THE TECHNOLOGICAL INNOVATIONS OF THE DISASTER COMMAND CENTER BASED ON THE EXPERIENCE OF THE JI-JI EARTHQUAKE

Tsung-Hsien Chen[1] and Ban-Jwu Shih[2]

[1]National Fire Administration, Ministry of Interior, Taipei, Taiwan, ROC
[2]Associate Professor, Department of Civil Engineering,
National Taipei University of Technology, Taipei, Taiwan, ROC

Abstract: To orchestrate future disaster relief operations, the authors had learned from their experience of the Ji-Ji Earthquake that both the equipment and the staffs need to be modernized. Also, to have a better chance to fight disasters, it is obvious that a state-of-art command center built upon the most current technologies is desired. This paper will focus on this aspect to examine the current trends of disaster communication, information processing, and image transmission.

Keywords: Ji-Ji earthquake, command center, geographical information system

1. INTRODUCTION

The Ji-Ji Earthquake brought an unprecedented calamity to the central part of Taiwan. The first author was in charge of the commands, deployments and coordination tasks at the Ji-Ji Earthquake Central Command Center and visited the disaster area personally to understand the extents of the disaster. He deeply realized that timely and effective responses of emergency rescues were what the victims of the earthquake anxiously expected. Hence, they were also the supreme golden rule of all Disaster Command Centers. To manage extensive disasters similar to the Ji-Ji Earthquake in the future, besides enhancing rescue equipment and personnel training, applying cutting edge technologies to Disaster Command Centers is also essential. First, by setting up various wire/wireless, radio, and satellite communications, an integrated communication network can be constructed. Second, using a computer network to collect information and report the extents of damages with the help of an integrated geography information system is also critical. At the same time, disaster warning networks, disaster simulation software, and decision support systems should be deployed. Together with the video cameras at selected controlling points and the cameras on board the unmanned aircraft, real time images can be transmitted to the large screen display in the Central Command Center. All of these technologies will help the commander of the Central Disaster Command Center to make proper decisions in a short amount of time, and make every rescue effort count.

2. THE EMERGENCY RESPONSE SYSTEM AND THE DISASTER COMMAND CENTERS IN TAIWAN

Guarding against disasters has always been one of the focal administrative works in Taiwan. To improve the disaster mitigation system, consolidate disaster prevention measures, and execute efficient emergency rescues, the Executive Yuan of the Republic of China announced the Disaster Rescue Program on Aug 4, 1994 to establish and enforce the disaster mitigation system against natural disasters in Taiwan. In this program, the central and local governments are required to set up active Ad Hoc Committees on Disaster Mitigation, and establish government rescue forces to perform disaster rescues when natural disasters occur. In addition, to fully prepare for natural disasters, the Central Committee on Disaster Mitigation is required to develop a coordinated Central Mitigation Plan as the basic policy of the central government. All relevant central agencies should implement their own Hazard Mitigation Action Plans, and every local government should draft its Regional Mitigation Plan according to its needs and interests [1].

Finally, the central agencies in charge of mitigating different disasters should develop their respective action plans for the Central Disaster Command Center, and call up relevant agencies to operate the Disaster Command Center when disasters strike. All levels of government are also involved in earthquake mitigation efforts by operating their levels

of Disaster Command Centers according to various Disaster Mitigation Plans and Action Plans. For major earthquake disasters, the Ministry of Interior develops the Action Plan for the Central Disaster Command Center. Whenever an earthquake caused severe casualties, the Ministry of Interior will assemble an emergency response team from its subsidiary agencies. Also, Interior Minister will act as the commander to convene the representatives of the Ministry of National Defense, the Ministry of Education, the Ministry of Transportation and Communications, the Ministry of Economic Affairs, the Council of Agriculture, the Governmental Information Office, the Environmental Protection Administration, and the Department of Health to set up an Earthquake Disaster Central Command Center at the National Fire Administration to respond to the disaster.

3. THE RESPONSE TO THE JI-JI EARTHQUAKE

Right after the earthquake that took place at 1:47 A.M. on the 21st of September, 1999, the Taiwan government established the Ji-Ji Earthquake Central Command Center to coordinate the emergency responses and rescue activities. At the same time, the government also instructed the local county and city governments in the disaster area to set up Disaster Response Centers for disaster relief activities. Furthermore, a field command center is established in the Nantou County to support field activities, distribute emergency supplies, coordinate field operations, and assist the local governments. However, because the damages caused by the earthquake was too massive and beyond the local resource capabilities, the Central Command Center then decided to mobilize all island-wide resources and dispatch rescue forces from neighboring counties to participate in the rescue efforts. This brought the emergency rescue into full play. In all, the total number of persons participated in the rescue efforts reached 276,310, and the total number of emergency vehicle deployments exceeded 181,235 times.

