Situational Disabilities and Shared SA devices: Insights from Full-Scale Emergency Exercises

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ABSTRACT

This study examines how situational disabilities (SDs) act as barriers to situational awareness (SA) in multi-organisational emergency response, using empirical data from four full-scale crisis exercises (2022–2025) in Norway. Drawing on Endsley's SA framework and models of disability (medical/social/ICF), we combine observations, qualitative interviews and open-ended survey responses to explore how contextual factors, device design, and human stress interact to produce Situational Disabilities (SD) that degrade perception, comprehension, and projection. Findings show pronounced sensory SDs (auditory masking and reduced verbal communication), device-induced SDs (auto-muting of radio channels, small screens, fine-motor requirements incompatible with gloves), and cognitive SDs (information overload, attentional tunnelling, SA-level lock-in). SDs often amplify Endsley's SA "demons" by creating emergent socio-technical accessibility barriers: protective equipment, noise, extreme weather, and interface affordances frequently prevent actors from receiving or acting on critical shared information. We argue that crisis systems and Shared SA devices must be designed with situational-disability awareness, adopting universal-design principles, configurable audio/visual channels, and resilient interaction modalities, to strengthen shared situational awareness under real-world stressors.

Keywords

Situational Disabilities, Situation awareness, Shared SA devices, Full-scale exercises

INTRODUCTION

In today's society, there is pronounced optimism about technology and a belief that it can solve complex societal challenges, particularly in relation to crises and crisis management. Crises are disruptive events that can have enormous effects on society, organisations and individuals. Their complexity and scope often create a need for collaboration across established organisational boundaries. This collaboration is challenged by differing cultures and organisational goals and is described as a recurring challenge at the organisational level. (Boersma & Wolbers, 2021; Eide et al., 2013). At the technological level, access to technology that actually supports real crisis management is also frequently discussed. Lack of interoperability and the design of technology and supporting infrastructure have been addressed and problematised (Kapucu et al., 2016; Munkvold et al., 2019; Turoff et al., 2004; Waring et al., 2026). Crises are characterised by a high degree of uncertainty, particularly in the initial phases (Curnin & Owen, 2013; Quarantelli, 1998). The strain from this can challenge established structures beyond their initial capabilities. Information in this phase can be ambiguous, erroneous and incomplete. It can change (e.g. escalating severity) and requires continuous interpretation. The interaction between people and technology will therefore be coloured by this. Central to the context-related, socio-technical interaction, different actors from different organisations must make decisions and act based on what the situation requires at the time. Achieving a high degree of Situation Awareness (SA) and attempting to stay one step ahead of the crisis are recognised as common goals. This places special demands on information flow and accessibility, which in turn places special demands on the design and nature of the technology. Many studies have been done on the design for SA. A well-known approach to these problems is Endsley's user-centred design. It outlines various design criteria that must be met for the socio-technical interaction to work effectively in high-intensity scenarios. (Endsley & Jones, 2025). Furthermore, research on Universal Design has stood out as an important piece of the puzzle for making technology available under stressful conditions (Gjøsæter et al., 2019; Gjøsæter et al., 2023; Rustenberg et al., 2023). Design in line with the principles of the Ministry of Foreign Affairs is required by law and implemented to a large extent in accordance with EU regulations, but operationalisation in technology, especially used in crisis management, still has a gap.

A less described mechanism is Situational Disabilities. Disabilities and the use of technology facilitated by accessibility and Universal Design are well described in the literature, but the link between context-dependent disabilities that can arise as a result of crises is sparsely discussed and then primarily in the context of the general public, not professional responders. However, Gjøsæter, Radianti et al. (2019, 2023) also examined this topic with regards to different professional actors in crisis management, with a focus on how SD could constitute barriers to achieving SA, and in particular for the use of shared SA devices (Gjøsæter et al., 2019; Gjøsæter et al., 2023). The role of SD-induced barriers for effective operation of first responders in disasters was further researched by Nesse et al. (2025).

