p. 195). The text was structured in MS Excel, and the summary of the results was written by both authors.

4 | RESULTS

4.1 | Complexity—organizations and levels

Positive feedback was received from all participants on the appropriate complexity and realism of the scenario. The introduction of the scenario and the timeline of every additional event that

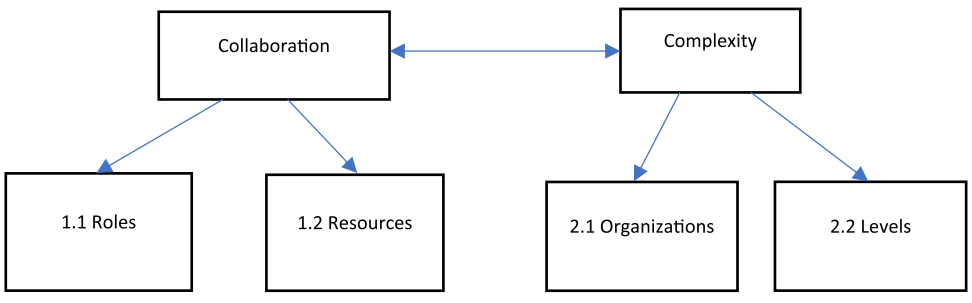

FIGURE 2 Categories and codes.

developed was accurate, with all the details that are necessary to simulate a realistic incident, along with relevant discussions.

The questionnaire results showed perceptions of own learning about complexity when it comes to actor interdependencies and division of functions. The majority of the participants (61.7%) answered that they learned more about the division of roles and responsibilities between the maritime SAR system and nuclear preparedness. A few of the participants (26.9%) considered themselves to have learned something about the division of responsibilities.

The participants' feedback and observation notes contained several points with regard to complexity. At first, it was important to focus on the central sectors and organizations involved in the incident response. The feedback included both elements that were present and lacking in the exercise. One participant expressed an opinion on the organizations involved and their interdependencies:

> 'It is interesting to see how complex such an event is. This will involve different actors at the central, regional, and local levels. I have learned about the range of tasks that arise when a nuclear event occurs. I think it is relevant to know the division of responsibility between the Joint Rescue Coordination Center and the Crisis Committee in an incident involving nuclear emissions'.

A radiological-nuclear SAR incident will include several actors in the initiating phase, where knowledge of their own organization, as well as organizing other involved stakeholders, is crucial. The decision made at the beginning of a complex incident will have both short- and long-term consequences. One of the respondents reflected:

> 'I think the most important moment in a tabletop exercise is to understand what the other agencies are doing in a given situation'.

In a complex emergency response situation, when many organizations are involved, the focus is often on the primary systems that are in charge of coordinating the response.

> 'This gives an increased understanding of the complexity of the rescue service, especially during nuclear deterrence. It gives an increased understanding of all the actors' tasks'.

However, there was a comment from one participant that stated a desire to understand how other emergency dispatch centres and services are involved in the situation:

> 'Two systems were the main focus today. I wish I could have learned something about how police, health, and civil defense are involved in supporting the radiological nuclear situation at sea'.

The observation notes included the focus of the exercise to provide a good insight into how large and broadly interacting an atomic event is.

Second, some comments highlighted the importance of focusing on the hierarchical management levels. The same was observed from the mentors' feedback. The published guidelines and state documents focused on the two systems involved at the local, regional and central levels, but the management levels were not explicitly discussed. One participant expressed in his/her feedback:

> 'In addition to central and local, we can go systematically from the top to on-scene—from strategic to tactical levels—at each organization'.

When it comes to learning prerequisites, the participants connected understanding of the complexity in a given situation with their own backgrounds:

> 'In relation to my practice, it is very relevant to get a better insight into the complexity, especially with regard to the actors who participate in a collaborative nuclear incident. Having the knowledge that actors are represented in different committees and councils with different representatives is good to know when I am the strategic manager of Emergency Medicine Communication Central, which is an operational level within the health sector'.

