Understanding Situational Disabilities and Situational Awareness in Disasters

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ABSTRACT

In this paper, a scenario-based approach augmented with personas typically used in universal design and interactive design domains is used to illustrate the occurrence of situational disabilities in emergency situations, and to show how environmental factors can trigger these situational disabilities. With the help of personas representing selected archetypical characteristics and roles, the scenarios are further examined to show how these situational disabilities can affect the situational awareness of different stakeholders, not only in the command and control centers, but also first responders in the field as well as affected members of the public. This approach provides a better understanding of the importance of universal design of ICT for Emergency Management, not only for people with disabilities and the elderly, but for anyone.

Keywords

Situational Disabilities, Situational Awareness, Universal Design of ICT for Emergency Management.

INTRODUCTION

Attaining situational awareness (SA) is an important part of being able to take appropriate actions in catastrophic situations. It is equally important both for individual and closely related social groups in disaster events, as well as for all emergency responders that require shared or intergroup SA (Pogrebnyakov and Maldonado 2018; Seppänen et al. 2013). SA as a concept is introduced in the human factor domain in 1990s (Endsley 1995), especially in connection with the decision making and analyzing human errors and human performance (Endsley 2015). Scholars have explored, used and develop this concept into various domains in industrial automation, pilots, air traffic control and other high-risk activities in organizations or industries. The applicability of the use of SA concept in the area of emergency management has been explored, analyzed, used and demonstrated in some studies, e.g. for gaining common operational picture (Wolbers and Boersma 2013), development of information system decision support tool (Luokkala and Virrantaus 2014), emergency responder collaboration (Seppänen et al. 2013) and social media crisis communication (Pogrebnyakov and Maldonado 2018).

The concept of the perception – all human senses should work such as seeing, listening, smelling when it comes to establishing situational awareness in emergencies. One is supposed to use comprehension and cognitive capability to be able to understand and interpret all cues gathered by human sense, and to see the possible outcomes and to take actions. People also use tools and technologies to improve the human ability to sense and interpret the environmental cues that can also include either long or short numerical and written information and require a complex process before comprehending the information.

While we are aware of the importance of SA in disasters, the World Report on Disabilities states that the prevalence of disability is 15% and is increasing due to a global increase in chronic health in overall aging population. These catastrophic events not only increase the impairment incidence in certain regions but also may exacerbate medical conditions when disability-related health needs are not attended to appropriately. In the

disasters, people often need to be self-organized before the first responders come, and the ICT tools have been used to enhance the knowledge of the current situation. In this case, significant parts of the population have some kinds of disabilities that may prevent them from accessing relevant information and understanding quickly what happens, and what to do. Here, the role of the universal design of the ICT tools is important, as discussed by Radianti et al. (2017) and Gjøsæter et al. (2018). Also in the control room, universal design can play a role in supporting situational awareness (Gjøsæter and Radianti 2018).

In general, ICT is taking a bigger role in emergency management; and in the field, smart phones are becoming increasingly important as a first responder tells in his account of lessons learned during the hurricane Harvey[1]: *Smartphones are Extremely Powerful Tools*. "You can view maps, look up data and communicate effectively, as long as you keep your phone charged and functioning". However, we have to keep in mind that when introducing smart phones, we are also introducing the risk of encountering barriers to situational awareness through situational disabilities. The obvious cure for these barriers is Universal Design.

Universal Design concerns the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. A prerequisite for Universal Design is accessibility. According to WAI/W3C, for the web, accessibility means that people with disabilities can perceive, understand, navigate, and interact with websites and tools, and that they can contribute equally without barriers (Bennett et al.2017; Gjøsæter et al. 2018). In other words, accessibility and usability for the broadest possible diversity of users.

Universal Design is said to be "Necessary for Some and Good for Everyone". This means that Universally Designed solutions that are absolutely necessary for some people, can also be very useful for others in certain situations or contexts. For example, subtitles on video is not only useful for people with a hearing impairment or an ear infection, but also for commuters watching the video on the bus with lots of traffic noise and other auditory disturbances, or in the library where they have to be quiet. In addition, people with a limited knowledge of the language spoken in the video may also benefit from the additional assistance of subtitles. These situations can be thought of as temporary or situational disabilities (SD).

