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Research on Disaster Communications

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Abstract. From our experience the Great East Japan Earthquake in March 2011 to help out the people in the affected area in terms of IT support such as internet-working and providing PCs, we came across an interesting issue concerning collaboration with people including supporters as well as the victims. We call this problem disaster communications. We also came to know the needs for disaster information processing as there was no such systems to manage shelters, goods distribution and volunteers. On the other hand such systems have been researched in the United States of America and Europe in terms of information processing for emergency management to a great extent. While we have had many natural disasters in Japan, only a very few of the researchers in computer science and information systems have been working on this issue. From this perspective, we try to identify the information required at disaster in this research. In particular, we explored the needs and seeds for disaster information processing in Iwate, Japan. We interviewed some supporters at Iwate in March 2011 such as local government officials, doctors and university administrators and found the situation awareness was required desperately in the beginning of the disaster. This paper reports our project of interviewing people who worked on disaster relief during the emergency response as well as our trial of a system for situation awareness based on the results from our interviews.

Keywords: Disaster Communications, Situation Awareness, Information Processing for Emergency Management.

1 Introduction and Motivation

The Great East Japan Earthquake on March 11th, 2011 caused severe damage to the northern coast of the main island in Japan. 15894 people died, 2546 are missing and 6156 are injured [1]. Just after the disaster, industry in the Tokyo area wanted to provide PCs and printers to the affected areas but did not know who would like to have them. Academic and industrial groups of engineers wanted to provide internet connection services but again did not know where the services were most needed. With requests from such organizations and groups of people, we started our support as a coordinator of such requests and finding the needs for such services, with a few of us in a university in Iwate, Iwate Prefectural University ten days after the disaster [2].

Our activities included collecting local information on requirements for IT equipment and internetworking services in the affected area as well as arranging to receive,

store and manage incoming IT equipment. We got the information on such needs by communicating with people in the various local government entities and with a volunteer center located in Tohno, Iwate, just a behind the affected area. We also set up a mailing list with those people and sent a daily reports on what we did. Most of our activities lasted for four and a half months from March to the end of July during the initial emergency response. By the end of July, most shelters were closed and the people moved to temporary housing constructed by local governments. Gradually we went back to our normal work.

Through our support activities we were aware of the needs for information systems to coordinate the needs from the affected area and the support coming from the outside that area. For instance, the information system for shelter management was required desperately after one month of the disaster, as the emergency response team at the Prefecture office would like to know the statistics of disaster weak o each shelter to provide medical support as well as collecting the accurate needs for goods for their timely distribution. We also came across an interesting issue concerning collaboration with supporters from heterogeneous backgrounds; we call this problem disaster communications and found that trust plays an important role [2].

We found the lack of research and development of such an information system for emergency in Japan, while the issue has been researched for long time in the other countries [3] [4]. We learned from the related work [3] that case studies were of great help to many researchers. Moreover, we learned that Hiltz and Plotnick started interviewing risk managers on the use of social media [5]. Consequently, we started interviewing officers, doctors and volunteers who worked for the earthquake and tsunami emergency response in Iwate [6].

Finally, we also introduce one of our work of information systems for emergency management. We have implemented some systems required to help out the affected area [7] and one of them was recovery watcher system to keep people being aware of what is happening in the affected area [8]. In our project, we implemented the system again with use of smart phones and found it applicable for other applications as well.

In this paper, we introduce our previous work on disaster communications including our experiences and interviews as well as the recovery watcher system. The paper organization is as follows. The next section reports IT support required at the disaster in Iwate Prefecture. Section 3 discussed the interviews and their results. Section 4 reports about some institute hit by tsunami. Section 5 presents our new recovery watcher. Section 6 gives some conclusions.

