Chapter 9
Use of IT for Situation Awareness for Disaster Risk Reduction

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Abstract Situation awareness is one of the key issues for first responders and relief agencies. Communication is important to raise situation awareness and share common pictures between relevant stakeholders. This chapter describes IT roles to increase situation awareness for disaster risk reduction. We look at situation awareness in each phase of the disaster management cycle. For instance, the first responders need to know what has happened and where they should have priority to go and rescue victims. During and before a disaster, people in the disaster area need to know what situations are to decide whether and how to evacuate. A command control office needs to know the size of disaster to locate resources to deal with rescue as well as with damages. Shelters need to be set up accordingly and local government may well need to manage those shelters in terms of providing goods and foods keeping track of the number of victims in the shelters as well as the statistics of the people vulnerable in disaster such as people with disabilities, elderly, children, and pregnant women. In the recovery phase, one may well need to keep informing people outside the disaster area about the recovery process so that they can share the disaster recovery together with the victims to keep providing helps. We look into how those requirements of situation awareness could be supported by the use of IT and ICT.

Keywords Situation awareness · Team situation awareness · IT use in disaster risk reduction

9.1 Introduction

In this chapter, we present the use of information technologies for situation awareness at disaster. Research on situation awareness started originally in aviation as a pilot needs to know the situations (Endsley 1998). It has been applied to many other areas in other dynamic and complex situations which require human control such as driving, nuclear plant operation, medical treatment, and firefighting. It is important

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for disaster management as well and we discuss the issues in situation awareness taking examples of applications in each phase of disaster management.

This chapter is composed as follows. We present original work on situation awareness in the next section. Section 9.3 describes disaster management cycle and situation awareness in this context. Section 9.4 reports the IT use for situation awareness at disaster with some case studies. Section 9.5 discusses the situation awareness at disaster. Section 9.6 gives some conclusions.

9.2 Research Domain of Situation Awareness

The term, situation awareness (SA) came originally from the aviation area for aerial warfare (Endsley 1988, 1995, 1998; Endsley and Selcon 1997). It was recognized as important for military aircraft crews in the First World War and its importance has been increasing since then (Endsley 1988). SA is defined by Endsley as follows (Endsley 1998):

> Situational awareness or situation awareness (SA) is the perception of environmental elements within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.

Endsley introduced the three hierarchical phases of the above definition (Endsley 1988):

Level 1. Perception of the Elements in the Environment
Level 2. Comprehension of the Situation
Level 3. Projection of Future Status.

At Level 1 above, one needs to perceive the status, attributes, and dynamics of the relevant elements. At Level 2, based on Level 1, one needs to understand the significance of those elements and events to form a holistic view of the environment. Based on the knowledge from Levels 1 and 2, one can project future actions in the near future. In this way, SA is not only the perception of the status of the environment but also includes more activities. SA is also applicable in other domains than serial warfare, such as air traffic control, large system operations such as nuclear power plant, and tactical and strategic systems such as firefighters and police.

Harrald and Jefferson (2007) summarized the above such that SA has an information component, a perception component, and a meaning component. They described more about the information component as follows:

> To provide the information component required for situational awareness, the system must be capable of collecting, filtering, analyzing, structuring, and transmitting data. Situational awareness is not only the correct perception of reality, it the correct perception of the relevant elements of the current reality necessary for correct, protective, tactical, and strategic response.

According to Sapateiro and Antunes (2009) and Salmon et al. (2008), Dominguez defines individual SA as follows:

the continuous extraction of environmental information and integration with previous knowledge to form a coherent mental picture and using that picture to directing and anticipating future events. (Sapateiro and Antunes 2009)

Endsley (1995) described another type of situation awareness (SA) within a group of people as team SA. It requires team members to share a mental model at level 2 to comprehend the situations, whereas they need to share the level 1 situation awareness information. Endsley presented the needs for some overlap between each team member's SA requirements. Moreover, a shared mental model is important for each team member to achieve the same higher level SA.