In this paper we will examine how situational disabilities are particularly relevant in Emergency Management, not only for the general public but also for first responders and other stakeholders. We aim at understanding how SD affects SA in emergency situations, and based on this understanding we will argue for the importance of Universal Design of digital systems for SA in diverse contexts within Emergency Management, to mitigate the effects of SD on SA.

The SD issue is one of the unexplored areas with respect to the Universal Design of ICT for Emergency Management, and can be considered as the main contribution of this paper. While people with disabilities in emergency contexts are equally important, the potential invisibility of people experiencing SD sometimes means they do not receive the support required to cope with disaster contexts until those conditions become apparent to others. SD can occur both for the first responders and public who are affected by the disaster in general. Another contribution that is worth to mention is the use of *personas* for scenario analysis in emergencies, which would help better understanding of individual persons when it comes to disabilities and SD. Personas are imaginary characters representing user archetypes that are frequently used in research in interaction design and universal design of ICT, to illustrate how common groups of users might interact with systems (Pruitt and Grudin 2003).

This paper is organized into five sections. After this introduction, in the theoretical concepts and related work section, we introduce some important terms in this area such as disabilities, situational disabilities, and universal design. We also try to introduce briefly the concept of situational awareness, including the situational awareness barriers. Next, we present our research questions and explain briefly our method. In the analysis and discussion part, we answer our research questions and explain how disasters can trigger situational disabilities that in turn can reduce situational awareness. In the conclusion part, we summarize this paper, reveal some limitations and the future work.

THEORETICAL CONCEPTS AND RELATED WORK

Permanent, Temporary and Situational Disabilities

In this section, we will present some basic concepts used in this paper. What is disability? In 1980's disability is a personal attribute: "In the context of health experience, a disability is any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human

[1] https://www.itstactical.com/intellicom/mindset/lessons-learned-first-responder-hurricane-harvey/

being." –World Health Organization (WHO). However, today the WHO defines disability as context dependent, and no longer consider it just a health problem, but a complex interaction between features of person's body and features on the society where he or she lives, covering wider context:

- *Impairments*: a problem in a body structure;
- *Activity limitations*: a difficulty encountered by an individual in executing task or action;
- *Participation restrictions*: a problem experienced by an individual in involvement in life situations.

People are more aware on the issue of disabilities, and more efforts have been made to remove the difficulties face by people with disabilities, including social and environmental barriers, sometimes, it can occur that people are in the situation that cause auditory, cognitive, physical speech and visual impairment, which often referred to *situational disabilities*.

For example, a short-term injury or context affects the way people interact with the world around them, Likewise, when people are wearing a cast or ordering dinner in a foreign country. People's ability can change as they move through different environment. Noisy sound background can reduce someone's hearing ability. New parents often do their tasks one-handed. A strong bright light when driving a car can cause visual impairment. An overwhelming day can cause sensory overload. What's possible, safe, and appropriate is constantly changing (Shum et al. 2016). To understand these situational disabilities, temporary disabilities and permanent disabilities, we cite the Persona Spectrum that can be used to understand the inclusive design as seen in Table 1.

Table 1. The Persona spectrum with respect to permanent, temporary and situational disabilities (based on Shum et al, 2016).

	Permanent	Temporary	Situational
Touch	One arm	Arm injury	New parent with a child on the arm
See	Blind	Cataract	Distracted driver
Hear	Deaf	Ear infection	Bartender in a noisy bar
Speak	Non-verbal	Laryngitis	Heavy accent that is difficult to understand

Using this "situational disabilities" perspective, we obtain a new understanding that many people may have experienced a sort of situational disabilities. When situational disability happens, the situational awareness may reduce significantly. For instance, in a noisy crowd or due to ear infection, the announcement of the likely evacuation due to fire may not be heard. In a strong light, or driving situation, one may not be able to read or see the alert message, e.g. on the likely flash flood ahead.