4. MODERNIZING THE DISASTER COMMAND CENTER FROM THE JI-JI EARTHQUAKE EXPERIENCE

There are three major aspects:

4.1 The structural safety of the Disaster Command Centers

After the Ji-Ji earthquake, the buildings that housed the disaster command centers at all levels of government were more or less damaged. Especially the fire bureau of the Nantou County, the fire bureau of the Taichung County, and some of their district fire departments were severely damaged. The building structures were examined and evaluated by professional engineers and determined to be dangerous structures that needed to be vacated immediately or retrofitted. Moreover, the Central Command Center at the National Fire Administration was also partially damaged. It turned out that some of the rescue workers were also victims of the earthquake disaster. Therefore, they needed help instead of providing help to others. This was a blow to the emergency rescue system. From this experience, it is clear that the seismic proof of the building structures of the Disaster Command Centers is a basic requirement. For maximum resilience to disasters, a back up Command Center may also be necessary.

4.2 The disaster communication of the Central Command Center

The chain of command will be broken if the communication system breaks down after a disaster. Therefore, establishing a disaster communication network is one of the most urgent tasks facing the disaster mitigation effort. The Ji-Ji earthquake caused severe casualties in many areas such as Jungliau Shiang, Guoshing Shiang, Puli Jen, Jushan Jen (all of them in Nantou County), Dungshr Jen, Shrgang Shiang, Heping Shiang (all of them in Taichung County), and Gukeng Shiang (in Yunlin County). However, the communication and transportation links were both broken, which prevented the causalities being reported to the command centers. On the other hand, regional power outages and telecommunication failures also paralyzed the local Disaster Command Center's communications. These centers could only rely on satellite phones and video systems provided by the Central Command Center. These systems were insufficient in number and created problems for all aspects of the operation of the local command centers.

To strengthen the disaster communication system, we need to consider the wire communications, the wireless communications, and the satellite communication systems [2]:

I. Wire communication

   A. Establish a communication system for the three levels of Disaster Command Centers—the central government, the metropolitan government, and the county, city, town, or village government. The communication system needs to be capable of transmitting voices, faxes, data, images, and videos to provide early warning, transmit disaster reports, enable decision supports, and follow

executive orders.

B. Set up a centralized 119 dispatch system (equivalent to the 911 system in the US) for each county and city government. The Automatic Number Identification system (ANI/ALI) will display the caller's phone number and address of every incoming 119 call. This centralized system will then coordinate the dispatch of rescue workers.

C. Establish a dedicated wire communication network for the emergency rescue forces that include the fire fighters, the volunteer fire fighters, and other emergency workers to avoid delays in dispatching due to busy signals.

II. Wireless communication

A. Establish dedicated channels for emergency rescues in every metropolitan area, county, and city. Also, establish shared channels for emergency responses between metropolitan areas, counties, and cities. Increase the flexibility of allocating emergency supplies and medical resources across the county or city borders to achieve the goal of uniting rescue resources and improving cooperation.

B. Assist every fire department to set up a transmission/relay station to eliminate transmission blind spots and improve the emergency communications.

C. Build up different kinds of radio communication equipment and facilities such as relay stations, transmission stations, ground substations, mobile vehicle substations, and portable substations in every metropolitan area, county, and city according to their individual needs for disaster mitigation.

D. Set up voice paging systems for volunteer fire fighters in every metropolitan area, county, and city to assist the government rescue forces.

E. Set up emergency rescue radio stations using the emergency frequencies and install emergency radio communication equipment in all levels of command centers, police stations, fire departments, medical facilities, and town halls to form a comprehensive communication network to monitor disaster calls and respond to emergencies.

F. Purchase emergency disaster communication systems that can transmit voices, digital images, data and two-way radio signals by microwave communication, High Frequency (HF) communication, T1-lines, and VSAT (Very Small Aperture Terminal) networks. Use mobile field command vehicles to set up field communication centers to support field rescue units in their communications, commands, coordination, and contacts.

III. Satellite communication

A. Establish dedicated satellite communication network systems for emergency rescues and disaster prevention. Use fixed small ground satellite stations, VSAT networks, and satellite phones to construct a reliable and efficient satellite communication network.

