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## **Inter-organisational communication and situational awareness in an emergency operation centre during major incidents**

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**Abstract:** Sharing information between different public safety organisations plays a vital role during major incidents. Common situational awareness among the actors is a key element in achieving successful end results in managing and leading operations. In this study, the information flow for enabling situational awareness in an Emergency Operation Centre during a major incident is described. The data were collected during the preparedness exercise. Emergency Operation Centres play a fundamental role in creating collaborative awareness, familiarisation with organisations, long-term commitment, and thus in helping to tackle the known challenges in multi-authority coordination. In addition to being the place where critical far-reaching decisions were made, the Emergency Operation Centre played a very significant role as an information hub in cooperation and collaboration.

**Keywords:** collaboration awareness; command centre; common operational picture communication; emergency operation centre; incident; ICS; incident command system; major accident; multi-authority cooperation; situational awareness.

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## 1 Introduction

### 1.1 Inter-organisational communication

An organisation's internal and inter-organisational communication, as well as its functionality, plays an essential role in the success of the decision-making and rescue

operation-related activities during major incidents. From the outside coming information, environmental changes have also a crucial part of the possibility to the right decision making acts. Several studies have shown that poor information sharing and communication within and between organisations leads to poor management and decision-making. This can result in rescue operations not proceed in the desired manner (Busby and Witucki-Brown, 2011; Dawes et al., 2004; Grunwald and Bearman, 2017; Helsloot, 2005; Junglas and Ives, 2007; Pan et al., 2005; Parush et al., 2011; Rådestad et al., 2012). Situational information available to the leader must be timely, meaningful and reliable. The key to establishing situational awareness (SA) is to convey the right information to the right person at the right time so that leaders can have an adequate and up-to-date understanding of the current situation to support decisions (MacFarlane and Leight, 2014).

However, there is also a downside to information sharing. Some studies have shown that an overwhelming amount of information can lead to an increased mental burden. In other words, more information does not invariably lead to better awareness. Hence, this can be corrected by filtering and passing on only necessary information (Endsley, 2001; Hershkovich et al., 2016.) The key to this is to have a good understanding of how your own, and your co-operative organisation operates. At different hierarchical levels, as well as in various organisations, the needs for information differ. If different needs are known, communication can be significantly enhanced through relaying only the information that is necessary and meaningful for decision-making purposes. In a nutshell, it is crucial to understand the kind of information that is relevant regarding to the right person at the right time, and how the information should be transmitted in order for the best possible decisions to be made (Norri-Sederholm et al., 2018; Treurniet et al., 2012; Wolbers and Boersma, 2013).

Traditionally, leaders make decisions using a radio system as an information-sharing method in emergency situations, whereby sub-officers periodically relay reports of their activities to their superior via the radio network. These processes are decidedly labour-intensive and often lead to latencies in information-sharing, and incomplete and low-resolution data (Demchak et al., 2007). In general, low data quality is a significant factor in the failure of information-sharing (Piprani and Ernst, 2008). Although sharing information between different organisations plays a vital role in cooperation and collaboration situations, it is often limited due to the lack of knowledge and understanding of each other's work processes at a community, agency or individual level. It is crucial for leaders to look at the big picture and not to merely focus on their own organisation's information needs (Bharosa et al., 2012; Seppänen et al., 2013; Treurniet et al., 2012). The situation picture, namely "a subjective snapshot of a certain situation", is important (Kuusisto, 2005). However, the ultimate goal should be to acquire and maintain a common operational picture (COP), which requires up-to-date information, fluent communication, and open, active and effective co-operation within the organisation and between organisations (Norri-Sederholm et al., 2015).

## *1.2 Situational awareness*

In addition to understanding the current situation and maintaining a COP, situational awareness is also required. The most frequently used definition of situational awareness (SA) is the one by Mica Endsley (1995), which states that, in its simplest form, SA involves the individual's knowledge of what is happening around him/her and what can

be expected to happen next. In The Federal Emergency Management Agency (FEMA's) definition, "the ability to identify, process, and comprehend the critical information about an incident. More simply, it is knowing what is going on around you. Situational awareness requires continuous monitoring of relevant sources of information regarding actual incidents and developing hazards" the role of information is highlighted (Department of Homeland Security/Federal Emergency Management Agency, 2016, pp.48–49). A situationally aware leader can extract the essential elements from information pertaining to the situation, understand the surrounding context and what he/she is leading, what should be done in that situation, and how the situation may develop. To this end, situational awareness can be regarded as a prerequisite for successful leadership. In addition to the leader's personal experience, the focus of SA is on information relating to the specific situation, meaning the information that the leader receives and collates to support decision-making (Endsley, 1995; Endsley and Garland, 2000).