According to Endsley and Jones (Endsley and Robertson 2015), team SA requires both that team members have a high level of individual SA and that shared SA be developed between the team members as follows:

(1) Team SA requirements: an examination of what constitutes SA requirements in team settings. These requirements consist of information at each of the three levels of SA: Perception (basic data), comprehension, and projection.
(2) Team SA devices: for information transmission and communication.
(3) Team SA mechanism: it is important to develop internal mechanisms for shared mental models for achieving high levels of shared SA.
(4) Team SA processes for teams to use for effective group decision-making and performance.

They also introduce inter-team SA in which the issues in achieving shared SA between teams are similar to those in achieving shared SA between the individuals within a team (Endsley and Robertson 2015) as follows:

(1) *Inter-Team SA Requirements: shared SA requirements between teams will be less than that within a team as usually the goals between teams will be more independent than within teams.*
(2) *Inter-Team SA Devices: the devices available for achieving shared SA will be essentially the same as those available within the team, bearing in mind that these teams will almost always be distributed.*
(3) *Inter-Team SA Mechanisms: Significant issues exist regarding the degree to which multiple teams will share a common mental model with which to interpret shared data. One needs to get over the differences in organizational/team culture, jargon, and perspectives for communications for the development of a shared mental model.*
(4) *Inter-Team SA Processes: it may not be necessarily true the more information to be shared, the better mutual understanding between different teams for effective decision-making and performance. Sub-optimal decisions may well be better with less information to share compared to a good decision with a lot of information to share.*

According to Salas et al. (1995), coordination and sharing information are required specifically for team SA. They provided a framework for conceptualizing team SA and presented issues on measurement and training of team SA. The compatibility of the mental models among team members could be measured for a shared mental model.

Kanno et al. (2013) proposed a cognition model based on a mutual belief for team SA. The model is composed of three layers, viz. the first layer for individual cognition, the second layer for the individual's belief about the partner's cognition, and the third layer for the individual's beliefs about the partner's belief (Mahardhika et al. 2016).

Moreover, Endsley described organizational SA (Endsley and Robertson 2015) with team SA in a hierarchical way. On the other hand, disaster management has a heterogeneous nature in terms of stakeholders from different backgrounds (Murayama et al. 2013) and one needs to deal with this heterogeneity for SA so that inter-organizational SA or inter-team SA (Endsley and Jones 2001) may well be expected for disaster management.

9.3 Situation Awareness in the Disaster Management

In this section, we describe the needs for situation awareness in disaster management. The disaster management cycle identifies the flow of management at disaster in terms of the phases such as response, recovery, mitigation, and preparedness (Hiltz et al. 2010). We look into situation awareness in each phase. Figure 9.1 shows the cycle based on the integrated disaster management cycle originally produced by Guy Weets (Fig. 1.1 of (Hiltz et al. 2010)).

Just before and after a disaster, immediate response is required. The purpose of this phase is to save lives as many as possible as well as property losses. Alert should be issued timely so that people are aware of the situation and evacuate early enough

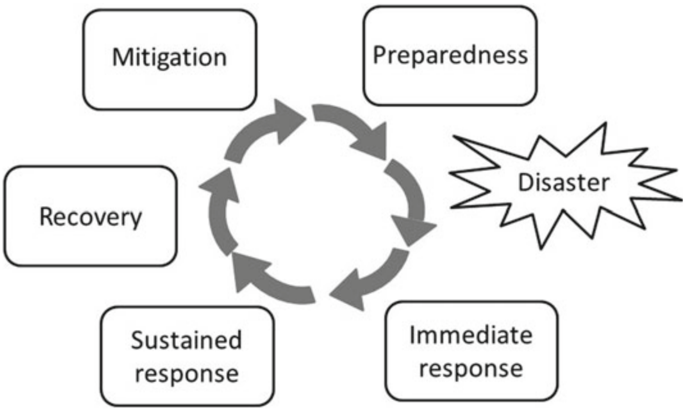

Fig. 9.1 Disaster management cycle

so that they are not attacked. Rescue is required as the first response. Meanwhile, one needs to set up shelters and manage them for evacuated people. Lifeline recovery is required here such as water supply as well as energy provision such as electricity, petrol, gas, and all that.