Moreover, a connection was made to their experiences:

> 'Having the opportunity to discuss with other students who have much more experience and/or other expertise means one acquires even more knowledge. This way, both get more out of the curriculum and can relate events to the curriculum'.

At the same time, the feedback highlighted the importance of preparing for the session and the relevant overview in the background materials. This may present a challenge for some groups in which the participants did not read the background material before the exercise. Such may cause a deficiency in the group dynamics and inadequacy or absence of discussion.

4.2 | Collaboration—Roles and resources

In our scenario, there were several different roles and responsibilities that the participants had to deal with during the radiological-nuclear SAR incident. The results from the questionnaires showed perceptions of own learning about the roles and responsibilities of the actors involved in the collaborative exercise. The majority of the participants (67.4%) answered that they absolutely learned more about the roles of the involved organizations and the organization of

maritime SAR and nuclear preparedness as a whole. A few of the personnel (25.8%) considered themselves to have learned something about the roles and organization.

Almost 41.1% of the participants gained increased knowledge of the capacities and limitations of some key agencies, actors and rescue services in the event of a nuclear incident. About 35.4% of the participants considered themselves to have learned something about their capacities and limitations.

The participants claimed that a discussion of the roles and responsibilities is an essential part of understanding the collaboration. As one respondent reflected:

> 'Roles and responsibilities are an essential part of the understanding of collaboration. In my opinion, it is a very complex system. There are several actors with different plans and competence bases. Through a discussion of the roles and responsibilities, one increases his/her understanding of how these actors should work together, who should do what, and who should not do certain things, with the intention of not getting in each other's way'.

The participants also expressed that more harmonious cooperation is largely about better role and responsibility understanding, as well as knowing each other's resources and speaking the same language.

For the learning prerequisites, dividing participants into groups with various backgrounds had a positive effect. One of the respondents answered:

> 'This is really a good way to learn. You will be involved, and the contributions from different experience backgrounds are very useful'.

Another comment on the diversity of the backgrounds added usefulness of learning based on a not-experienced scenario:

> 'I'm employed in the police force, and I've worked a lot with the task force leader. With this, I have been highly involved in the management of rescue services but have never participated or seen the bigger and whole picture'.

It may be challenging for a group to discuss the roles and responsibilities from a collaborative perspective if no one in the group has relevant emergency preparedness experience.

This learning element was lacking in one group. The participants found it challenging to be in a group where no one had a background from the relevant work areas or relevant emergency preparedness experience.

Some points also connected the increased understanding of roles in a complex field. Several respondents mentioned that such a discussion might contribute to a better understanding of higher complexity. Moreover, by placing other actors structurally in relation to each other, one can achieve a better collaboration understanding.

5 | DISCUSSION

5.1 | Skills for collaboration

The skills and competencies that may be useful in a collaboration process during emergency response are comprehensive and should encompass the capacity to develop new skills for dealing with the unexpected. The study results highlighted that the conducted tabletop exercise is suitable for gaining insight into some competencies that are useful for collaborative emergency management (Tena-Chollet et al., 2017). We observed good reflections and reasoning from the actors about their roles and responsibilities in a radiological-nuclear SAR incident. The participants showed great interest and commitment to acquiring knowledge about each other's roles and areas of responsibility in the collaborative incident.

The results of the study confirmed that a mutual understanding of the roles, organization and division of responsibilities is necessary for an operation with high complexity. In line with the discussions of Kapucu et al. (2010), mutual understanding and transfer of information provide the partners with an understanding of how they can use their resources jointly. In the radiological-nuclear SAR incident setting, understanding of the decisions made by the radiation authorities is crucial for the rescue controllers and their operational resources.

Learning about the resource capacities and their limitations somehow contributes to diminishing the uncertain cues–outcomes relationships (Steigenberger et al., 2017) and increasing the collective improvisation capacity (Mendonça & Wallace, 2004). In particular, our analysis confirmed the importance of an overview of the capacities and responsibilities and highlighted that knowledge of resource limitations might contribute to collaborative competencies. This may be explained by the fact that knowledge of the number of resources and details may be insufficient in complex, fast-changing situations. Collaborative principles should ensure interorganizational formal coordination mechanisms, such as liaising and organizational representatives in crisis committees, to increase collective improvisation capacity and flexibility. This may contribute to preparing for interaction and behaviour in changing and unpredictable social realities.