B. Set up field emergency communication systems in the disaster area. Use mobile command vehicles and helmet cameras to create an emergency communication channel connecting the command centers, field command posts, and the disaster sites, and provide decision supports to the decision-makers.

4.3 The internal operations of the Disaster Command Center

The Ji-Ji earthquake created severe causalities in a widespread area and large number of disaster reports were channeled to the Central Disaster Command Center. The Command Center needed to process this information in a short period of time and coordinate the rescue efforts. Therefore, the Disaster Command Center needed to integrate the disaster reporting system, the decision support system, and the geographic information system to perform its function properly.

4.3.1 Setting up disaster information transmission systems

To accelerate the transmission of disaster reports and improve the correctness of the information for the Central Command Center, the National Fire Administration established a Disaster Report Transmission System in the Central Command Center in 1998. It utilized computer networks to transmit the disaster-related information and compute subtotals automatically to speed up and improve the correctness of the disaster reports. After the installation, the system was put to the test during five typhoons in 1998 and one typhoon in 1999. The results were very satisfactory.

Also, in order to compile disaster reports, simplify user interfaces, and reduce the amount of time needed to forward information from local centers to the Central Command Center, the National Fire Administration has budgeted to redesign its computer software and change its NT systems to UNIX systems. In addition to simplifying the user interfaces, reducing the processing time, and improving the compilation of reports, a Geographical Information System (GIS) is also added to the system. It can be used to look up various emergency

resources such as personnel, vehicles, and equipment in the local governments, and provide decision supports to local command centers. The system is expected to be completed in December 2000.

4.3.2 Establishing disaster simulation systems and decision support systems for emergency rescues

Methods such as disaster potential analysis, possible damage analysis, and disaster simulation can be valuable tools for the local governments to understand the possible impact of disasters. Take the earthquakes for example. We can use the disaster potential analysis, risk assessment, and disaster simulation with the local geographic and demographic data to obtain the possible disaster sites, extents, and likely damages. Then, a practical and feasible disaster mitigation and emergency response plan can be developed according to this information. When a disaster occurs, real time images can be transmitted to large screen display in the Central Command Center using the video cameras at selected controlling points and the cameras on board the unmanned aircraft. All these technologies will help the commander to make the most proper decisions in the shortest amount of time, and make every rescue effort more successful.

4.3.3 Integrating geography information systems [3]

A geography information system can increase the accuracy of the disaster assessment and simulation results. Using it to investigate emergency resources such as rescue organizations, rescue workers, emergency supplies, hospital locations, and lifeline facilities can become a valuable reference in implementing a emergency plan and a perfect tool for in-disaster response [4].

Take the debris flow for example. The investigation and analysis of river valleys of potential mudflows has been completed. A database has been created according to the attributes of the data and integrated with the GIS to combine graphics, photos, characters, and numbers. This has made the preparedness of likely debris flows triggered by storms after the Ji-Ji earthquake more manageable with higher efficiently and accurately.

5. CONCLUSION

Taiwan is located in a region frequented by natural disasters such as typhoons, earthquakes and floods. In addition, Taiwan also has highly undulating landforms, steep mountains sides, and fast flowing rivers. Therefore, it is important to design a better disaster mitigation system. Applying modern disaster-prevention technologies and improving the disaster preparedness can help the government to protect the lives and properties of its citizens. Although the Ji-Ji Earthquake caused the loss of more than 2,000 lives and other countless property losses, we believe that we can rebuild our communities and create a better disaster mitigation system after a thorough review of our experience in the Ji-Ji earthquake.

REFERENCES

[1] Shung, K.-H., "The Study on the Organizations and Emergency Operation Plans of Local Governments for the Disaster Prevention and Protection," *A Compilation of the 1999 Hazard Mitigation Research Project Reports*, vol. 3, pp. 1.1-1.9, January 2000.

[2] Tserng, H.-P., “The Development of Survey and Evaluation Systems for Information Communication and Coordination of Hazard management," *A Compilation of the 1999 Hazard Mitigation Research Project Reports*, vol. 3, pp. 2.1-2.9, January 2000.

[3] Shih, B.-J., Chen, J.-H., and Wu, K.-C., "The Establishment and Applications of Geographical Information System for Disaster Mitigation and Emergency Rescues," *Proceedings of the Cross-Strait Conference on the Applications of GIS, RS, and GPS on Disaster Mitigation*, Taipei, pp. 72-99, 1998.

[4] Tsai, B.-W., "The Development of a Disaster Response Support System," *A Compilation of the 1999 Hazard Mitigation Research Project Reports*, vol. 3, pp. 5.1-5.9, January 2000.