From this we have derived the following research question (RQ):

How do Situational Disabilities manifest as barriers to Situational Awareness in crisis exercises?

In this article, we will draw on insights we have accumulated from full-scale crisis exercises and point out a link between context, access to technology, and situational disabilities that should be recognised more fully than today.

THEORETICAL PERSPECTIVES

Situation Awareness

Situation Awareness (SA) was coined by Mica Endsley and quickly gained traction in areas such as Emergency Management in the 1990s. Endsley's core definition states that SA is:

"The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley & Jones, 2025, p. 14)

From this definition, Endsley derives SA into three levels.

- SA level 1 is perception of the elements in their environment
- SA level 2 is comprehension of their current situation
- SA level 3 is projection of their future status

This, in turn, affects the actors' decisions and actions. Endsley expands on the SA concept and describes two directions: Team SA (TSA) and Shared SA (SSA). TSA is described as *"the degree to which every team member possesses the SA required for his or her responsibilities"*, while SSA is described as *"the degree to which team members have the same SA on Shared SA requirements"*. SA in teams is further dependent on various factors that mutually affect each other. Endsley describes the four major factors that are important for developing good TSA and SSA; 1) Shared SA requirements, e.g. elements that must be shared between all team members to achieve a common understanding, 2) Shared SA devices, e.g. devices with the ability to carry SA elements, 3) Shared SA mechanisms, e.g. shared mental models, and 4) Shared SA processes, e.g. good leadership with a focus on SA and continuous work to achieve equal understanding of a problem before seeking solutions (Endsley & Jones, 2025; Salas et al., 2005). Furthermore, Endsley argues that building and maintaining SA is difficult, dynamic, and cannot be seen as a steady state. The reason for this is both features of the human information processing system and features of complex domains that interact to form what she calls SA demons (SAD). These are factors that work to undermine SA in systems and environments. Endsley points to eight SA demons:

SAD 1: Data overload, SAD 2: Attentional tunnelling, SAD 3: Requisite Memory Trap, SAD 4: WAFOS (Workload, Anxiety, Fatigue, and other stressors), SAD 5: Misplaced Salience, SAD 6: Complexity Creep, SAD 7: Errant Mental

Models and SAD 8: Out-of-the-loop syndrome (Endsley & Jones, 2025, p. 31).

In design processes, the SA demons should be identified so that they can be avoided as far as possible, and in established IS for EM demons are recognised as barriers to SA (Endsley & Jones, 2025, pp. 31–42).

Models of Disability

The traditional *medical model of disability* can be illustrated with the definition from the Convention on the Rights of Persons with Disabilities, where persons with disabilities refer to "… *those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others*" (CPRD, 2006).

The World Health Organization (WHO) has a broader scope more in line with the so-called *social model of disability* and points out that almost everyone will temporarily or permanently experience disability at some point in their life. WHO's International Classification of Functioning, Disability and Health (ICF) framework classify disabilities as body and health functions, activities, and participation, that includes environmental factors and body structure (WHO, 2001). *Environmental factors* include factors and barriers in the physical as well as electronic environment that hinders or support persons with disabilities. In addition, environmental factors can include different assistive tools and technologies used by a person to enhance their abilities and mitigate environmental barriers, ranging from wheelchairs to mobile text-to-speech software, or even common protective gear like sunglasses and umbrellas.

In short, while the medical model treats disability as an abnormality of bodily function, the social model sees it as contextual, a result of the interplay between a person and the environment. Promoted by disability movements as a corrective to the medical view, the social model highlights that individuals are empowered through removal of barriers from the environment, placing responsibility on society to remove barriers rather than on individuals to adapt (Begnum, 2020).