Situational Awareness (SA)

SA is essential in an emergency situation, for the general public affected by the emergency as well as for first responders and decision makers. In the literature, SA developed on an individual level and on a team level to comprehend a crisis situation. In addition, there are numerous definitions of SA derived from different application areas such as military, aviation, air traffic control, large-systems operations, navy, and psychology. Consequently, SA has been defined in different ways, for example "the results of a dynamic process of perceiving and comprehending events in one's environment may change and permitting predictions as to what the outcomes will be in terms of performing one's mission. In effect, it is a development of a dynamic mental model of one's environment" (Nofi 2000). Endsley (1995) proposes a three-level model to define SA. It is referred as "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". These three SA concepts i.e. perception, comprehension and projection have been referred as Level 1, 2 and 3 SA respectively. When crisis management stakeholders and response team cooperate together in responding crisis, team SA would be equally important as the individual SA. However, the coordination would be very crucial as each team member may have a specific set of SA elements depending upon each member's responsibility in the team (Endsley, 1995).

Poor situational awareness has been considered as important factor that lead into poor team SA (Kaber and Endsley 1998; Stanton et al. 2001) such as failure to detect critical cues regarding the state of the system; or failure to interpret the meaning of information from monitoring technology. It can also occur due to misunderstanding of individual task and responsibilities, to communicate with other teams and with individual within other teams.

However, there are several factors that can affect the SA. Some of the factors that can affect SA are called *SA demons*. Eight categories of SA demons have been identified and each presents its own set of challenges to

maintaining SA (Bhatt and Güsgen 2012).

- *Attentional narrowing* - Humans are easily affected by attentional narrowing, systems need to support multitasking across multiple goals and decisions.
- *Requisite memory trap* – Humans tend to have limitation to hold short term memory and information and therefore systems should not rely on short term memory that is easily disrupted.
- *Workload, fatigue and other stressors* – Humans' capabilities decrease when having fatigue, stress and high workload. These factors all act to reduce already limited working memory and disrupt information acquisition.
- *Data overload* - The volume and rate of change of data in many systems can run faster than operators' abilities to keep up with it
- *Misplaced salience* - The overuse of prominent visual features such as bright colors and flashing lights overwhelm and misdirect operators' attention.
- *Complexity creep* – The more complex the system, the harder it is for operators to develop accurate situation comprehension and projection.
- *Errant mental models* – Humans tends to misinterpret data based on how a different part of the system works Without good mental models of how a system operates being triggered.
- *Out-of-the-loop syndrome* - Highly automated systems can leave operators with low awareness of the state of the system.

While the analysis of these situational awareness demons has helped us to understand what kinds of "disabilities" could happen to people in a stress condition, the discussions of these SA demons has been limited to those who work as operators in control rooms. Endsley (1995), e.g. has worked extensively on SA behaviors derived from very specific flight operations. While in this paper, we argue that in disaster situations, the SA is actually required for the general public (who receive lifesaving information), responders (who conduct lifesaving actions in a coordinated manner, uses various tools and technologies in the field to support the response activities), and the operators and decision makers in the command and control room (who collect information, use technologies and provide the decision supports). However, the discussion on SA of these three groups of important parties in crisis management, never fully discussed in depth, and especially their barriers to SA. We would like to portray the SA issue from the perspective of situational disabilities and eventually from the lens of the universal design.

Situational Awareness and Situational Disabilities

The Persona Spectrum shown in Table 1 have depicted that "disabilities" can also occur to everyone who is unnecessarily a part of the vulnerable groups due to specific, situational or temporary conditions. However, the effects of such situational disabilities may result in the same effects as those who are actually having disabilities. In other words, inclusiveness of crisis management should be understood in both cases: the vulnerable groups and situational disabilities as their abilities to survive disasters. Note that there are variations on the use of the term "vulnerable groups". Généreux et al. (2018) use "high risk population" to refer to "anyone who has functional limitations related to communication, housing, awareness, mobility/transportation, psychosocial factors, self-care/daily tasks, and safety/security that may put them at higher risk of negative impacts when an emergency or disaster occurs". We use the "vulnerable group" in the same meaning as the "high risk population". However, in this paper, we argue that the vulnerability goes beyond the "high risk population" only, as it can occur to anyone.