While discussing major incidents and inter-organisational communication, actors also need to build shared situational awareness. Several definitions are used to describe this phenomenon. Endsley (1995) refers to the phrase 'team situational awareness', according to which each team member has the required SA related to their responsibilities in the team. Team SA also includes coordination and information-sharing. Another definition of this is 'shared situational awareness', meaning that all team members have a similar awareness related to common responsibilities (Endsley and Robertson, 2000). In the third definition, 'distributed situational awareness', the basic idea is that each team member perceives the situation differently based on their own goals, experience, role, and education. This means that each team member has an individual situational awareness relating to the goals. As a consequence, although the team members possess the same information, they interpret it through their tasks. Distributed SA enables each team member to build the right SA to achieve the common goal. SA is reached and maintained via communication and knowledge-sharing. To this end, each team and team member uses the information based on their own needs, forms their own SA, and the combined SA of all actors duly forms the distributed SA and the actions based on it (Salmon et al., 2010). In Emergency Operation Centres where several different authorities work together during an incident, it is possible to share the same information and communicate to everyone during the time-outs. This enables distributed SA.

Different definitions of shared situational awareness also have their own weaknesses. They do not provide an answer to the most important question, i.e., different situational awareness between different actors and agencies working at the same accident scene. In a major accident, each actor and team form situational awareness based on their own needs, and the information available on-scene is at least partially different between different actors. In practice, this results that each actor and team act the best possible way from their own point of view in a situation where the actors often also perform overlapping activities. To achieve real cooperation and collaboration, rescue operations must be coordinated through centralised management between the various actors to achieve the best results. Another challenge for situational awareness is the format of SA, namely it consists of texts, pictures, symbols, data etc. and how differently we can decode the meanings of the same SA. This is the reason why military organisations use the standardise concepts and procedures.

Having a common operational picture and distributed SA requires information management processes and organisations as well as supporting information systems to be

in place. Hutchins (1995, 2000) brings out the fact that distributed cognition is actually a complex interaction with other individuals and systems. Although distributed SA and a common operational picture are essential, they will not suffice in ensuring more effective cooperation or collaboration between responding actors. Collaborative awareness is the key to improved collaboration between different actors, meaning that cooperation and collaboration can be enhanced by knowing the needs, goals, expectations, culture, capabilities and work processes of the collaborative actors. Similar idea is in shared mental model (Cannon-Bowers et al., 1993) where knowing team members' skills, knowledge, tasks and goals is in focus. This enables predicting other's needs, steering communication and thus increasing team performance. Team reflexivity, defined as a deliberate process of discussing team goals, processes, or outcomes, has been proven to enhance team performance and decision quality (McHugh et al., 2020; Schippers et al., 2020; Yang et al., 2020). Team diversity with distinct backgrounds and experiences also benefit team performance and decision making by having multiplicity of perspectives with critical and integrative thinking (Yang et al., 2020). Yang et al. (2020) found out in their study that team diversity strengthens this. In Pramanik's (2015) systematic literature review the following five challenges for multi-authority coordination were identified: communication, information management, organisational structure, organisational culture, and organisational identity. The findings show that familiarity and long-term commitment between organisations are essential elements in improving the effectiveness of crisis response management and should be implemented even during the planning and preparedness phase.