Situational Disabilities

Situational Disabilities are impairments or disabilities experienced by a person in a given environmental (and mental) situation that can occur to people who are not usually considered to be in the category of "person with disabilities" (Gjøsæter, 2024). The concept of Situational Disabilities first appeared as Situationally Induced Impairments and Disabilities (SIID), introduced in 2003 by Sears et al. (2003), where they propose a model consisting of the human, the environment, and the application. While impairments and disabilities sometimes are used interchangeably, Wobbrock points out that they are actually different, with impairments being features of the *body itself*, while disabilities are difficulties in *performing* a certain task (Wobbrock, 2019). For example, in a situation with cold weather, a Situational Impairment could be the inability to move fingers in an agile manner because of the cold weather, while the corresponding Situational Disability would relate the stiff fingers with the inability to use a smart phone app that requires agile finger movements, for example typing on a virtual keyboard. In this article, we focus on Situational Disabilities occurring during use of technology in crisis situations, for example for situation awareness, as previously elaborated in Gjøsæter et al. (2019), Gjøsæter et al. (2020) and Gjøsæter et al. (2023). In particular, they exemplify how different types of situational disabilities can occur in crises as well as pointing out the relationship between situational disabilities and Endsley's demons of situation awareness (Endsley & Jones, 2025, pp. 31–42). To illustrate this relationship, we can think about information overload coming from multiple sources competing for attention. A crisis situation may affect a person's cognitive abilities through stress and fear, and thereby make them more susceptible to the demons of situational awareness, and the information overload can in turn further stress the person in a vicious circle (Gjøsæter et al., 2019).

METHODOLOGY

This article uses a qualitative research design that largely relies on data collected from four full-scale crisis exercises from 2022 to 2025. The exercise was carried out in a limited geographical area in Norway. The article's first author worked from a partly insider position, drawing on prior professional experiences. This allowed the researchers to be both insider and outsider, but it must be regarded as a potential source of bias. This involves a deliberate reflexivity on part of the researchers regarding their own position and how it may have influenced the collection and interpretation of the data. Originally, we used thematic coding of collected empirical data, but through repeated reviews of the material the relationship between Shared SA devices and Situational Disabilities became clear. This led to a more abductive approach, where we revisited the observations and interpreted them in light of relevant theory.

Full Scale Exercises

Full-scale crisis exercises are a routine part of preparedness work in the Norwegian context and are intended to test, prepare, and improve multi-organisational collaboration at the system level (Steen-Tveit et al., 2024). These exercises involve both public and private actors and are integral to the national crisis management framework. Under Norwegian and European legislation, organisations are required to train and prepare for unforeseen events that demand extraordinary effort. Such events are commonly identified by assessing the relationship between likelihood or probability and potential consequences (Eriksen et al., 2021; Lunde, 2019), defining an area of preparedness, or a preparedness domain (**Figure *1***). While organisations actively prepare for risks within their defined preparedness domain, high-impact events with low probability often fall outside what any single organisation can fully mitigate or handle if realised. These events must nevertheless be addressed, typically through best-effort approaches, thereby activating the Norwegian SAMVIRKE doctrine, where coordinated inter-organisational collaboration becomes essential (Justice & Security, 2008; Aasland & Braut, 2023).