At a few months after the disaster, the recovery phase starts when victims are moving from shelters to temporary housing and then to more concrete housing in a few or more years. Social infrastructures such as public transportation services, roads, governmental services including health and education, and many other services required for daily life would be recovered.

At the mitigation phase, one would need to identify risks and providing countermeasures to those risks by modifying the current status of infrastructures, policies, and rules to mitigate the risks. A hazard turns into two responses, viz. risk and danger. For those who will try and mitigate the effect of hazard, it will turn to be a risk, while for those without such a challenge, it will be a danger which will cause anxiety and fear to people. Anxiety and fear are the feelings of insecure and unsafe. Experts accept a hazard as a risk, whereas people without knowledge about the hazard could remain in anxiety. Comprehensive risk communications would be important to the public at this phase. IT could be used by those experts to find out risks and countermeasures.

At the preparedness phase, one might provide training to disaster responders as well as evacuation exercise for people.

Situation awareness has been researched in emergency management. Johnson et al. (2011) combine the data available from various sources with human expertise to build customized models for situation awareness at an emergency. Sophronides et al. (2017) discuss the need for a centric network for sharing the common view at situation awareness.

9.4 IT in Disaster Risk Reduction for Situation Awareness

The use of Information Technology (IT) in Disaster Risk Reduction has been researched in terms of information systems for emergency management (Hiltz et al. 2010).

Turoff introduced the historical background of emergency management information systems (Turoff 2002).

Vieweg et al. (2010) analyzed the use of twitter for enhancing situation awareness at Spring 2009 Red River Floods and Oklahoma grass fires and anticipated the use by emergency responders. White et al. looked into the use of Social Network Services (SNS) for emergency management (White et al. 2009; Hiltz et al. 2014). Trustworthiness was one of the factors that causes risk managers in the U.S. not to use social media (Hiltz et al. 2014). Tanaka, Sakamoto et al. tried to deal with false rumor with SNS and presented the need for critical thinking (Tanaka et al. 2014). We identified how people would decide to spread rumor over SNS (Abdullah et al. 2017). On the other hand, it might be quite difficult to judge precisely whether a piece of information is true or not. One may well need to go on with uncertainty in such a chaotic situation as emergency response. There appear to be individual preferences on how to deal with the information collected using SNS.

IT could support situation awareness in each phase of the disaster management cycle introduced in the previous section. In this section, we introduce some example cases of IT use in disaster management and examine them particularly in terms of individual SA as well as team SA.

Most cases, those tools, and systems support individual SA Level 1. On the other hand, it needs the expertise of an individual for Levels 2 and 3. When we only had a limited number of emergency management experts, we would need to use intelligent system making use of Artificial Intelligence (AI) and learning systems based on a big amount of data in future.

Sapateiro and Antunes (2009) looked into team SA, based on which they proposed their emergency-response model (Sapateiro and Antunes 2009) based on the work by Bolstad and Endsley (2000) on the following four crucial factors of team SA: "

(1) *Shared SA—the degree each team member understands what information is needed by the other team members);*
(2) *Shared SA devices—supporting communication and information sharing;*
(3) *Shared SA mechanisms—supporting shared mental models; and*
(4) *Shared SA processes—supporting effective team processes."*

We shall look at the use of IT for individual and team SA as the above in disaster management in the following sections.

9.4.1 Information Systems for Immediate Response

We had interviews with several people coping with disaster management at the Great East Japan Earthquake and Tsunami in March 2011 in Iwate Prefecture located in the northern part of the main Island, Japan (Murayama et al. 2016). We introduce the two systems which we came to know of after interviews; an integrated disaster management information system (DIS) (Cabinet Office 2011; Cabinet Office, Government of Japan 2015) and the emergency medical information system (EMIS) (Ministry of Health, Labour and Welfare of Japan 2020).