### *1.3 Choo's knowledge management model*

According to Choo's (2006) knowledge management model, organisational information flow is characterised by three phases: sense-making, knowledge-creating, and decision-making. During the first phase, sense-making creates a framework for shared meanings and purpose, the perception of problems, or opportunities that the organisation needs to work on. Actors need to make choices as to which message to include or exclude, as well as which information to prioritise. These choices are seldom pure rational, but stressful situation, emotions and limit of time influence to choices. Actors also share information and opinions while trying to interpret the situation. Efficient decision-making depends on sense-making. Secondly, in knowledge creation, the essential question to address is what kind of knowledge is needed, and how it can be obtained. During this phase, knowledge is modified by combining both the explicit and tacit information possessed by individuals and groups. In addition, knowledge creation depends on the knowledge links and alliances that have been developed with other partners. The effectiveness and activity of leadership is essential in managing knowledge sharing. The decision-making phase is guided by preferences that are based on a shared understanding of the purpose and goals of the organisation. The key action is processing the information and choosing the most appropriate means of achieving the target. The vital question, however, is how to avoid information overload, and to identify the essential information that needs to be shared with other service participants for decision-making purposes.

#### *1.4 Incident command system*

Californian wildfires in the early 1970s revealed many recurring problems and challenges related to cooperation and communication in a multi-authority response to major incidents. The challenges that arose included lack of a common standardised terminology, lack of the capability to expand and adapt to the prevailing situation, lack of standardised communication, lack of consolidated action plans, and lack of predesignated facilities. On this basis, a unified management system (Incident Command System – ICS) for major incidents was developed and introduced in the United States later in the 1970s. Due to the background of many in a leadership position at the time, the developed model was more or less based on the military models of command and control. In the ensuing decades, the model has been further developed, but the basic concept has remained the same. Currently, ICS has been adopted as a part of the US National Incident Management System (NIMS). The principles and concept of the US ICS model have been extensively applied in incident command systems (ICSs) in different countries around the world (Chang, 2017; FEMA, 2017; Stumpf, 2001).

The concept of the Incident Command System in Finland during major incidents is based on close co-operation and collaboration between responding actors. The organisation involved in the rescue operation (Figure 1) consists of various actors divided into different hierarchical levels: Actual rescue operations, on-scene command post, Emergency Operation Centre (EOC), and administration (Castrén et al., 2015).

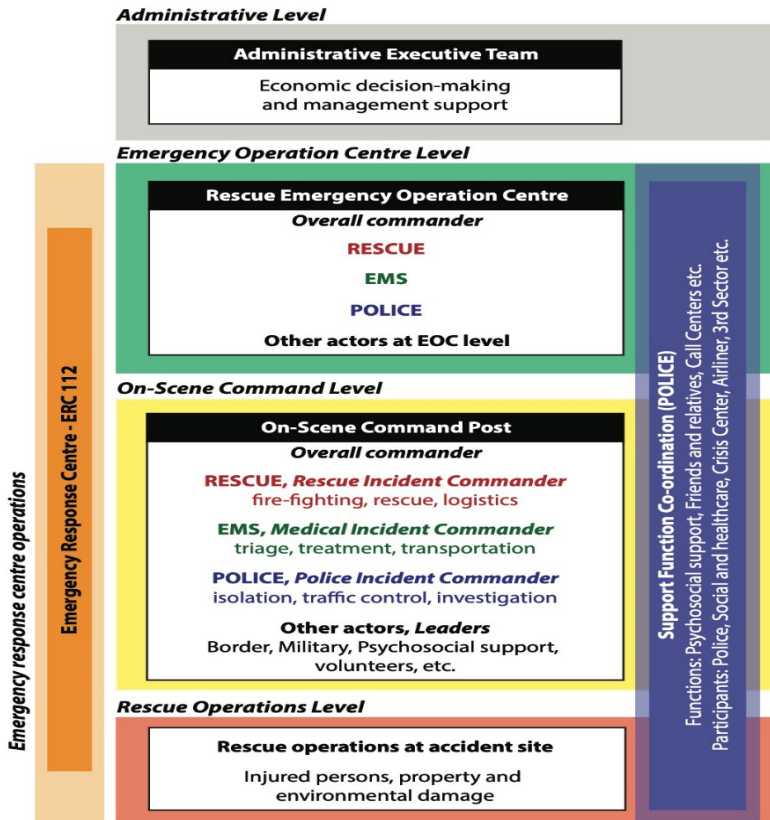
At the accident scene, three key authorities – rescue services, police, and emergency medical services (EMS) – constitute the core of the operation, which is supported by other responding authorities, voluntary organisations, and other actors. The core operation is divided into parallel operations by the rescue services, police and EMS, which are organised and managed from the on-scene command post acting as a unified (joint) command post for all three key authorities. The operation is led by the competent authority, which operates as an on-scene overall commander. The leading authority is determined by the type of incident, based on Finnish legislation and practices. The principle is that the authority in charge is the one with the best means of responding to the incident. For example, in the case of an accident, the rescue service is the competent authority, while in the event of an act of violence, the police will take charge. The overall commander is responsible for maintaining the situation picture and situational awareness, and for coordinating the parallel operations so that the measures taken by them all aim to achieve the common goal at the scene. The resources of the different actors such as the rescue service, the police, and EMS operate under their management, namely the incident commanders (Castrén et al., 2015; Rescue Act, 2011).