When the actors have basic knowledge of and insight into each other's roles and areas of responsibility, they have better conditions for practicing communication, information exchange, common situational awareness and decision-making in a complex radiological-nuclear SAR incident. In relation to the study of Comfort (2007), gaining mutual cognition is a prerequisite for shared situational awareness. In the setting of two collaborating systems, in particular, the situation may be assessed differently based on the different expertise that each system brings in. Mutual trust for the recognition of risk level is an important skill for collaboration between experts from the maritime SAR and nuclear preparedness systems.

Moreover, mutual cognition may be a prerequisite for understanding of the roles and responsibilities of the other team members. Gaining a better understanding of the different roles the organizations should fulfill while interacting with each other may help align role expectations between actors. In line with the managerial role theory of Mintzberg (1977), role defining is an important aspect of the radiological-nuclear SAR event. Everything starts with individual participants' understanding of the tasks. This may provide good collaboration and reduce ambiguities with regard to the many different roles that an individual actor has to deal with. In line with this perspective, important competencies should be aimed at knowledge and understanding of the formal structure in a stable situation. The collaboration will then become smoother by relying on initial knowledge.

A perspective discussed by Kapucu and Hu (2014) may also explain the importance of the formation of institutional networks for collaboration processes. In the case of radiological-nuclear SAR, formal emergent institutional organizations comprise interagency teams that should initiate collaboration. A clear understanding of the distribution of responsibilities in a complex incident is a prerequisite for obtaining efficient interaction between actors.

5.2 | Preparing for complexity

Maritime nuclear safety preparedness is characterized by complexity, especially due to the multiple organizations and at least two emergency preparedness systems involved, namely, maritime SAR and nuclear preparedness. The organizational complexity perspective described by Czarniawska (2004) highlighted the involvement of a large number of interdependent authorities and levels. The analysis results may explain why the presence of discussion elements of the involved organizations is important. Once the organizations are structured as being at the central, regional and local levels, dividing these into management levels may situate the interdependencies into other levels of complexity. Thus, another discussion on adequate coordination and control mechanisms acknowledged by the literature as crucial to achieving an effective agency interplay may be useful (Bigley & Roberts, 2001). The initial mechanism for such interplay is system resetting. The interdependences of the actors are demonstrated by the complexity of the levels within these actors to be connected to each other.

Weick and Sutcliffe (2011) explained further that complexity is present in high-risk environments, as complex operations in such settings often do not go as planned. The division of the responsibility for the mission between SAR and radiological authorities may be explained by an organizing principle for the difference in expertise. Therefore, the discussion element in an emergency exercise should seek to explain the principle, together with learning about the flexibility of control and sensitivity to operations. In volatile environments, the coordination of emergency response may be hampered by a hierarchical division of responsibilities for prompt decision processes, where flexible structures, on-the-spot decision-making and informal coordination are needed (Faraj & Xiao, 2006). There is a lack of hands-on experience in dealing with SAR during radiological or nuclear emergencies and a rapidly changing unpredicted situation. This requires the involved authorities and responding personnel to rely on each other's expertise and professional judgements. Exercising may compensate for the limited opportunities available for acquiring actual experience (Paton & Jackson, 2002).

The lack of capacities within relevant authorities or countries may often cause higher dependency on international assistance and coordination of each other's resources and actions. In general, coordination may be preprogrammed in the form of standard operating procedures, mechanisms or rules. As Okhuysen and Bechky (2009) discussed, standard operating procedures may raise the effectiveness of the response in stable situations by saving time and streamlining actions. The participants demanded overviews of organizational systems, as well as action patterns, presented in a timeline of a possible situation. However, in the case of radiological-nuclear SAR, the exercises showed a lack of established formalized mechanisms. In rapidly changing situations and volatile and complex environments, coordination is less dependent on design than on ongoing work activities that emerge in response to imminent coordination challenges (Bouty et al., 2012). In an upscaling phase, it is difficult to predict which organizations will engage in the response operation and what tasks, people and expertise are needed at different times. In an exercise, it is important to learn about the boundaries of new emerging teams or institutions.