Indeed, we are aware of a recent concept of disaster resilience that has encouraged the all-of-society approach to survive disasters, i.e. by enhancing the capacity of individual, citizens and society at large to cope with, resist and respond to disaster. Généreux et al. (2018) propose a community resilience framework of the vulnerable groups, while O'Sullivan et al. (2017) use the stroke patients as a case study of a vulnerable group to derive keys for household resilience, which cover the social, physical, energy and personal characteristics as keys. Assistive devices such as lifeline personal alarms, lanyard/wristbands and mobile phones are the tool examples for reducing the individual vulnerabilities. While we acknowledge the efforts to increase disaster resilience to the household unit, even well-prepared plans can sometime fail, because of failing to understand the potential barriers when using assistive tools and the role of situational disabilities, where a person may be unable to operate the technologies that they use on a routine basis.

Previous studies have tried to explore barriers encountered by the vulnerable groups in disaster situations. For instance, Sullivan and Häkkinen (2006) argue that the historical evidence has documented significant numbers of population affected by disasters fail to take actions upon warnings of imminent disaster. People with disabilities become disaster victims due to trapped in a high-rise structure during the fire, crushed in collapsing structures during an earthquake, swept away in a tsunami or drowned in a hurricane storm surge are all examples how people

with disabilities can encounter barriers of receiving critical lifesaving information or mobility problems. Häkkinen and Sullivan (2007) analyze some assistive technologies to improve the effectiveness of the communication of warning and critical information, especially with respect to the speech-based delivery of critical information. Specifically, the authors suggest the accessible Web content and Digital Talking Books as means to convey urgent, critical messages. The authors also highlight the importance of communication that also applied for multi-lingual and multi-cultural environments which in our point of view can also be categorized as a form of situational disabilities.

On one hand, the efforts of linking the universal design with disability issue and situational awareness are evident such as in Häkkinen and Sullivan (2007) work, but the fact the "disabilities" can occur to anyone are missing in the current literature. For example, what factors that can lead into these situational disabilities, and why it is equally important to understand both vulnerable groups and situational disabilities. Would the SA demons' valid in the crisis management context, and especially when involving people with disabilities and situational disabilities? In the following, we will examine how emergency situations can cause situational disabilities which in turn can trigger SA demons.

RESEARCH QUESTIONS AND METHODS

Based on the identified issues above concerning situational awareness as it is affected by situational disabilities, we have defined the following research questions:

- RQ1: What kinds of situational disabilities will people typically experience (physically and mentally) in disaster situations?
- RQ2: How do these situational disabilities affect situational awareness in disaster situations?

We have applied a scenario-based analysis method to examine these research questions through different disaster scenarios and discuss how different categories of people can be affected by situational disabilities in these scenarios. The scenario-based analysis method is frequently used in software engineering to elicit requirements, and is here adapted for eliciting examples of SD and their effect on SA demons. We have enhanced the scenarios with simplified imaginary individuals, or *personas*. In addition to an invented name, personas will have relevant characteristics typical for an important group of users, and might also be supplied with less relevant information and a semi-realistic backstory to assist in making the scenarios more realistic. The personas were created based on literature analysis through which we have identified the main stakeholders, their activities and challenges in emergency situations.

SCENARIOS, PERSONAS AND ANALYSIS

RQ1: Situational Disabilities in Disaster Situations

To examine the occurrence of situational abilities in disaster situations, we provide some typical imaginary scenarios. These scenarios are organized from three categories in terms of stakeholders, actions and potential situational disabilities. In both scenarios, the stakeholders are represented by personas from four groups of stakeholders;

1. local members of the general public
2. non-local members of the general public,
3. first responders,
4. control room personnel.

Scenario 1: Earthquake in a city.

Earthquakes can contribute to triggering several situational disabilities, as the following imaginary scenario will illustrate.