The basic ideology and concept of the Finnish ICS are consistent with the US system. The differences are mainly related to the terminology used, the hierarchy and the relationships between the different actors. In the Finnish system, each actor is responsible for managing their activities, while the responsibility of the on-scene overall commander is to coordinate the cooperation and collaboration between the different actors to achieve a common goal. In the Finnish model, all functional areas of the US system, such as command, operations, planning, logistics, intelligence and research, finance and administration, are included, although they are not presented separately in the simplified organisational modelling. The organisation model makes it possible to deploy all the equipment, personnel, and facilities from the various private, municipal, and state actors

needed to deal with the situation. If the situation so requires, the management structure can be expanded so that the state administration is also represented.

**Figure 1** The framework of the Finnish incident command system in major accidents (see online version for colours)

### Levels of Command in a Major Accident



Source: Adapted from Castrén et al. (2015)

Although the Finnish model of the ICS is not based on the ICS model used in the US, the principles and benefits of the model are similar to those presented by Chang (2017). This model is based on the all-hazards approach, which makes the system suitable for all types of incidents. The organisation is well structured, and the delegation of authority and responsibility is unambiguous, allowing a manageable span of control. The model is scalable and simple enough, so its principles are suitable for everyday use. Moreover, due to its scalability, it can be used for small to large incidents. The system is also appropriate for incidents involving a variety of actors engaged in rescue operations – from authorities to voluntaries and private companies – and all of the different actors share a unified core terminology.

### 1.5 *Emergency operation centre*

According to the definition by the US Federal Emergency Management Agency (FEMA) (2017), the Emergency Operation Centre (EOC) is a location where staff from the various bodies responding to the major accident come together to deal with the immediate threats and hazards, and to provide coordinated support for the incident command, on-scene personnel and/or other EOCs. EOCs can have fixed locations, temporary facilities, or virtual structures with staff participating remotely. In Finland, an EOC is defined as a functional entity for the management of emergency operations, including personnel, facilities, equipment, and operational documents. In the case of a major incident, the EOC coordinates the efficient use of the responding resources of different authorities and other actors (Haverinen et al., 2016).

In the organisation hierarchy, the Emergency Operation Centre (Figure 1) is above the on-scene command post and has two main tasks:

- 1 To support the operations of the on-scene overall commander by providing adequate equipment, units, and personnel resources. In the event of more than one simultaneous incident, the EOC coordinates the efficient use of available resources in the area between the different incident scenes.
- 2 To provide adequate resources for day-to-day operations. The EOC's task is to ensure that sufficient resources are available for urgent daily operations. Despite the major incident, regular daily operations should be carried out as normally as possible. One way to manage the situation is to put all non-urgent operations on hold and to handle only the urgent operations (Castrén et al., 2015; FEMA, 2017).

Most authorities, such as the rescue service and the police, have pre-defined and equipped facilities for the EOC in central fire stations and police stations. However, there is usually no continuous 24/7 staffing of the EOC, and they are staffed only when needed. On weekdays, during office hours, the EOC staff are drawn from people working in the facility. Outside office hours, the EOC personnel are alerted from home. The EOC is always set up by the same responsible authority as the one in charge at the incident site. Other responding authorities, volunteers, and other actors involved in rescue operations send their representatives to the established EOC. At the EOC level, the representatives are high-ranking officers of their organisations, supported by the necessary expert staff. Most often, all operators of various parties are physically present at the EOC, but it is also possible that in some cases only the liaison officer is sent to the EOC, or participation in the EOC operation is handled via a video link (Castrén et al., 2015; Norri-Sederholm et al., 2018).