2 IT Support required at the Disaster

We supported mainly four cities and two towns on the coast in Iwate prefecture during the initial four months after the disaster. The following supports were required:

1. Information acquisition and provision:
 - Safety information for search people,
 - Visualizing Lifeline information
 - Portal sites of disaster information

2. Networking for information infrastructure:
 - internetworking with communication links
 - IT environment with PCs and printers
3. Shelter information management
4. Volunteer Support

We describe more on the above requirements in the following subsections.

2.1 Information acquisition and provision

For safety information, initially we did not have any network connectivity in shelters. One of our graduates, working as a volunteer at the volunteer center, created an off-line system for people search. Another graduate in Tokyo created software for mobile phone access. The safety information was provided by local police; the information was also available on the Prefecture's home page.

For safety information, we had an interesting technology deployment in Japan for this disaster: the use of broadcast services. People in shelters appeared on TV with a piece of paper on which their names were written, saying where they were staying as well as any other comments such as whom they were seeking. Iwate Broadcast Company (IBC) converted such information on their TV and radio services into the digital form and provided them at their web site. The problem was that the IBC digital form was different from the one provided by the police. We merged those two types of information for the search system on the mobile phone.

For visualizing lifeline information, we mapped road conditions, transport, electricity, water supply and so on. For road conditions, the information was provided by use of GPS car navigation systems. The system was originally created by a car company [9]. Now the information was integrated into major web search systems.

We set up a portal site of disaster information. We provided all the above information and also information such as radioactivity levels, because in the beginning some people including the volunteers in the Volunteer Center (VC) did not know this because they were too busy every day to look at the news.

2.2 Networking for information infrastructure

For Networking for information infrastructure, we supported the engineers for internetworking by providing information where to set up the network with communication links. Accordingly, we provided an IT environment with PCs and printers in shelters and other sites such as city halls in which networks were set up. Networking was hard due to the size of Iwate Prefecture. For instance travel would take nearly three hours one way to the city located in the south of the prefecture. It took almost one day for network engineers to go there and set up networks.

We consulted the prefectural emergency response headquarters for which sites to be connected in the beginning and asked the network engineers to set up when communication links and electricity could be made available. We asked mainly medical doctors at the headquarters who wished to talk to the local doctors at shelters.

The engineers researched each site thoroughly by visiting and seeing what type of communication links should be set up such as a 3G link or a Satellite Communication link. Gradually, those network engineers knew the affected areas much better than we or engineers in the prefecture headquarter did. In the end, the field engineers were deciding where to set up networks independently by talking directly with the local government officers. Through our joint work the major shelters were connected onto the network and we provided around 200 PCs and 50 printers in total.

2.3 Shelter information management

Shelter information management was required from the beginning, however, we were asked to help with it one month later after the disaster. What happened was that goods and foods sent to Iwate prefecture were stored in the central warehouse near the prefectural office then they were delivered to shelters at the coast. However, the requirements from each shelter were not reported precisely enough and many shelters received some unnecessary goods. Initially, the requirements were collected manually and sent to the prefecture's emergency response headquarters by fax.

A management system with a good communication system was required desperately. We came across the people working on the Sahana system [10]. Sahana is an information sharing system for humanitarian assistance at disaster and was developed originally by programmers in Sri Lanka just after the 2004 Indian Ocean earthquake and tsunami. The system is based on a free and open software and has been used extensively at disaster such as the 2008 Chengdu-Sitzuan Earthquake in China and the 2010 Earthquake in Haiti [11]. Sahana has been introduced to the Japanese open source community in 2010 and some started with operating the system with a type of Sahana software called Sahana Eden which is based on Python [12].

We introduced Sahana to the prefecture's emergency response headquarter. After March 11th, 2011, Sahana Japan Team (SJT) [13] was set up and those industrial volunteers developed a new system for distribution for Iwate with the help from SJT [12].

The system was ready eventually, at the end of May, but it was late as most of the shelters were about to be closed by July and the residents were to move to temporary housing. It would have been more useful if the system had been provided much earlier in March or April. Nevertheless, the system was used experimentally in some cities [12]. The system was used to collect requests for daily accommodation as well as the statistics on the number of people from shelters, and commodities were distributed daily based on the requests.