In Reykjavik on Iceland, a strong earthquake strikes one day in late February, around 2AM in the morning.

Martin lives in a small 12th floor apartment in downtown Reykjavik. He is used to evacuating during fire drills, but this is different. He fights the panic as he awakes, puts on some warm clothes, grabs his smart phone, locks his apartment and quickly walks down the stairs among a crowd of other people, who are equally stressed and worried, and making a lot of noise. When he finally comes out of the building, he sees that some of the surrounding buildings have partly collapsed. He tries to check the news using his smartphone to find out more information

about what has happened, but although he is wearing warm clothes, his hands are still shaking from the cold combined with his high level of stress, so he has difficulty navigating the news. All the noise from the crowd and the still shaking ground is making it even harder to focus. His neighbor Alejandra is recently arrived to Iceland from Mexico to work on her PhD. In a panic, she didn't think of taking warm clothes with her as she left the apartment. Fortunately, she remembered to grab her smartphone on the way out. She is now very cold, and the noise makes it even more difficult to concentrate on finding safe shelter. There is a woman wearing a Red Cross uniform coming towards her, but she doesn't understand what she is saying. The woman is Anna. She has been a volunteer for Red Cross for several years, but this is the first big emergency she has been a part of. Although she has had a lot of training, she still feels unprepared for the challenge of finding, prioritizing and helping victims in such a disaster. Also, the emergency communication equipment is unfamiliar to her, and she is trying to remember the correct channel and how to communicate effectively. Olav works in the emergency control room communicating closely with different first responders in the field, including Anna. He is surrounded by monitors with warning messages and audible alarms. He is very stressed and overwhelmed by all the reports of collapsed buildings in his area of responsibility, and have a really hard time choosing how to distribute resources, gravely aware that his decisions can have severe consequences.

Stakeholders, actions and potential situational disabilities:

- Local member of the general public in the process of evacuating from the location of an earthquake ("Martin").
    - The person is trying to get an overview of the situation through his smartphone.
    - The person is trying to submit information about the situation to the local authorities through his smartphone.
    - Situational factors: stress, fear/panic (countered by some basic training in emergency response through earthquake drills), shaking ground, movement (running), crowds, noise.
    - Situational disability risks: hearing (noise from the crowd, collapsing buildings), dexterity (own and ground movement), cognitive (stress, panic).
    - Potential consequences: Cannot adequately use the smart phone because of SD.

- Recent immigrant in the process of evacuating from the location of an earthquake ("Alejandra").
    - The person is trying to get an overview of the situation through her smartphone.
    - The person is trying to use smartphone for translating some of the messages and information provided.
    - Situational factors: stress, fear/panic, shaking ground, movement (running), crowds, noise, lack of training in evacuation.
    - Situational disability risks: hearing (noise from the crowd, collapsing buildings), dexterity (own and ground movement), cognitive (stress, panic, language barrier).
    - Potential consequences: Cannot adequately use the smart phone because of SD. Do not understand messages and orders given, with potentially fatal consequences.

- First responder in the field during an earthquake ("Anna").
    - The person is trying help where it is most needed, and therefore needs to achieve SA through observation as well as communication equipment connecting them to the central control.
    - Situational factors: stress, crowds, noise, cognitive overload trying to prioritize victims. Ground shaking.
    - Situational disability risks: hearing (noise from victims, collapsing building), dexterity (own and ground movement), cognitive (stress).
    - Potential consequences: Cannot adequately use the mobile communication equipment because of SD. Risk of wrong decisions because of communication problems.

- Control room personnel during earthquake ("Olav").
    - The person is trying to continuously perform observation, analysis, decision-making, communicating orders.
    - Situational factors: Information overload through multiple information channels, stress from life-and-death-affecting decision making.
    - Situational disability risk: cognitive (stress).
    - Potential consequences: error in judgement caused by information overload.

Scenario 2: Fire in a multi-floor shopping mall.

Fire can contribute to triggering several situational disabilities, as the following scenario will illustrate.