A harsh environment may hamper the conduct of an SAR operation. The operational conditions for radiological-nuclear SAR in a cold Arctic climate may be unpredictable. This adds an example to a discussion of 'cold disasters' (Dahlberg, 2015; Lauta et al., 2018), which connects judgements of resource capacities to the understanding of how consequences in this context may evolve. If a nuclear accident occurs, the consequences can be very serious, depending on where the accident occurs, the type and amount of radioactive substances involved, how emissions are transported and the ability of organizations and authorities to handle and take action. This calls for shared knowledge and experiences on the operational conditions in the Arctic and the lessons learned in managing complexity in prior accidents and exercises.

Crisis management exercises in complexity require focusing on competencies to successfully operate in an environment with scarce resources and infrastructure, multiple actors and interdependencies and uncertainties in situational awareness. The more complex the events become and the higher the degree of inexperience, the more dependent the actors become on interacting and relying on each other.

5.3 | Planning tabletop exercises and group learning

When it comes to conducting collaborative exercises, thorough work with didactical planning should be carried out in the planning, implementation and evaluation phases. The purpose of collaborative exercises for participants is to receive learning outcomes in a collaborative setting.

As Paton et al. (1999) explained, emergency management exercises provide experience for participants in defining the roles for dealing with high-pressure situations. When professionals with mixed backgrounds participate in a tabletop exercise, their learning is connected to their personal experience and to the interpretations of the other participants in the group. The positive effect perceived by the participants in dividing them into groups of mixed backgrounds on the exercise effectiveness may be explained by the fact that discussions in groups help the process of interpretation (Crossan et al., 1999; Nyborg, 1985). The existing knowledge of the training audience, their positions in organizations and their professional interests may lead to different interpretations of the situation and possible response action. In addition, the intervening variable of the varied levels of expertise in the given scenario showed the importance of mixing participants to contribute to learning in a group. Collaboration emergency management tabletop exercises constitute an arena where the participants may socialize and learn from other professionals who may interpret the given situation in a different way based on their existing experiences or interests. A collaborative understanding at the individual level will also foster competence in the organization and contribute to a higher understanding of the complexity related to a radiological-nuclear SAR incident.

The exercise participants as adult learners brought their understanding further into meaningful reflection connected to their personal practice (Dewey, 1938; Thomas, 2018). Group learning may then be explained by the process of integrating (Crossan et al., 1999). This learning process raises the participants' curiosity and desire to acquire richer experiences in the future, in practice or through other exercises. Thus, exercises may uncover the potential for improvements and develop people's capacity to respond to new and unpredictable situations. The process is essential for the acquisition of knowledge and skills that may be useful for those who will be called upon to respond to another disaster of high complexity.

Several prerequisites in the exercise design make an exercise suitable for good learning (Wilson, 2000). Starting from defining the learning objective, this study confirmed the importance of formulating general competence objectives, such as obtaining a better understanding of the two systems working together rather than testing the knowledge of the existing procedures. This is in line with the ideas expressed by Torgersen and Sæverot (2016). Choosing competence objectives to develop skills dealing with the unforeseen may apply to collaboration learning in tabletop exercises. The participants acknowledge that all the actors get an equal understanding of each other's tasks, area of responsibility and scope in a collaborative event, as well as clarify ambiguities about an individual actor in complex settings. Therefore, understanding the organizational role in an operation may be a suitable objective for a collaboration exercise with high complexity. Appropriate solutions or ways of handling the situations will not emerge immediately, but a better understanding and mastery will be achieved after training through reflection and discussion.

The effectiveness of the tabletop exercises was acknowledged by the participants by perceiving the scenario as both complex and realistic. In line with the discussions of Rolfe et al. (1998) and Borodzicz and Van Haperen (2002), the radiological-nuclear SAR scenario was built in a way that required coordinated responses from several organizations. A worst-case scenario may be a tool for challenging the experienced participants to acquire new skills in collaboration.