2.4 Volunteer Support

We also provided information on shopping and other daily-life-related tasks for newcomers to the Volunteer Center. We were asked to set up a Volunteers' site for sharing information. In the VC, they were not capable or too busy to set up a server. Moreover, a physical system would have been hard for them to maintain.

We set up their site using a cloud service. We found it very practical. The cloud services are sustainable in that they do not suffer any damage such as blackout or physical damage to the server from local disaster. One does not have to worry about maintenance. Compared to physical servers, cloud services were much more flexible and easier to set up.

2.5 Findings from the Support Experience

From the above experiences we figured out what is needed for disaster information systems as follows:

1. Need a standard format
2. Open Source: e.g. Sahana
3. Need a well-known interface
4. Killer Application for Cloud Computing

As 1 above, we needed a standard format for the exchange of disaster-related information. In the subsection 2.1, we reported about the difference in the safety information formats between the one used by a broadcast company and the other by the police. If they had used the same format, it would have been a lot easier for us to put together the information from the both sources. Such standards were required in shelter management information, goods distribution and medical information. Information on donation could be standardized for traceability as well.

For 2 above, open source software would be usable at disaster because a global community of software developers would be of help. On the other hand, open source may need the local software engineers to deal with local language some times. That happened in Japan this time.

Sahana was not used immediately after the disaster in Japan presumably due to two reasons. One was a language problem. The great efforts were made by SJT to make the system workable in the Japanese language environment, but it was eventually available in April 2011, so that promotion for a use of the system was late. The other presumed reason would be the programming language. Python used in Sahana was not so popular in Japan. Sahana was needed to be adapted for the needs in Iwate and there were only a limited number of developers available who were able to do so. We may well need for a software engineers' community to work globally to exchange the information yet they can deal with local language problems.

For 3 above, for any information system for emergency management, user interface is important and should be well-known. If one provides a new interface for the systems at disaster, the users have to learn how to use them firstly; that would be impossible when one needs to deal with things immediately.

For 4 above, most of the information at local governments were papers which were lost or contaminated with sea water physically. The information would be kept electronically and in a distributed manner for disaster so that the original information could be saved. From this perspective, cloud computing is ideal for the governmental information at local governments.

3 Interviews of the relief workers

Hiltz and Plotnick started interviewing risk managers on the use of social media [14]. Consequently, we interviewed thirteen people since December 2014; they were officers, doctors and volunteers who worked for the earthquake and tsunami emergency response in Iwate [6].

As some interviewees mentioned, many outsiders came and helped the disaster area. However, communications between relief workers and local workers were not so good. Misunderstandings happened easily when one was exhausted with short sleep while daily work and situations were not familiar. We identified the need for trust [2] in communications between relief workers at disaster.

Indeed, swift trust was required for those who need to collaborate with the outsiders. Swift trust is a novel issue in the research on trust and defined by Debra Meyerson et al [14] based on related work. According to Aggarwal [15], social diversity influences decision making in swift groups. For emergency response, governmental officers as well as doctors need to work together forming swift groups. We could apply findings from researches in swift trust.

Our findings include the followings:

- It is important in emergency response to collect information, to coordinate different sectors and entities and to make decisions without enough information
- One needs to make decisions promptly and to proceed under unusual mental situations such as dealing with corpses.
- One needs to work together with people from heterogeneous perspectives and organizations.
- A trustworthy and reliable coordinator is required for a swift team of relief workers with different perspectives to deal with various issues.
- In hospitals, doctors need to deal not only with acutely-ill victims but also with the chronically ill patients. Coordination is needed between regular doctors and DMAT doctors.