The EOC plays a significant role as an information and communication hub in managing operations involving several different authorities and other actors. Extensive inter-organisational information-sharing, communication, cooperation, and collaboration via various means (Table 1) is the key to achieving a common goal. At the EOC level, communication between the on-scene command post and the EOC via the radio network plays an essential role in the command structure of Finnish public safety authorities. Currently, information from the incident scene to the EOC is usually relayed via a Tetra technology-based Public Safety Network radio (VIRVE). Mobile telephones are also



used alongside the latter to convey information between different levels of the organisation. However, at every organisational level, face-to-face information exchange within and between organisations is always used whenever possible. In addition, all of the authorities have their own technical information systems solutions, such as incident logbook software, and ICS software. Some actors also have the technical capability to transmit a live video stream from the on-scene to the EOC level (Norri-Sederholm et al., 2018). Currently, there are no inter-authority applications for sharing information, although the national inter-authority incident command application is under development and is expected to become available nationally in the next few years.

**Table 1** Means of information-sharing at the EOC level

<i>Data transfer method</i>	<i>Notice</i>
VIRVE network	TETRA-based network used by Finnish authorities and their partners such as voluntary rescue services. One-way communication (simplex). All actors have their own talk groups in use. In addition, there are shared talk groups to be used in multi-authority communication
Mobile phone communication	Used alongside TETRA network. Enables private conversations. Reduces load of the TETRA network
Face-to-face communication	Mostly used as the main communication method between different authorities and actors at the EOC level
Software e.g., incident logbook, incident command system, instant message application	For documenting the information flow, decisions, and actions during the incident. Enables information-sharing between authorities with certain restrictions
Camera technology e.g., bodycams, dashboard cams in vehicles, drones	For transmitting livestream from the scene and to record it for later use

*Source:* Norri-Sederholm et al. (2016)

Although there has been a significant development in cooperation and collaboration between authorities in recent years and decades, there is still a need for further development when it comes to the interoperability of different actors responding to major incidents, as underlined by Simola and Rajamäki (2015). Moreover, the lack of commonly standardised inter-organisational terminology can have a negative impact on collaboration due to the potential misinterpretation of the shared information (Laakso, 2014). The improvement and development of collaborative awareness are key challenges calling for greater attention in the future. This would resolve the aforementioned problems and serve to enhance inter-organisational cooperation, collaboration and communication significantly.

The principal aim of this paper is to describe the information flow for enabling situational awareness in an Emergency Operation Centre during a major incident. With the risk of information overload in our mind, we had a special interest to find out the kind of information that was needed and delivered, and what its sources and targets were. Our ultimate purpose was to obtain understanding of the critical elements during inter-organisational communication.

## 2 Material and methods

This paper is based on a qualitative case study design, using an observational approach. The empirical data were collected in an emergency operation centre during a major incident exercise, and included the incident logbook. The latter consists of time-stamped documentation of all rescue service-related communication and actions in the emergency operation centre during a particular case.

The major incident exercise during which the data were collected was part of a larger preparedness exercise conducted in the county. The major incident exercise was organised by the emergency services in the area. The aim was to fine-tune the inter-organisational collaboration between the Public Safety Authorities in a hybrid environment. The authorities in the emergency operation centre were composed of the Fire and Rescue, Emergency Medical Services (EMS), Police, and the Defence Forces. In addition, several other authorities including the Emergency Response Centre (ERC), the Regional State Administrative Agency, the community, the Safety Investigation Authority, as well as the Red Cross and local university of applied sciences were part of the exercise. In total, more than 300 people and dozens of police and rescue service units participated.

The scene of the incident was an old paper mill area, which had been renovated for cultural and commercial use. The scenario was a big explosive fire during a concert, affecting about 200 people. The fire originally broke out as a result of pyrotechnics used on the stage, which caused an 11-kg gas bottle behind the stage to explode. The patients had injuries and burns caused by the fire and the explosion, and respiratory problems due to the inhalation of fumes and smoke. The secondary injuries were caused by the ensuing stampede. At the same time, a demonstration was simulated in the old paper mill area, with actors wearing different coloured clothing to represent advocates and opponents of immigration.