Through a thorough discussion, mutual interpretations and individual knowledge integration, the actors gained good insights into their own roles in a complex incident and, most importantly, an understanding of others' roles and responsibilities. As Andersson et al. (2013) explained, it is important to encourage and facilitate collaboration behaviour in complex scenarios, as this motivates the participants and fosters good engagement in the scenario. According to the perspectives on engagement and motivation (Lukosch et al., 2012), this may lead to good learning outcomes for the learners and improvement in their real work tasks.

6 | CONCLUSION

Many of the recent incidents and crises are characterized as complex, thus raising the demand to discuss how exercises may enhance the capacity to cope with unknown tasks and prepare for collaboration with unfamiliar teams. This study addressed the question of how an exercise in emergency management can be designed to enhance knowledge and skills for collaboration in complexity. The contribution of the study is in providing reflections on skills and knowledge of the participants that can be enhanced by tabletop exercises for more effective future collaborations during emergency response and in dealing with complexity. The study outlined also some collaborative elements of exercise design that are recommended for facilitating group learning processes.

First, the study postulates the important skills for collaboration, namely, mutual understanding of roles, formation of interagency teams and division of responsibilities. Through tabletop exercises, participants may gain a greater understanding of their own and others' roles and areas of responsibility in the scenario. Other important skills include mutual recognition and awareness of risks and risk assessments. Learning about resource capacities and their limitations also contributes to more effective collaboration processes.

When it comes to knowledge that may help prepare the participants to deal with emergency management complexity, it is important to obtain an understanding of the boundaries of the new emerging teams and organizing principles for system resetting. In the case of multiteam collaboration, this knowledge may help understand the interdependencies between authorities and levels. Operative volatility also demands skills for collaboration in complexity. Emergency responders are highly skilled within their own professional fields but have limited capacity, a professional environment, and expertise to solve the incident themselves when a larger or 'colder' incident occurs. Training and exercising may be the key to enhancing the participants' ability to work with each other in real-life situations, especially in the Arctic.

Second, the study presents important recommendations for planning an exercise design to capture the abovementioned

competencies. The design of collaboration exercises for working professionals should adopt pedagogical approaches that help group learning processes. By planning the discussion in groups of mixed professional backgrounds, one can facilitate interpretative learning. By individual reflection on own practice and possible future collaborations, one can stimulate the integrative learning.

To facilitate collaboration within emergency response exercises, there is a need to plan for learning outcomes and methods that capture various skills and competencies to deal with complex situations. One way is to look back and learn from the mistakes committed in previous crises and unwanted events. Another way to promote collaborative practices is to include participants who will actually handle complex situations in real incidents and go through possible worst-case but realistic scenarios. Exercising challenging scenarios may compensate for limited actual experience. To achieve realistic exercises in which several actors can participate, thorough work must be carried out to credibly design and plan the exercise form, identify the participant prerequisites for learning, as well as the scenario and evaluation which should mirror these items.

Emergency management tabletop exercises are an efficient tool for participants to learn how to solve unknown tasks in collaboration with others. This study shows that a more generic competence objective, such as understanding the organizational role in an operation of high complexity, is efficient while exercising a complex scenario.

Future research may be studies of quantitative research design investigating the dependent variables of the effectiveness of the different exercise designs and the value of the experiential learning. It will be interesting for other qualitative approaches to focus on different aspects of exercise design planning and innovative approaches to facilitate interagency teams learning, roles' expectations and risk perception during collaborative emergency response.

ACKNOWLEDGEMENTS

This work was supported by the Research Council of Norway, project ATOMEX: Collaboration Complexity in Nuclear Emergency Preparedness in the Maritime Arctic, grant No.: 336285. We wish to acknowledge support of the Norwegian Radiation and Nuclear Safety Authority and the Joint Rescue Coordination Centre Norway. We are thankful to students at master programme in Preparedness and Emergency Management at Nord University for giving consent to participate in our research study.