We also interviewed one of the officers of the prefectural government again in March 2017, who moved to work for a local government in the affected area. He raised two more findings both related situation awareness:

- At the disaster in 2011, in the beginning, information was not enough for situation awareness.
- Before one talks to the local government officers in an affected area, we may well need to consider what situations the local government officers were involved; they might have been stressed by loss of family members and colleagues, as well as by too much work load with a limited number of officers.

The following issues need to be explored in future:

- a) Swift trust in disaster relief workers.
- b) How to deal with false information at emergency response.
- c) Information processing with or without network connections.
- d) Protection of information.

- e) Swift trust could be applicable for communications at emergency response to let people collaborate with one another.
- f) Situation awareness is important in various situations such as for rescue and emergency management as well as communications to the people in a disaster area.

We need those issues solved in future as well as keep interviewing to get more information on needs at disaster. One could protect information locally by use of USB stick memories as reported in the next section. Use of cloud computing would be ideal. The problem with cloud computing is that without communication links, it does not work. Indeed, communication links were gone at the disaster.

We also need to look into how one can handle false information when the situation is chaotic. We could apply some research results on how one can trust the information [16]. How one can deal with false information has been researched for SNS [17][18].

4 An office at tsunami

Prior to our interview we heard informally what happened in the disaster area from one of the office workers at our university office, who was working for Iwate Fisheries Technical Center, a prefectural government organization, at the Great East Japan Earthquake and Tsunami. [19].

Iwate Fisheries Technical Center was located by a bay in Kamaishi City, which is in the disaster area in Iwate Prefecture. The center conducts research and provides information and support for fisheries in Iwate. The center office was severely affected by the Tsunami. The ground floor of the center was flooded with seawater and computers and IT equipment were soaked in the water. As the research center had a system to produce distilled water, hard discs were washed with the water. Some of the disks' data were recovered successfully but others' were not. Among various methods to recover data, a traditional USB stick memory with a cap protected data almost perfectly. In our support project, we had many requests for data recovery from memory and PCs soaked with seawater. We shall need IT support for such hardware as well as distributed information management making use of cloud computing services.

At the Fisheries Center, they had many documents on paper. They were soaked with seawater but saved. After some time, they got too moldy and smelly to be used. The documents would need to be digitalized to be saved. Also, at the disaster area, there was popular voluntary work to wash and save personal photographs which were soaked with seawater. One could develop a way to clean and preserve paper documents for an office.

5 Recovery Watcher

It takes long to recover and reconstruct the towns and cities at disaster area. Meanwhile the interests into such recovery and reconstructions would be faded out outside the disaster area as time goes by. Accordingly we came up with the idea on recovery watcher to keep people being aware of what is happening. On the other hand, we could use the

system for situation awareness at the early stage of disaster management cycle such as emergency response and even at the rescue phase.

In the beginning, we use the u-stream service and located a camera at the town hall of Yamada, Iwate, Japan. The system used video so that it took some bandwidth at the town hall. We implemented a still image-base system which did not need so much bandwidth [8]. It recorded images in a calendar so that people can look back on the past. We located the system in other two cities in Iwate as well. The system was operated for several years but due to administration changes, we needed to stop.

This time, once again we implemented the system with the use of smartphones as cameras. Fig. 1 shows the model of the system. Smartphone cameras are to be located at multiple places in the disaster area. Images are to be uploaded to the server which provides the image share space through Open Street Map (OSM). Uploaded photos are located in the space so that one can look them up through the OSM. The information manager may manage the uploaded sites so that if we add a new camera site, the new calendar will be prepared by the manager so that we control the camera sites. The user look up for a particular place over the OSM and look up for the images, current ones as well as archives through the calendar. The smartphones will use either Wi-Fi connections or telecommunication links.