DIS is developed by the Cabinet Office of the Japanese Government based on the experience from the Great Hanshin-Awaji Earthquake in Japan on 17 January 1995. The main features of the system include the functions for early assessment of damage from earthquakes based on the information received from Japan Meteorological Agency (JMA) as well as from satellite images and for information sharing with the use of a map. The system is to be activated by a big earthquake with an intensity level 4 according to the seismic intensity scale defined by the Japan Meteorological Agency (JMA) or greater and estimate the number of deaths.

According to one of the interviewees, a medical doctor who used to work in the emergency response team in Iwate, DIS underestimated the number of deaths in Iwate as the cause of the death was mainly by tsunami and not earthquake. Consequently, the government overlooked the situation and the Disaster Medical Assistance Team (DMAT) did not respond promptly. Moreover, the past earthquake along the coast of Miyagi and Iwate was named after Miyagi prefecture, south of Iwate, and Iwate Prefecture looked presumably fine.

In terms of Endsley's three SA levels for individual SA, DIS gives the information at level 1 while it may well depend on the information receiver's knowledge or experience to comprehend the situation at level 2. If the receiver presumed the threats from tsunami related to the earthquake, one might have gone and checked for its possibility. In terms of team SA or team SA, there was a lack of shared mental model (shares SA mechanisms) in the view of possibility of multiple disasters—i.e. tsunami after the earthquake.

The nation-wide EMIS is an information-sharing system operated by the Ministry of Health, Labour and Welfare of Japan. It collects and provides information on disaster medical care and relief, such as the situations of hospitals, shelters, and first-aid stations in the disaster area. EMIS was not working on 11 March 2011 due to the destruction of telecommunication links so that no information was available from northern Japan.

According to three individual SA levels, again it depended on the information receivers to comprehend the outcomes at level 2 that no information might indicate the possibility of the telecommunication destruction. Alternatively, at level 1, the system could have provided the receivers with the current status of the communication links.

In terms of team SA, EMIS operators or users need to have another channel for "devices for shared SA" to communicate with organizations in disaster area to figure out the possibility of the distraction. Moreover, the EMIS users might have needed to improve "the mechanisms for shared SA" so that their mental models could be updated enough to presume the possibilities of multiple disasters as well as consequent communication link distractions.

According to the interviewed doctor, SNS was not used because there was too much information available for him to process and some were inaccurate. On the other hand, another doctor who was a member of the emergency response team at Iwate Prefecture told us that he would prefer to get all the information including incorrect ones so that he could decide whether to trust the information or not by himself. That would raise the issue of how to deal with a big amount of information and to deduce which was trustworthy as discussed in Sect. 9.3.

Indeed, the trustworthiness problem of information from SNS at disaster was resolved by the Disaster-information Analyzer (DISAANA) (Mizuno 2016). DISAANA analyzes the messages (tweets) on Twitter real time, deduces automatically problems at disaster, and shows any related tweets as a reply to a question. It deals with bogus tweets with presenting all the related tweets together with an attention mark so that the user is aware of the contradictions; it leaves the user to decide which one is trustworthy (Otake 2015). The system would be of help for the information receiver to understand the situations at SA level 2.

This issue is also related to the use of SNS or any other ICT tools for citizens to report emergency. Emergency call using SNS has been researched. The identification of a reporter such as location with GIS information and telephone number of the reporter would be the major factors to make the message trustworthy (Torieda 2014). Such authentication helps individual SA at level 2. In terms of team SA incorporating SNS as an input for such first responders could be regarded as unreliable information from "devices for shared SA" so that the receivers need to justify whether to take the information or not. The "mechanisms for shared SA" need to take account of the authentication information of reporters such as GIS and the telephone numbers for decision making. Moreover, the first responder team needs to update their shared mental models.

For fire emergency, a web service, The Net119 emergency reporting system was introduced recently in Japan for people with disabilities to report fire or call an ambulance (Fire and Disaster Management Agency 2019). This service provides individual situation awareness at level 1.

McManus et al. (2007), Milis and Van de Walle (2007), and Kanno and Futura (2006) looked into organizational resilience at emergency in terms of situation awareness.