DATA AVAILABILITY STATEMENT

The participants of this study did not give written consent for their data to be shared publicly, so considering that the qualitative surveys and observation field notes contain information that could compromise the privacy of research participants, the research supporting data is not available.

ORCID

Rune Elvegård http://orcid.org/0000-0003-2934-0482
Natalia Andreassen http://orcid.org/0000-0002-1068-1589

REFERENCES

Abdeen, F. N., Fernando, T., Kulatunga, U., Hettige, S., & Ranasinghe, K. D. A. (2021). Challenges in multi-agency collaboration in disaster management: A Sri Lankan perspective. *International Journal of Disaster Risk Reduction*, *62*, 102399. https://doi.org/10.1016/j.ijdrr.2021.102399

Andersson, A., Carlström, E., & Berlin, J. M. (2013). Organizing a simulated reality: On exercises with public safety organizations [Organisering Av En fingerad Verklighet: Om ovningar mellan blåljusorganisationer]. *Nordic. Organization Studies*, *15*(3), 34–64.

Andersson, A., Carlstrom, E., Ahgren, B., & Berlin, J. M. (2014). 'Managing boundaries at the accident scene—A qualitative study of collaboration exercises'. *International Journal of Emergency Services*, *3*(1), 77–94.

Andreassen, N., Borch, O. J., & Sydnes, A. K. (2020). Information sharing and emergency response coordination. *Safety Science*, *130*, 104895. https://doi.org/10.1016/j.ssci.2020.104895

Andreassen, N., & Pincus, R. (2022). Disaster definitions from an Arctic perspective. In M. Aronsson-Storrier & R. R. Dahlberg (Eds.), *Defining disaster: Disciplines and domains*. Edward Elgar Publishing.

Bardach, E. (1998). *Getting agencies to work together: The practice and theory of managerial craftsmanship*. Brookings Institution.

Bardach, E. (2001). Developmental dynamics: Interagency collaboration as an emergent phenomenon. *Journal of Public Administration Research and Theory*, *11*, 149–164.

Berlin, J. M., & Carlström, E. D. (2015). Collaboration exercises: What do they contribute? *Journal of Contingencies and Crisis Management*, *23*(1), 11–23. https://doi.org/10.1111/1468-5973.12064

Bigley, G. A., & Roberts, K. H. (2001). The incident command system: High-reliability organizing for complex and volatile task environments. *Academy of Management Journal*, *44*(6), 1281–1299.

Borodzicz, E., & Van Haperen, K. (2002). Individual and group learning in crisis simulations. *Journal of Contingencies and Crisis Management*, *10*, 139–147. https://doi.org/10.1111/1468-5973.00190

Bouty, I., Godé, C., Drucker-Godard, C., Lièvre, P., Nizet, J., & Pichault, F. (2012). Coordination practices in extreme situations. *European Management Journal*, *30*(6), 475–489. https://doi.org/10.1016/j.emj.2012.03.015

Brunero, S., Dunn, S., & Lamont, S. (2021). Development and effectiveness of tabletop exercises in preparing health practitioners in violence prevention management: A sequential explanatory mixed methods study. *Nurse Education Today*, *103*, 104976. https://doi.org/10.1016/j.nedt.2021.104976

Comfort, L. K. (2007). Crisis management in hindsight: Cognition, communication, coordination, and control. *Public Administration Review*, *67*(s1), 189–197. https://doi.org/10.1111/j.1540-6210.2007.00827.x

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research* (2nd ed.). Sage.

Crichton, M. T., & Flin, R. (2004). Identifying and training non-technical skills of nuclear emergency response teams. *Annals of Nuclear Energy*, *31*, 1317–1330.

Crossan, M. M., Lane, H. W., & White, R. E. (1999). An organizational learning framework: From intuition to institution. *The Academy of Management Review*, *24*(3), 522–537.

Czarniawska, B. (2004). On time, space, and action nets. *Organization*, *11*, 773–791.

Dahlberg, R. (2015). Resilience and complexity: Conjoining the discourses of two contested concepts. *Culture Unbound*, *7*, 541–557.