Just before closing time, a fire breaks out in the "Galleriet" shopping mall in Bergen, Norway. It was caused by an accident in the kitchen of one of the ground floor snack bars. The fire alarm goes off, and evacuation begins. Bill is an American tourist on a one day visit from a cruise ship. He is a bit lost, but finds a map on the wall. To his dismay, the information is only in Norwegian. He tries using google translate to translate the text, but because of stress he gives up and rather follows the crowd to the nearest exit. Janne is on the top floor, and she is trying to use a smartphone indoor map of the mall to find the way to the nearest emergency exit. Along the way, she sees a person in a wheelchair who is unable to evacuate without assistance, and he is too heavy for her to carry. She sends a message about the trapped person to the local fire department using twitter, since the noise from the fire alarm is too loud for being able to communicate using the emergency phone number. Nils in the fire department control center is overwhelmed by all the messages about the rapid development of the fire, but sees the tweet from Janne, calls Petter the fire fighter over the emergency communication network, and Petter makes his way to the top floor and is able to help the trapped person out of the burning building.

Stakeholders, actions and potential situational disabilities:

- Local member of the general public in the process of evacuating the building ("Janne").
  - The person is trying to locate emergency exits through their smartphone indoor map.
  - The person is trying to notify the emergency responders about a person in a wheelchair trapped on the top floor by sending a tweet to the fire department through their smartphone.
  - Situational factors: stress, fear/panic (countered to some degree by regular training in building evacuation through fire drills), smoke, crowds, moving fast, noise (loud fire alarm).
  - Situational disability risks: vision (smoke in the eyes), hearing (loud alarm), dexterity (walking/running), cognitive (stress/panic).
  - Potential consequences: Cannot adequately use the smart phone because of SD.

- Tourist in the process of evacuating the building ("Bill").
  - The person is trying to use the smartphone to translate evacuation map text.
  - Situational factors: stress, fear/panic, smoke, crowds, moving fast, noise (loud fire alarm), lack of training in building evacuation.
  - Situational disability risks: vision (smoke in the eyes), hearing (loud alarm), dexterity (walking/running), cognitive (stress/panic, language barrier)
  - Potential consequences: Cannot adequately use the smart phone because of SD. Do not understand messages and orders given, with potentially fatal consequences.

- First responder in the fire ("Petter").
  - The person is trying help where it is most needed, and therefore needs to achieve SA through observation as well as communication equipment connecting them to the central control.
  - Situational factors: stress, crowds, noise, cognitive overload trying to prioritize victims. Smoke, heat.
  - Situational disability risks: vision (smoke), hearing (alarm noise), dexterity (fast movement, bulky protective equipment), cognitive (stress)
  - Potential consequences: Cannot adequately use the mobile communication equipment because of SD. Risk of wrong decisions because of communication problems.

- Command and control center's personnel during fire ("Nils").
  - The person is trying to continuously perform observation, analysis, decision-making, communicating orders
  - Situational factors: Information overload through multiple information channels, stress from life-and-death-affecting decision making.
  - Situational disability risks: cognitive (stress).
  - Potential consequences: error in judgement caused by information overload.

RQ2: How SD can Feed the Demons of SA in Disaster Situations

The following overview shows which SD will feed the different SA demons (Bhatt and Güsgen 2012). First, we adapt the Persona Spectrum from Table 1 (Microsoft, 2016) in Table 2 (for issues in the field) and Table 3 (issues in the control room) with disaster-specific situational disabilities, as well as several additional types of disabilities including cognitive and dexterity/fine-motorics. For clarity, we divide the tables into two types of disabilities; sensing and perception-related, and action-related.