9.4.2 Information Systems for Sustained Response

Throughout our experience of IT support to provide personal computers and internet connections in disaster area at the Great East Japan Earthquake and Tsunami in March 2011, we could not find any information system available at hand in Japan for emergency response (Murayama et al. 2013, 2016). In the middle of April 2011, we were asked by our prefectural governmental emergency management officers to implement an information system for shelter management in 3 days so that the distribution of goods to shelters from the capital of Iwate Prefecture could be performed timely and effectively. That was impossible but we asked industrial volunteers to implement such system based on Sahana (Currion et al. 2007).

Sahana, an information-sharing system for relief operations at disaster, was developed originally by programmers in Sri Lanka just after the 2004 Indian Ocean earthquake and tsunami which hit Indonesia, Thailand, Sri Lanka, India, and many other countries in December, 2004 (Currion et al. 2007; Careem et al. 2006), and was used for disaster response such as the 2008 Chengdu-Sitzuan Earthquake in China and the 2010 Earthquake in Haiti (Sahana Software Foundation 2020). The system was implemented as a free and open-source software application and has been supported by a developers' community (Sahana Software Foundation 2020).

Sahana came into the Japanese open source community in 2010 and was started operating with Sahana Eden which is based on Python (Yoshino 2012). Just after the Great East Japan Earthquake and Tsunami, Sahana was introduced to Iwate Prefecture and expected to be used for shelter management.

The system was developed by the industrial volunteers developed with the support Sahana Japan Team (SJT). It was ready at the end of May, but too late. Shelters were supposed to accommodate the victims only for a few months and then those victims were expected to move to temporary housing in July. The earlier the system had been provided, the more it would have been of help. Nevertheless, the system was used to a certain extent in some cities (Yoshino 2012). The system was used to collect the requests for daily necessities as well as the statistics such as the total number of people in a shelter as well as the number of vulnerable people (Murayama et al. 2016; Yoshino 2012).

The system provides individual situation awareness of shelters at levels 1 and 2. With the past requests, one may estimate the future requests so that it could have served for individual situation awareness at level 3. We could see the users of the system as an inter-team with shelter managers from the local government, responders including governmental officers, doctors, and first responders for Iwate prefectural governmental emergency management headquarters, who would make decisions on goods distribution to shelters as well as collecting statistics of the people in shelters. The system was used to provide shelters for goods and statistical information, indeed so that requirements and devices for shared SA are provided. On the other hand, the system could not pass the perspectives of the requirements—i.e., why people need those good items. Therefore, "Shared SA mechanisms" to support shared mental models might have been missing. Nine years ago, local government officers were victims in the way that many of them lost their family members, and under those stress, they had to work for shelter management and other work in the disaster area. Several years later, one of the officers who used to work at the prefectural governmental emergency management headquarter had a chance to visit and work for one of the local governments in the disaster area, told me that he was not aware of how the local officers felt when communicating with those in the headquarters. There was a gap between those in different teams—a team in the disaster area and a term outside the disaster area. Sharing SA mechanisms between shelters and the emergency management headquarter are important and missing in such an information-sharing system for disaster management.

While there was a desperate need for the information system for disaster response such as shelter management at the 2011 disaster in northern Japan, Sahana was not used immediately. We presume the following two reasons (Murayama et al. 2016). One was a language problem. The SJT made the system eventually workable in the Japanese language environment in April 2011, whereas the disaster came in March 2011; accordingly, the introduction of the system was a bit late. The other reason would be the programing language, Python used in Sahana. We only had a limited number of programmers who knew Python in Japan at that time. On the other hand, one had to adapt the system according to the needs in Iwate (Murayama et al. 2016).

9.4.3 Information Systems for Recovery

We introduce a system we developed, Recovery Watcher, for situation awareness for people outside the disaster area to know the recovery pace by sending camera images periodically from the disaster area (Saito et al. 2012; Murayama and Yamamoto 2017; Murayama et al. 2019). Recovery from disaster takes long; meanwhile, people outside the disaster area may well lose their interest in how the recovery goes the disaster as time goes by. How can we let those people to keep their interests? This is our original motivation to develop the Recovery Watcher system. Presumably, the system could be used for situation awareness at the earlier stage of disaster management than recovery, such as for emergency response as well as rescue (Murayama and Yamamoto 2017; Murayama et al. 2019).