Dewey, J. (1938). *Experience and education*. Macmillan.

DSB [Norwegian Directorate for Civil Protection]. (2019). *Analysis of crisis scenarios*. https://www.dsb.no/rapporter-og-evalueringer/analyses-of-crisis-scenarios-2019/

EPPR [Emergency Prevention Preparedness and Response Working Group of Arctic Council]. (2019). RADEX 2019 table-top exercise. Final Report. https://oaarchive.arctic-council.org/handle/11374/2618

Faraj, S., & Xiao, Y. (2006). Coordination in fast-response organizations. *Management Science*, *52*(8), 1155–1169.

Flin, R. (1997). Crew resource management for teams in the offshore oil industry. *Team Performance Management*, *3*(2), 121–129.

High, E. H., Lovelace, K. A., Gansneder, B. M., Strack, R. W., Callahan, B., & Benson, P. (2010). Promoting community preparedness: Lessons learned from the implementation of a chemical disaster tabletop exercise. *Health Promotion Practice*, *11*(3), 310–319. https://doi.org/10.1177/1524839908325063

International Maritime Organization (IMO). (2013). *International aeronautical and maritime search and rescue manual* (vol. 3).

Johannessen, A., Christoffersen, L., & Tufte, P. A. (2011). (3rd Ed.) *Forskningsmetode for økonomisk-administrative fag* [Introduction to Research methods] Abstrakt Forlag.

Johannessen, S. O. (2018). Strategies, leadership and complexity in crisis and emergency operations, *Routledge advances in management and business studies*. Routledge.

Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: A failure to disagree. *American Psychologist*, *64*(6), 515–526.

Kapucu, N., Arslan, T., & Demiroz, F. (2010). Collaborative emergency management and national emergency management network. *Disaster Prevention and Management: An International Journal*, *19*(4), 452–468.

Kapucu, N., & Hu, Q. (2014). Understanding multiplexity of collaborative emergency management networks. *The American Review of Public Administration*, *46*(4), 399–417. https://doi.org/10.1177/0275074014555645

Lauta, K. C., Vendelø, M. T., Sørensen, B. R., & Dahlberg, R. (2018). Conceptualizing cold disasters: Disaster risk governance at the Arctic edge. *International Journal of Disaster Risk Reduction*, *31*, 1276–1282. https://doi.org/10.1016/j.ijdrr.2017.12.011

Lukosch, H., Ruijven, T., & Verbraeck, A. (2012). The participatory design of a simulation training game. *Proceedings of the 2012 Winter Simulation Conference* (WSC), 1–11. https://doi.org/10.1109/WSC.2012.6465218

Marchenko, N., Andreassen, N., Borch, O. J., Kuznetsova, S., Ingimundarson, V., & Jakobsen, U. (2018). Arctic shipping and risks: Emergency categories and response capacities. *International Journal on Marine Navigation and Safety of Sea Transportation*, *12*(1), 107–114.

Mendonça, D., Beroggi, G. E. G., van Gent, D., & Wallace, W. A. (2006). Designing gaming simulations for the assessment of group decision support systems in emergency response. *Safety Science*, *44*(6), 523–535. https://doi.org/10.1016/j.ssci.2005.12.006

Mendonça, D., & Wallace, W. A. (2004). Studying organizationally situated improvisation in response to extreme events. *International Journal of Mass Emergencies & Disasters*, *22*(2), 5–29.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Mintzberg, H. (1977). Policy as a field of management theory. *The Academy of Management Review*, *2*, 88–103.

Mitroff, I. I., Shrivastava, P., & Udwadia, F. E. (1987). Effective crisis management. *Academy of Management Perspectives*, *1*(4), 283–292. https://doi.org/10.5465/ame.1987.4275639

Moynihan, D. P. (2008). Combining structural forms in the search for policy tools: Incident command systems in U.S. crisis management. *Governance*, *21*, 205–229.