The EOC was manned by the commanding officers, with several officers from the rescue services as they were the responsible authority for the operation. They occupied one large table. At another table were commanding officers from the Police, EMS, and Defence Forces. The researcher conducting the observations was seated at this table. The personal responsibility of the police and rescue services crisis communication occupied a table of their own. One of the walls in the EOC was covered with screens, depicting the incident logbook, for example, and live video from the scene transmitted via dashboard cameras in the fire engines. During the exercise, a police drone also delivered live video footage as requested by the authorities in the EOC. There were several 'time-outs', where all the commanding officers provided an update on their current situation, forthcoming actions, challenges, and requests to other authorities/actors.

The empirical data were analysed using deductive content analysis, a research technique which, through the use of categories, draws replicable and valid inferences from texts in the context of their use (Silverman, 2012; Krippendorf, 2013). The study applied Choo's (2006) information management model in creating the themes for analysis, which comprised information needed and delivered, information sources and targets, and methods used to receive and deliver information. The total number of findings was 563. The narrative text was content-analysed and categorised in the same manner as the incident logbook data to enable comparison.

## 2.1 Ethics

The rescue department responsible for the preparedness exercise gave its official permission for the research. This included a permission from all the participating organisations in the emergency operation centre. Before starting the exercise, all participants in the emergency operation centre were informed about the study and the given permission.

## 3 Results

The results of the communication during the major incident exercise in the emergency operation centre are presented according to the information flow and critical information categories. Some quotations from the actual information flow are interspersed with the findings to illustrate the content. The information flow is described simultaneously as information needed and information delivered ( $N=238$ ). Subsequently, the sources ( $N=92$ ) and targets of the information ( $N=185$ ) are described, and lastly the methods of receiving and delivering the information are presented.

### 3.1 Information needed and delivered

The analysis of the information flow at the Emergency Operation Centre (EOC) during the disaster exercise yielded 238 findings in all. Findings related to information needed represented 34% ( $n=81$ ) of the results, while 66% ( $n=157$ ) were related to the information delivered. As presented in Table 2, 18.51% of the information flow was related to endeavours to create or enhance situational awareness: *The Police are securing the area of operations; A picture from the drone is needed; What is the estimated time of arrival for priority one patients?* Issues related to resources and various forms of information relay both represented 13.58% of the information needed: *The police are evacuating victims, but police resources are insufficient; Fire and rescue and EMS can't provide situation updates – the healthcare resources are inadequate.* Challenges related to evacuation, traffic, and the emerging additional damage each accounted for 7.40% of the information flow: *What is the estimated number and location of the exposed?; The police can't handle the traffic control.* In the early phases of the incident, the rescue units aimed at obtaining an estimate of the number of exposed persons, which represented 6.17% of the information needed. The miscellaneous group included data related to isolation, relatives, daily actions, incident command, incident investigation, and incident data.

Information delivery turned out to be largely focused on creating and enhancing situational awareness, which amounted to 37.58% of all information delivered. Challenges related to resources represented 14.01% of the delivered information. Hence, these two main categories accounted for half of all the delivered information, or 51.59% to be precise. The miscellaneous group related to delivered information included data similar to that in the information needed group. In addition, there were data related to communication, disaster victim identification (DVI), and shutdown of actions.

**Table 2** Information needed and delivered, %

<i>Category</i>	<i>Information needed (n = 81)</i>	<i>Information delivered (n = 157)</i>
Situational awareness	18.51	37.58
Resources	13.58	14.01
Relaying information	13.58	0.00
Additional damage	7.40	7.64
Evacuation	7.40	5.09
Traffic	7.40	1.91
Executive assistance	6.17	7.64
Data on the exposed	6.17	4.46
Safety at work	3.70	5.73
Assembly area	3.70	0.00
Miscellaneous	12.39	15.94

### 3.2 Information sources and targets

The police incident commander played a crucial role as the provider of information, especially in the early phases of the multi-authority work in the EOC (Table 3). Most of the information (20.61%) was received from this source: *Total number of people involved; Aggressive crowds are disturbing the rescue work*. The rescue incident commander acting as the on-scene overall commander was the source of information in 11.96% of the information flow. The EOC itself played a prominent role in providing information as 10.87% of the information was received from this source: *When are the additional resources available?* The Emergency Medical Service in the field provided 8.70% of information received: *How traumatising are the incidents in the field – is psychosocial support needed?* The Finnish Defence Forces were actively involved in the case, as they acted as an information source in 5.43% of the cases. The EMS command centre share was equal to that of the Defence Forces, while the medical incident commander was the source of information in 4.35% of the cases. The miscellaneous group included the Fire Rescue Command Centre, the city safety officer, and social media.