The first version of our system used the streaming service, U-stream. The live camera was set up at the town hall of Yamada, Iwate, Japan. As video took much bandwidth of the town hall network, a still image-based system was implemented (Saito et al. 2012). The system accumulates images as an archive and presents them to a user to look back to the past. The system was operated for a few years in other two cities in Iwate and then had to stop the operation due to administration changes (Murayama and Yamamoto 2017; Murayama et al. 2019).

We have been implementing a newer version of the system using smartphones as cameras instead of a web camera attached to personal computers so that it is easier to set up the observation site in the disaster area (Murayama and Yamamoto 2017; Murayama et al. 2019). The server receives images from smartphones periodically and locates them on each camera's Web page.

Camera locations are to be presented on a map using Open Street Map (OSM) and a user looks up the images specifying the camera on the map. Images are presented in a calendar through which the user can specify the month and date to get the images on a specific day (Murayama and Yamamoto 2017; Murayama et al. 2019).

The system for watching recovery provides individual users outside the disaster area with situation awareness possibly at levels 1 and 2 in a way that seeing is believing. Our first version of the system made use of Ustream which provides users with live-streaming of the disaster area with a chat function so that users can watch the disaster area and talk with others to share the feelings. Later we changed to provide images rather than video-streaming without chat so that users lost a chance to communicate with others. The chat function worked as a social media and might have provided users with an opportunity to share individual mental models at level 2 to understand more in a subjective way on the video information they saw. Such subjective and emotional aspects were not discussed in individual SA as the research domain of SA started with more military and professional perspectives. It needs further study to investigate how such emotional aspects of information receivers could influence mental models to comprehend the situation with individual SA.

Moreover, it may well be possible for the system to help the users to project future status at level 3. If the system would be used for the emergency response phase, the emergency responders may take the information from the system in a similar way as the one from social media. It may well depend on how much trustworthy those responders feel about the system providers, the system itself and the provided information. That is the trust is required for "shared SA devices" for those responders to use the information. That would be a part of "shared SA mechanism" how much mental models are shared between the system providers and the responders as a user. The authenticity of the images and camera locations in the disaster area may well be presented. Another information source could be used by responders to authenticate the images such as the communications with local government officers or any others whom those responders trust.

We use android smartphones for implementation and operate for an experimental use for barrier-free information support at a university environment. The idea is to help people with disabilities and their supporters to be aware of the situations of the university campus before they come. Through our work on Recovery Watcher, we came to know that the system could be used for situation awareness not only for disaster but also for inclusive support (Murayama and Yamamoto 2020).

9.4.4 Information Systems for Mitigation

At the mitigation phase, IT could be of use for those experts to find out risks and the countermeasures. Based on simulation, environmental scientists use it for identifying risks. Simulation is used for disaster response (Imamura 1995; Imamura et al. 2006). Simulation has been used extensively for evacuation as well (Makinoshima et al. 2018). Dangdale et al. look into building evacuation using simulation and use of recent Internet of Things (IoT) technologies (Dugdale et al. 2019). Simulation would help individual SA at all three levels. We can look at those responsible for building management as a team and they may well need such information to produce an evacuation plan for emergency, which could be considered as team SA. Simulation is a "shared SA device" and team members need to have the mechanism to share mental models to understand the implications of the simulation results.

Recent technologies, such as artificial intelligence (AI) and big data mining technologies could be used. Barakbah provided information on risk about earthquake in a region in Indonesia by use of big data analysis (Barakbah 2017).

9.4.5 Information Systems for Preparedness

One of the active uses of IT in the preparedness phase of the disaster management cycle is an evacuation map which could be a good indication for people how to evacuate when facing a disaster. In the northern coast of the main island in Japan, there used to be an old wisdom, "Tendenko": scatter away and evacuate first without trying to save your family (Kahoku Shimpo Online NEWS 2015). The region has been attacked by tsunami every 30 or 40 years, so the wisdom is important for people to remember. However, people felt guilty to evacuate by themselves without taking care of family and the other people they know when facing tsunami. Yamori (2012) suggests that it is important to have the mental preparedness to save oneself first, trusting that the other people shall make best effort by themselves to evacuate.