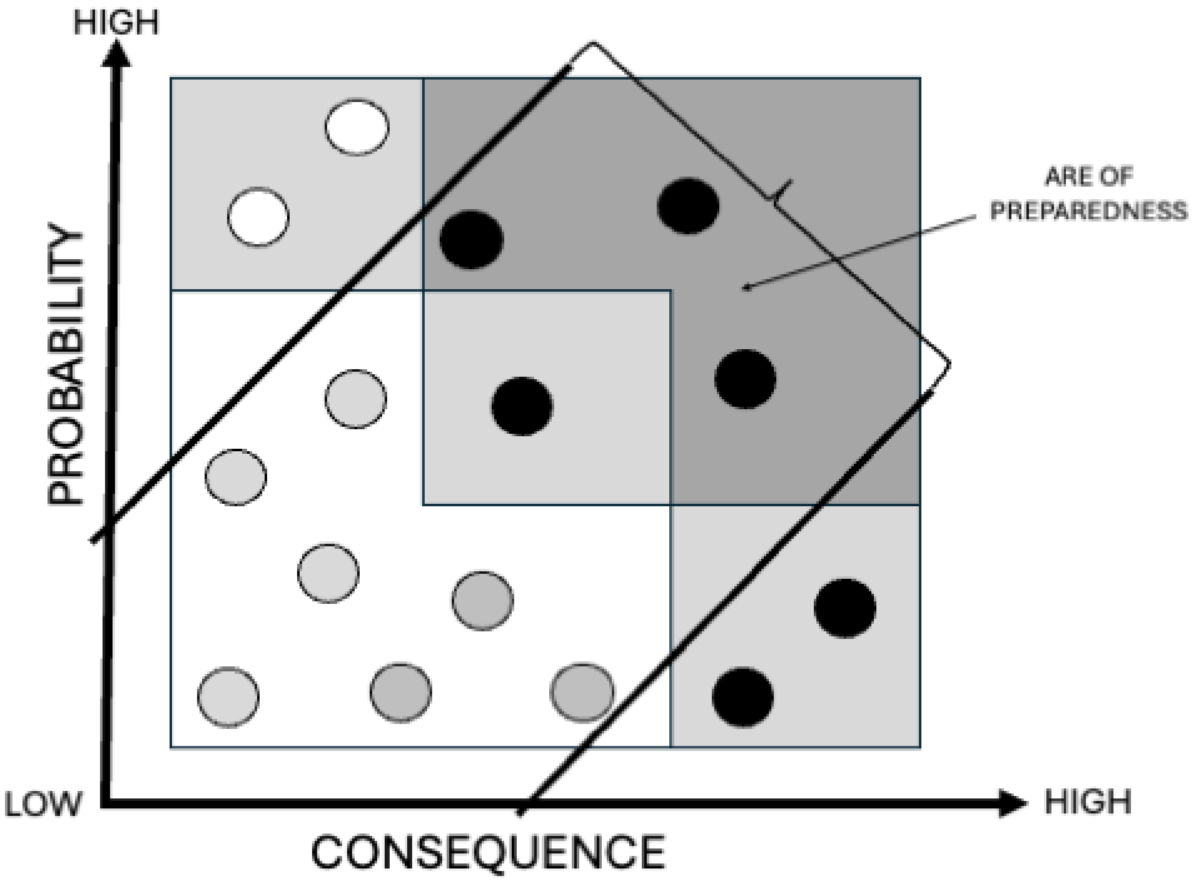

Figure 1. Area of preparedness matrix (Lunde, 2019)

In the Norwegian context, emergency preparedness exercises are typically divided into three main categories, based on complexity and execution (**Table *1***).

Table 1. Overview of exercise types

Exercise category	Characteristics	Purpose
Discussion Exercise (Tabletop)	Roundtable discussions in which participants work through the scenario presented by the facilitator.	Clarify roles, responsibilities, and decision-making paths within a preparedness plan.

Functional Exercise (Simulation)	Semi-realistic exercise where specific functions or parts of organisations (e.g. crisis management) are trained under pressure.	Practice coordination, information flow, skill sets, use of technical systems in real-time, without mobilizing personnel in the field.
Full-Scale Exercise	Comprehensive exercise, involving entire organisations in real-time with actual personnel and equipment deployed in the field.	Test coordination between different agencies (police, fire, health and private sector) in realistic environments.

The learning outcomes of full-scale exercises remain contested in the literature, with critiques addressing cost-benefit, perceived lack of realism, and exercise narratives that tend to steer scenarios towards successful outcomes. As a result, the chaos and uncertainty of real-world crises may be downplayed. These dynamics are also reflected in post-exercise evaluation reports, where reluctance to critically assess one's own actions or those of collaborating actors can overshadow genuine knowledge production.

The exercises examined in this article primarily consist of full-scale exercises, complemented by extensive preparatory phases, including tabletop exercises to clarify exercise objectives. While functional exercises were not a focus of this study, they are acknowledged as part of internal organisational preparations and follow-up activities.

DATA COLLECTION

The data discussed in this article are primarily obtained from qualitative interviews and observations from exercises and complimented by qualitative findings from open-ended questions of surveys distributed to participants in EX 2-4. Brief descriptions of the exercises are provided in **Table *2***.