Table 2. Situational Disability Triggers in the field

		Situational Disability Triggers
Perceive		
	Touch	Hot/cold/wet/protective gear leading to loss of feeling
	Vision	Dust and/or smoke
	Hearing	Noise/alarms
	Cognitive (understand, interpret)	Language barriers, information overload
Action		
	Speaking	Dust and/or smoke in the throat, language barriers
	Moving	Protective gear, crowds, panic
	Fine-motorics /dexterity	Panic/stress, protective gear
	Cognitive (plan – act)	Information overload, confusion (wrong communication channel, forgetting protocol)

Situational awareness demons encountered in the field (effects that are not among the established demons are shown in parenthesis, while the situational awareness demons are marked with bold italic):

- Touch SD: (Not detecting haptic feedback/vibration).
- Vision SD: ***Data overload***; ***Misplaced Salience***.
- Hearing SD: ***Data overload***; ***Misplaced Salience***.
- Cognitive (understanding) SD: ***Attentional narrowing***; ***Requisite memory trap***; ***Workload, fatigue and other stressors***.
- Speaking SD: (Language barrier, too much noise to be heard).
- Moving SD: (Blocked, slowed or redirected movement),
- Dexterity SD: (Barrier for access to ICT-based SA tools).
- Cognitive (act) SD: ***Attentional narrowing***, ***Requisite memory trap***, ***Workload, fatigue and other stressors***.

Table 3. Situational Disability Triggers in the Control Room

		Situational Disability Triggers
Perceive		
	Touch	
	Vision	Many screens and blinking lights
	Hearing	Noise/alarms
	Cognitive (understand, interpret)	Information overload
Action		
	Speaking	
	Moving	
	Fine-motorics /dexterity	Stress
	Cognitive (plan – act)	Information overload, confusion (wrong communication channel, forgetting protocol)

In the control room scenarios, the following situational disabilities map to the following SA demons (effects that

are not among the established demons are shown in parenthesis, while the situational awareness demons are marked with bold italic):

- Vision SD: ***Data overload***; ***Misplaced Salience***.
- Hearing SD: ***Data overload***; ***Misplaced Salience***.
- Cognitive (understanding) SD: ***Attentional narrowing***, ***Requisite memory trap***, ***Workload, fatigue and other stressors***; ***Data overload***; ***Misplaced Salience***.
- Dexterity SD: (Stress affecting ability to manipulate control room equipment).
- Cognitive (act) SD: ***Attentional narrowing***; ***Requisite memory trap***; ***Workload, fatigue and other stressors***.

We notice that several of the effects are outside the scope of the demons of situational awareness, in particular when it comes to situational disabilities triggered in the field. Thus, the situational disabilities are not aligning well with the demons of SA, beyond the control room parts of the scenarios above. This makes sense since the demons of SA were defined in the context of control room SA.

From this research, we find that the demons of SA are not sufficiently general to cover the issues met by the general public and first responders. They cover mainly cognitive overload in control room situations, but not so much situations in the field with mobile equipment. This is a major issue that will be investigated in future work.

CONCLUSIONS AND FUTURE WORK

In this paper we adopted scenario-based analysis with simplified personas to identify situational disabilities among stakeholders in disaster situations and the demons of situation awareness. We have found that the Demons of SA (Bhatt and Güsgen 2012) are not adequately covering the issues of loss of SA caused by situational disabilities for major groups of stakeholders in typical disaster scenarios, such as the general public and first responders. Further studies should be performed to examine this issue in more details and provide a more complete picture of the demons of situation awareness, and we are currently working on extending the "Demons of SA" so that they cover other contexts as well.

In our scenarios, we see that ICT in addition to providing opportunities for increased situational awareness, can also introduce barriers to situational awareness through situational disabilities which can further hinder effective actions. It also becomes clear that not only obviously vulnerable groups like the elderly and people with disabilities needs special consideration when designing ICT tools for EM. We wish to highlight that Universal Design of ICT tools for emergency management can play an important role in removing these barriers and make the tools usable for a broader range of users, even those affected by situational disabilities (Gjøsæter and Radianti 2018; Gjøsæter et al. 2018; Radianti et al. 2017). Further research should focus on how Universal Design principles and guidelines can be used in the development process of ICT tools for Emergency Management, and a process model to illustrate the use of universal design principles in the design of ICT systems to support SA is part of ongoing work. This model is built upon the process model for information system of SA (Luokkala and Virrantaus, 2014) and demonstrate the adoption of UD in the whole process of ICT systems for SA.

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