Evacuation mapping has been conducted from the viewpoint of urban planning (Yamamoto et al. 2015; Yamamoto 2015). Yamamoto and industrial members provide workshops to produce evacuation maps with residents in several towns including those hit by disaster in Japan (Noigechizu Web 2020). As a result of the workshop, they produce the evacuation map on a sheet of paper, in which roads and paths on an evacuation route are presented in different colors according to how long it would take from the evacuation goal with a walking speed of the elderly for instance; e.g., green indicates a 3-minute distance, lawn green for 3–6 min, yellow for 6–9 min, and so on. Participants to the workshop discussed and colored the map as well as inputting more information on a map. While the map could be digitalized and more information would be input on the map, the process to create a map is paper-based.

Through the course of producing an evacuation map in a workshop, the participants would be aware of the situation in their residential area and the final map would inform the other residents with the situations as well. IT could be used to support to production and presentation of the map. The workshop would help the participants to understand the meaning of the information they collected so that individual SA levels 1 and 2 are achieved. Also, at the workshop or after the workshop, one may well find future risks so that level 3 could be achieved.

We can also view the workshop as a community activity, so that it provides team SA. Participants share "requirements," and "shared SA devices and mechanisms" throughout the course of the workshop. As a result, effective decision-making and performance are possible based on the map and interactive communications to share mental models.

Yoshino and his team have been working on an information system for disaster prevention and support for people at disaster, Akari map which would motivate users to try and use regularly before the disaster (Yoshino 2017; Hamamura et al. 2014). Users would download the disaster information before the disaster so that they could make use of it offline even there is no network connections after disaster.

More recently, Yoshino and his research group developed another disaster information system, Agara map to support participants of the evacuation map workshop (Enokida et al. 2018a, b). With the Agara map system, users would take a walk with a smartphone in a town and collect information. After that they attend the workshop and based on the collected information on a map, one can produce an evacuation map which would be presented to stakeholders so that the workshop participants would get more feedback. The Agara map system would help team SA as a useful device to collect the information for producing a map at the workshop. Within the workshop participants share "requirements," "mechanisms" to share mental models with stakeholders and teammates which would produce a better map for future decision making and effective performance at disaster.

9.5 Discussion

In the disaster communications which is the communications between stakeholders in disaster management (Koshino 2015), we looked into a specific aspect, situation awareness.

Fig. 9.2 Information processing in disaster management

Information processing in disaster management is to create intelligence as in Fig. 9.2 whereas traditional information processing in information science and technology is to create information. In a specific IT research domain, Artificial Intelligence, information processing is to produce Fig. 9.2. Information Processing in Disaster Management intelligence and knowledge out of data.

In situation awareness at disaster management, with the same data and information, each one of the information receivers would take it differently depending on their knowledge, experience, and mental model. From the viewpoint of distributed name management, Sollins (1985) described that it is necessary for the sender and the receiver to share the context in order to have a common understanding of a piece of information.

For sharing situation awareness in disaster management, we need to exchange this context for understanding the situation in the same way. On the other hand, when the context is based on experience and knowledge, only a limited number of experts have them in disaster management, since disasters including recent disasters, COVID-19, differ completely from one another. Previous knowledge may well be not useful or even harmful for a new disaster. AI and machine learning may well help us to produce such a context based on the previous data so that even novice could have a common comprehension with the experts. On the other hand, "unlearning" (Grisold et al. 2017) would be required for experts to deal with a new type of disaster where knowledge and experience would be harmful.

9.6 Conclusions

In this chapter, we looked at some exemplar IT uses for disaster management in the viewpoint of situation awareness. Related work on situation awareness suggested that it requires to share information as well as its comprehension. One needs to have enough intelligence, knowledge, and experience to understand situations. We need to share such intelligence, knowledge, and experience to share situation awareness. Recent technologies such as AI and learning methods may well be of help.

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