Surveys

The surveys were conducted as part of the researchers' active involvement in the planning and executions of these exercises, where we took an active role in the evaluation afterwards. In the questionnaires respondents had to respond to statements using a 5-point Likert scale from 1 to 5, where 1=strongly disagree and 5=strongly agree. In addition, the survey included open-ended questions where respondents could provide their own qualitative answers. In this article only qualitative responses were used.

Table 2. Overview of exercises, participants and data collection

#	Type of exercise	Number of partici-pants(N)	Survey response (n)	Description	Data collection
EX 1	Ongoing Life-threatening Violence.	150	-	Continuous cross-organisational, collaborative exercises every Monday over a three-week period.	- Observations - Interviews
EX 2	Maritime Incident	>400	147	Maritime accident: A collision between two vessels, where one is a passenger carrier. Massive need for evacuation.	- Table-top exercise - Observations - Survey - Interviews - Evaluation - Socio-technical Network Mapping
EX 3	Wildfire on Island	>400	200	Natural hazard, wildfire: A house fire spread to the terrain on an island accessible only by boat. Massive need for evacuation.	- Observations - Survey - Evaluation

EX 4	Extreme Weather-Flooding	>400	250	Natural hazard, flooding/mudslides: Heavy rain over several weeks lead to mudslides and water problems	- Observations - Survey - Evaluation
Total	4	N>1350	n=597	-	-

Interviews

We have conducted qualitative interviews in connection with EX 1 and EX 2. The interviews have followed a structured interview guide designed to bring out the participants' experiences after the exercises, with a particular focus on interaction and information flow between the various actors. The interviews explored factors such as personal motivation, role understanding and the use of technology and standardized procedures, and how this affects the ability to handle complex situations across organizational boundaries, but we did not explicitly search for a connection between SDs and Shared SA devices. A key topic was however the mapping of technological and situational barriers to communication. Examples of relevant questions to this article`s RQ related to situational barriers and constraints are:

- Did you find that external factors prevented you from using available technology? (Noise, slamming doors, sunlight, wind, etc.)
- Was your available technology limited by external conditions? (Poor noise shielding, disturbing elements, cannot withstand water, small buttons, touch screens etc)
- Did this prevent you from receiving or providing information?

An overview of relevant respondents in this article can be found in Table 3.

Table 3. Overview of interview respondents

Res#	Organisation	Role	Interview length (min)
1	Joint Rescue Coordination Centre	Rescue leader	70
2	Joint Rescue Coordination Centre	Rescue Leader Trainee	60
3	Joint Rescue Coordination Centre	Rescue Leader Trainee	50
4	Joint Rescue Coordination Centre	Rescue Leader Trainee	50
5	Joint Rescue Coordination Centre	Rescue Leader Trainee	50
6	Police	Incident Commander	40
7	Police	Operations Leader, operations Centre	150
8	Police	Operator, Operations Centre	60
9	Police	Operator, Operations Centre	60
10	Police	*Police officer / Incident commander*	30
11	Municipality	Preparedness Manager	90
12	Municipality	Preparedness Manager	60
13	Volunteer Organisations (FORF)	Leader Volunteer Organisations	60
14	Volunteer Organisations (FORF)	Radio Specialist	60
15	Ambulance service	Paramedic/EMT	60
16	Ambulance service	Paramedic/EMT	30

PRELIMINARY FINDINGS AND DISCUSSION

From the collected material, we have several clear examples of what we would define as Situational Disabilities, e.g. that it is the contextual element that inhibits the actors' sensory apparatus to a greater extent than the inherent limitations of technology seen in isolation, and how SD interplay with SADs. The most characteristic is the purely sensory limitations related to the auditive, and with it the hearing and verbal communication between the various actors. All the exercise scenarios had elements of noisy environments and sound levels that extended beyond normal work environment sound levels. Some of these elevated sound elements were natural consequences of machines and equipment (e.g. bilge pumps or boat engines), while others came as a direct consequence of the fact that the amount of information to be handled caused increased stress and with-it natural raising of voices. We observed this especially inside operation centres under EX 1, Res 8 describes this well when she says:

"My voice doesn`t carry well. When I have a lot of noise in my ears (a lot going on at the same time), and a lot of noise in the room my voice is completely drowned out."