Musharraf, M., Khan, F., & Veitch, B. (2019). Modeling and simulation of offshore personnel during emergency situations. *Safety Science*, *111*, 144–153. https://doi.org/10.1016/j.ssci.2018.07.005

Nilssen, V. (2014). *Analyse i kvalitative studier. Den skrivende forskeren* [Analysis in qualitative studies. The writing researcher], Universitetsforlaget.

Nyborg, M. (1985). *Læringspsykologi (Learning Psychology)*. Norsk spesialpedagogisk forlag.

Okhuysen, G. A., & Bechky, B. A. (2009). 10 Coordination in organizations: An integrative perspective. *Academy of Management Annals*, *3*(1), 463–502.

Paton, D., Flin, R., & Violanti, J. (1999). Incident response and recovery management. In J. M. Violanti & D. Paton (Eds.), *Police trauma: Psychological aftermath of civilian combat* (pp. 124–138). Charles C Thomas Publisher.

Paton, D., & Jackson, D. (2002). Developing disaster management capability: An assessment centre approach. *Disaster Prevention and Management: An International Journal*, *11*(2), 115–122.

Perry, R. W. (2004). Disaster exercise outcomes for professional emergency personnel and citizen volunteers. *Journal of Contingencies and Crisis Management*, *12*(2), 64–75.

Rolfe, I., Saunders, D., & Powell, T. (1998). *Simulations and games for emergency and crisis management*. Kogan Press.

Roud, E., Gausdal, A. H., Asgary, A., & Carlström, E. (2020). Outcome of collaborative emergency exercises: Differences between full-scale and tabletop exercises. *Journal of Contingencies and Crisis Management*, *29*(2), 170–184. https://doi.org/10.1111/1468-5973.12339

Shuffler, M. L., Jiménez-Rodríguez, M., & Kramer, W. S. (2015). The science of multiteam systems: A review and future research agenda. *Small Group Research*, *46*(6), 659–699. https://doi.org/10.1177/1046496415603455

Sinclair, H., Doyle, E. E., Johnston, D. M., & Paton, D. (2012). Assessing emergency management training and exercises. *Disaster Prevention and Management: An International Journal*, *21*(4), 507–521.

Steigenberger, N., Lubcke, T., Fiala, H. M., & Riebschlager, A. (2017). *Decision modes in complex task environments*. CRC Press.

Tena-Chollet, F., Tixier, J., Dandrieux, A., & Slangen, P. (2017). Training decision-makers: Existing strategies for natural and technological crisis management and specifications of an improved simulation-based tool. *Safety Science*, *97*, 144–153. https://doi.org/10.1016/j.ssci.2016.03.025

Thomas, M. J. W. (2018). *Training and assessing non-technical skills: A practical guide*. Taylor & Francis Group.

Torgersen, G. E., & Sæverot, H. (2016). Competence levels of didactic practice for the learning of the unknown. *Arts and Social Sciences Journal*, *7*(3), 194. https://doi.org/10.4172/2151-6200.1000194

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases: Biases in judgments reveal some heuristics of thinking under uncertainty. *Science*, *185*(4157), 1124–1131.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Waugh Jr., W. L., & Streib, G. (2006). Collaboration and leadership for effective emergency management. *Public Administration Review*, *66*, 131–140. https://doi.org/10.1111/j.1540-6210.2006.00673.x

Weick, K. E., & Sutcliffe, K. M. (2011). *Managing the unexpected: Resilient performance in an age of uncertainty*. John Wiley & Sons.

Wilson, H. C. (2000). Emergency response preparedness: Small group training. Part I—training and learning styles. *Disaster Prevention and Management: An International Journal*, *9*(2), 105–116. https://doi.org/10.1108/09653560010326987

Wolbers, J., Boersma, K., & Groenewegen, P. (2017). Introducing a fragmentation perspective on coordination in crisis management. *Organization Studies*, *39*(11), 1521–1546. https://doi.org/10.1177/0170840617717095

How to cite this article: Elvegård, R., & Andreassen, N. (2024). Exercise design for interagency collaboration training: The case of maritime nuclear emergency management tabletop exercises. *Journal of Contingencies and Crisis Management*, *32*, e12517. https://doi.org/10.1111/1468-5973.12517