Almost half (39.45%) of all information delivered during the incident was targeted at the EOC: The Frontier Guard helicopter is approaching the scene; More than 10 EMS units are at the scene – a request for additional help has to be sent to the Defence Forces. The police incident commander received 11.35% and hospital management 10.81% of the information delivered. 9.20% of the residual information was targeted at the rescue incident commander, while the EMS in the field, the medical incident commander and the Defence Forces each received 5.40%. The miscellaneous group included the dispatch centre, city management, regional administration, Ministry of the Interior, social work on duty, and the general public.

**Table 3** Information sources and targets, %

<i>Source/Target</i>	<i>Received from (n = 88)</i>	<i>Delivered to (n = 161)</i>
Police incident commander	20.61	11.35
Rescue incident commander	11.96	9.20
Emergency Operation Centre	10.87	39.45
EMS in the field	8.70	5.40
Hospital management	4.35	10.81
EMS command centre	5.43	3.78
The Finnish Defence Forces	5.43	5.40
EMS field commander	4.35	5.40
Police incident command centre	2.17	3.78
Fire rescue officer in the field P3	2.17	3.24
Miscellaneous	23.96	2.19

### 3.3 *Methods used to receive and deliver information*

According to the observation results at the EOC, the Public Safety Network radio (TETRA) turned out to be the most frequently used method of both receiving and delivering information. It was used mainly by the rescue services and the EMS. Mobile phones were used much more often to deliver rather than receive information. Naturally, face-to-face communication was used, particularly in ‘time-outs’. Several technical solutions were in use, which made it impossible to obtain the real statistics on the methods used. The police mainly used LYNC (Microsoft’s commercial instant messaging application) for their internal communication. Information was also received via a drone, and the dashboard cameras of fire engines transmitted live video from the scene to the monitors on the wall of the EOC. In addition, the situation logbook was visible on the wall at all times. Social media played only a minor role as a method of receiving and delivering information.

## 4 Discussion

The purpose of this study was to describe the information flow for enabling situational awareness in an Emergency Operation Centre (EOC) during a major incident. The data under analysis were collected in the EOC during a preparedness exercise. The empirical data also included the incident logbook, time-stamped documentation of all rescue service-related communication and actions in the EOC during the exercise.

During the early sense-making phases (Choo, 2006) of the exercise, the personnel working at the Emergency Operation Centre aimed at constructing situational awareness to form the basis for further decision-making. The largest percentages of information needed as well as delivered were related to forming this situational awareness. In general, the focus was on delivering the information, as one of the main tasks of the EOC is to serve as a hub for all actors (Castrén et al., 2015; FEMA, 2017). During this sense-making phase, the actors at the EOC make choices as to which information they will relay to all operating actors (Choo, 2006). In order to make the right choices, it is crucial

to understand the needs of the other actors (Norri-Sederholm et al., 2018; Treurniet et al., 2012; Wolbers and Boersma, 2013). The officers in charge were naturally concerned about the adequacy of the resources responding to the incident. Almost half of all the information needed and delivered consisted of these issues. This finding corresponds with Haverinen et al. (2016).

In the knowledge creation phase (Choo, 2006), the police field commander's role as the provider of information was noteworthy at the EOC, especially in the early phases of the operation. Unexpectedly, it was more prominent than the role of the fire rescue officer in charge of the on-scene command. The EOC itself was a valuable source of information in multi-authority co-operative work, as more than 11% of all information was received from the EOC. This is in line with Choo's basic perception of the knowledge creation phase, where knowledge creation depends on the knowledge links and alliances that have been developed with other partners. As presented in Table 3, these took numerous forms, with both safety (EMS, dispatch centre, Defence Forces, city safety officer), social (social work on duty, psychosocial management), and governmental authorities (Ministry of the Interior, state command centre, city management) all involved in the knowledge creation. The fact that the EOC has connections to all levels of command, from rescue operation and on-scene to administrative level and all support functions (Castrén et al., 2015), creates a solid and competent operational framework for responding to major incidents.