She says that she has to shout to the others in her team to make herself understood. In this setting the system Res 8 was using has Shared SA capabilities, but the situation creates temporary disabilities directly affecting her senses, and thus the ability to receive and send information. Further, this hampers her ability to achieve and maintain a high SA level. We recognise workload and stressors (SAD2) and complexity (SAD4) as barriers to SA in the above example, and we also observe that the SDs related to both voice and hearing provide an additional, explanatory level. Although her hearing and voice are in general fully functional, the situation requires a louder voice to cut through the noise than she is able to provide, and the noise is also making it harder to separate several simultaneous information threads. A similar mechanism is described from a police officer at the tactical level. Res 6 says that the amount of stress and the overall high noise level affect him: *"It (the contextual) does something to my hearing. So even if it is said on the emergency radio, it may have passed me by. I don't get it."* Also, here the SADs mentioned in the previous example is noticed, and not only the noise but also the stress of the situation contributes to a SD where his hearing and the ability to process what he is hearing is hampered, thus creating a barrier to SA.

The technology itself had features that created SDs. One example was a form of system-induced deafness. Some of the systems in use were designed to handle both radio traffic and telephony and had a function that meant that the sound on the connection was automatically lowered if the operator was talking on the phone. Res 3 says:

"If I'm on a phone, the sound from the radio suddenly disappears. Then I miss important information"

The intention of this feature is to mitigate SADs, e.g. SAD 1, Data Overload, but also SAD 4 (workload and stress). But at the same time the users lose the possibility of choosing what information stream to focus on.

Limitations were evident on Shared SA devices with screens. Smaller screens were used on both mobile devices and map-based systems on tablets, and on monitors used by drone operators. Processing map information and video feeds on smaller screens limits the visual overview. In addition, situational constraints such as light and precipitation were factors that hampered visual information retrieval. This created visual as well as tactile SDs.

The socio-technical interaction in these two scenarios is interesting, we see that the accessibility, or barrier to the information, cannot be seen in isolation as related only to the interface, but to the sense-robbing mechanism that the situation invites to. SD thus becomes a form of emergent property from the interaction between the technologist, the individual and the context, which in these cases can be directly spurred on to the individual's sensory apparatus.

Cognitive overloads in the form of information overload and stress were frequently observed and appear as clear barriers to both access and processing of information. This can also be spurred directly on to the individual, both in an environment inside an operations centre, and out in the field. Res. 3 from Joint Rescue Coordination Centres describes the mix of receiving both radio traffic, telephony and noise from other operators in the exchange as follows:

"It's horrible. Total overload. You can't take in everything, at least not the two (split headset, different audio-input in right and left ear) and the oral (from other operators). It's three things at once."

This cognitive overload caused operators to turn down the volume or opt out of information in certain channels (physical or selective hearing) in order to be able to interact in other channels.

Stresses from the environment were particularly applicable during high-intensity exercises, such as the EX 1 exercises, where tactical crews had to deal with screaming and strong visual impressions. Res 15 says:

"These are situations where there is a risk of seeing dead bodies and lots of blood. Screaming and howling. An absolutely terribly stressful situation. It does something to you. You get a bodily reaction with sweating and.. It's all about getting control of your breathing."

Furthermore, he describes how this affects the ability to think clearly when the impressions overwhelm the normal cognitive capacity. Information in the exercises was broadcasted in several emergency radio channels, and at times respondents needed to switch channels to receive important information and maintain a high level of SA. SD manifest, for example, when a respondent attempts to change the radio channel on his handheld device. This is a combined task in which a rotary knob on top of the radio must be turned while selections are made on a digital display with relatively small buttons. Stress reactions can cause people to become more coarse-motor, making such fine-motor tasks difficult. In this case we observed respondents who attempted to switch to the correct channel but gave up after one attempt because they had to focus on the contextual demands of the situation, thus hindering them in using the Shared SA device.