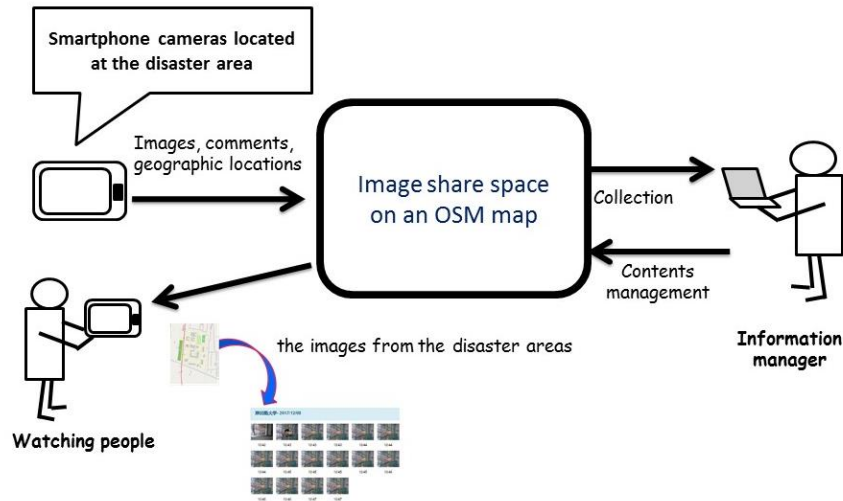


Fig. 1. The model of the new Recovery Watcher System

We have implemented with the use of android smartphones. In order to examine the operability within our university, we used the system for inclusive support in such a way that barrier free information is provided through this system for the people with disabilities as well as their supporters to find out the situation of the university campus. It is interesting to know that such situation awareness is required for inclusive support as well as for disaster.

Elevant [20] is working on sharing weather information. Presumably natural disaster could be considered a kind of the weather, so that a service for sharing weather information could be used at disaster. Indeed, one of our findings was that at disaster people would not dear to use a new interface of a system; they prefer familiar interfaces. If we provide a service to share weather information for a daily use, we could possibly make use of it for disaster as well.

For a long run, we could use this sort of sharing service to convey the warning information at disaster. One of the big issues at the disaster was that one needed to get out of Tsunami as soon as possible without caring your family members --- i.e. we need to help ourselves first. This old wisdom was not passed correctly from generation to generation and brought the tragedy again. The coast area of Iwate was attacked by Tsunami once thirty to fifty years again and again. The question is how one can convey such a warning to remind people daily. One of the solutions could be such a weather sharing site. We need more research on sustainability of information delivery sites.

6 Conclusions

In this paper, we reported our experiences from our support activities just after the Tohoku earthquake and tsunami on March 11th, 2011, and introduced some of our work in this research area. From our experience, the major supporters at the disaster in Japan would be officers in local governments, some in the prefectural emergency response headquarters and volunteers, whereas in the other countries, international organization such as Red Cross would play a major role at disaster management with volunteers. Sahana was used in such an environment. In Japan, due to local language, i.e. Japanese as well as the popularity of python language, Sahana was not used so extensively. We had better look into this issue in future as we have had so many different disasters since 2011.

We also presented a project to interview relief workers who supported disaster area in 2011 and reported the findings. One of the findings was situation awareness, so that we implemented recovery watcher once again. The system was introduced with a new model which makes use of smartphone cameras and OSM.

We presented trust is an important issue in disaster communications in our previous paper [2]. More work is required in terms of swift trust in future. From a sociological viewpoint, Yamagishi [21, 22] gave Japanese oriented characteristics compared to the concept of trust. In disaster communications we might need to consider such cultural differences.

We need to have further study on disaster communication to proceed as exploration in terms of social science [23]. Moreover, more documentation on what had happened in Japan is required to be published world-wide so that we can work on these important issues in more global manner [3].

Moreover, we are interested in investigating further on the use of social media in Japan. At the Great East Japan Earthquake and Tsunami, Social Networking Services (SNS) were not as popular as they are now. Research has been conducted to see the use in Tokyo area in which more people were using the service [20]. The use of SNS at the

disaster was reported that those data could be used in emergency response in future [21]. More work could be reviewed thoroughly in future.

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