One essential question in the knowledge creation phase is how knowledge can be obtained (Choo, 2006). From the Finnish perspective, the main method of receiving as well as delivering information both in inter-organisational and intra-organisational communication during incidents is via Tetra technology-based Public Safety Network radio (VIRVE), as was the case in this study. Verbal communication face-to-face is valued in longer-lasting, demanding multi-authority operations (Norri-Sederholm et al., 2018). Having all of the commanding officers in the EOC enabled face-to-face communication. This model also enables forming distributed situational awareness where each team and team member uses the information based on their own needs and goals to form their own SA (Salmon et al., 2010). In addition, they had regular 'time-outs' where each authority shared their situation picture with others. Technology in different formats was in active use. One of the walls in the EOC was covered with screens displaying the incident logbook and livestream via drone and dashboard cameras from the scene. This radically improves the situational awareness of the commanders. However, it may simultaneously pose a potential challenge because the information transmitted is not filtered, which may lead to the wrong conclusions being drawn at the EOC level. Of significance in the study was the fact that it was not possible to observe all of the information-sharing via software. For example, the police and Defence Forces were in possession of confidential data, which was not available for the study.

The third phase in Choo's (2006) model is the decision-making phase. Even though this phase was not the focus of this study, some elements became so obvious as to warrant a brief discussion. One of the fundamental purposes of the Emergency Operation Centre is to support the decision-making phase. This, in turn, is guided by preferences that are based on a shared understanding of the purpose and goals of the organisation. Having a better understanding of other team members and their needs, increases team performance (Cannon-Bowers et al., 1993). The key action is processing the information

and choosing the most appropriate means of achieving the target. The vital question is how to avoid information overload and to identify the essential information that needs to be shared with other participants for decision-making purposes (Choo, 2006). In this study, the EOC played a very significant role as the target of information, as almost half of the latter was targeted at the Centre. This is expected as the multi-authority EOC is the place where critical far-reaching decisions have to be made.

Overall, the EOC, as part of the Incident Command System, supports internal and inter-organisational communication in major incidents and disasters, and thus mitigates the known risks of poor information-sharing and communication (Busby and Witucki-Brown, 2011; Grunwald and Bearman, 2017; Parush et al., 2011; Rådestad et al., 2012) within and between organisations and their effect on management and decision-making. In addition, it seems that Emergency Operation Centres have a fundamental role in creating collaborative awareness, familiarisation with organisations, and long-term commitment, duly helping to tackle the known challenges (Pramanik, 2015) in multi-authority coordination. The approach of work at EOC seems to support team reflexivity and team diversity. These benefit team performance and decision making (McHugh et al., 2020; Schippers et al., 2020; Yang et al., 2020). Further research is needed to achieve a deeper understanding of enablers and bottlenecks in order to develop interoperability and, in turn, situational awareness in Emergency Operation Centres.

## **5 Conclusion**

This study has served to present a picture of an Emergency Operation Centre as an information hub. The study has identified the key information elements and methods that contribute to the formation of shared situational awareness among actors pursuing successful end results in managing during major incidents. We managed to find out issues related to the endeavours to avoid the risk of information overload, i.e., exactly what kind of information was needed and delivered as well as the sources and targets of that information. It became obvious that during a major incident the staff working at EOC needs especially information related to creation of situational awareness, the resources and information relaying. However, the information that was needed to be delivered most was also related to the creation of situational awareness and resources but not at all to information relaying. Information that was urgently needed to be delivered to the field, in addition to what was already mentioned, was related to additional damage and executive assistance.

Police incident commander turned out to be the foremost source of information. From that source information was obtained twice as often as from the rescue incident commander. However, as the source of information delivered, the EOC played a major role, which naturally is its fundamental role. Overall, it seems that the Emergency Operation Centre model can offer conditions and tools that enable collaborative awareness to be achieved through fluent inter-organisational communication. Furthermore, it can also be speculated that the EOC might be able to play a role in trying to avoid information overload by obtaining and delivering exactly the information that is most essential.

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