From the exercise, we also observed that various physical environmental factors affected the actors' ability to interact and operate as normal, which created SDs both related to operating the technological devices and physiologically. The different exercises took place at different times of the year, in different weather and temperature situations. These where direct reasons why technology was underused in some cases. Cold is an early example of an external factor that creates a number of SDs for the tactical respondents. An example comes from EX 2 where the scenario was a maritime event with low temperatures. Personnel who are at the tactical level must wear protective equipment in the form of survival suits and gloves to function in the environment. This is a trade-off where protection against the environment creates SDs in relation to mobility. The gloves affect the fine motor skills necessary to operate radio terminals and other communication equipment. A clear example of this challenge is the operation of map systems with touch screens for plotting on rescue vessels. Even though the observed systems had dedicated buttons and side functions, this was functionality that was difficult to access (e.g. a knob that must first be pressed and then turned to scroll through different menus), and thus barriers to good reception of information. We saw similar examples from drone operators, where the ground terminal was designed to be tough and easy to transport. Operators were from the fire department and use required operators to remove their gloves so they could perform fine-motor tasks with their fingers. (example **Figure *2***). As shown on figure 2 the ground station user interface was complex and vulnerable to SAD 6 (complexity), creating a barrier to SA. SD, manifested as cold fingers and gross motor skills introduced an additional factor that both amplified the SAD effect and constituted an independent barrier.

Another interesting finding in this regard is an incident commander who describes how a combination of noise and an enormous workload led to him being locked in the present and losing the ability to see ahead in time, and by that achieving a high SA level. Res 6 says: *"We got so busy just doing the most necessary. To handle incoming messages one by one. To be present in the moment. We didn't have time to think about the necessary two steps forward."* This indicates that the overall load locked the incident commander in SA levels 1 and 2, even though he acknowledged that SA3 was a target for working efficiently. A similar experience is reported by an operator who is constantly interrupted and has to do tasks that cause her to lose the overview. Res 7 says*: "I tried to listen to a play back of the audio (radio traffic), just to catch what had been said. But then a new phone rang and I never got to finish listening."* Here, too, we see that the large amount of information leads to a temporary cognitive limitation that locks the operator at a low SA level.

Visual impairments were observed on several occasions. The clearest example of this involves personnel who must move into hazardous areas, e.g., firefighters or divers. Breathing masks reduce the field of vision. Personal protective equipment such as helmets is also designed to protect against external hazards, including those approaching from the sides. This can restrict peripheral vision even in environments where such equipment is required but not immediately necessary.

Figure 2. Drone operator from the fire department during exercise

CONCLUSION AND FURTHER WORK

In this article we show from empirical findings how SDs are recognized, and how they amplify and interplay with SADs and both create and enhance barriers to SA in crisis situations. We argue that using SD as an explanatory intercalation gives added value for understanding how contextual, temporary disabilities, e.g. affecting sensory, cognitive and tactile accessibility to Shared SA devices must be acknowledged as a key factor for success or failure when multiple organizations need to collaborate and co-create a Shared SA through technology. We further argue that crisis systems, and in particular devices with Shared SA properties must be designed with SD awareness, adopting universal-design principles, configurable audio/visual channels, and resilient interaction modalities, to strengthen shared SA under real-world stressors. The research design used in the exercises was not originally tailored to address SDs, so our survey instruments is being adapted to capture relevant data. Further exploration of SDs in emergency exercise settings will aim to validate the added value of this perspective. To strengthen our findings, we plan to conduct lab experiments in collaboration with practitioners. These investigations will also examine the possible influence of SDs on user experience (UX) design and possible mitigation with Universal Design principles. Ultimately, future results may provide the basis for a new, validated set of design principles that align SD and SAD mitigation with established SA design principles.

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