Disaster Public Warning System in Taiwan: The Development of Cell Broadcast Services

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ABSTRACT

Early warning is a major element for disaster risk reduction. To prevent or mitigate the impacts of major disaster, many countries had taken action to build various kinds of public warning system. For example, the US installed an Integrated Public Alert and Warning System (IPAWS) after Hurricane Katrina while Japan developed the Real-time Earthquake Information System (REIS) to deliver earthquake alert messages since 2007. Taiwan took the initial step in 2011 and finally began to provide Cell Broadcast Services (CBS) since 2016 with the help from five major telecommunication corporations.

An effective early warning system focuses on people-centered and comprises the following four elements: risk knowledge, technical monitoring and warning service, dissemination and communication of warnings, and community response capability (UNISDR, 2006). Also, several cross-cutting issues of effective warning systems that national governments and community organizations can refer to while developing the early warning systems. These key issues are described as follows: (1) effective governance and institutional arrangements; (2) a multi-hazard approach to early warning; (3) involvement of local communities; and (4) consideration of gender perspectives and cultural diversity (UNISDR, 2006: 3).
To draw inspiration from the other two countries, the study first compares the development and experiences of the public warning system among the US, Japan, and Taiwan. By conducting in-depth interviews with several concerned stakeholders, my analyses then utilize the theory of four “people-centered” elements of the early warning system to explore the implementation and internal dynamic of delivering cell broadcast services in Taiwan.

**Keywords:** Public Warning System, Cell Broadcast Services, Disaster Management
I. Introduction

Early warning is a major element for disaster risk reduction. To prevent or mitigate the impacts of major disaster, many countries had taken action to build various kinds of public warning system. For example, the US installed an Integrated Public Alert and Warning System (IPAWS) after Hurricane Katrina while Japan developed the Real-time Earthquake Information System (REIS) to deliver earthquake alert messages since 2007. Taiwan took the initial step in 2011 and finally began to provide Cell Broadcast Services (CBS) since 2016 with the help from five major telecommunication corporations.

To draw inspiration from the other two countries, the study first compares the development and experiences of the public warning system among the US, Japan, and Taiwan. By conducting in-depth interviews with several concerned stakeholders, my analyses then utilize the theory of four “people-centered” elements of the early warning system to explore the implementation and internal dynamic of delivering cell broadcast services in Taiwan.

II. Literature Review

To date, most of literatures on disaster public warning have either the study of earthquake early warning (Kamigaichi et al., 2009; Meguro, 2008; Nakamura et al., 2009; Okada et al., 2004; Picozzi et al., 2015) or tsunami early warning systems (Papadopoulos, 2016; Wachter et al., 2012).

The Japan Meteorological Agency (JMA) started broadcasting earthquake early warning information to the public since October 2007. The information can be very useful to reduce damage during earthquakes, however, if used inappropriately, Meguro (2008) argued that it could be more damaging than no information at all. Regarding the effectiveness of earthquake early warning, Nakamura et al. (2009) evaluated the REIS and suggested that during 2005 and 200, more than 4,000 earthquakes with magnitude larger than 3.0 were detected by the REIS and source parameters for the majority of these events were determined within 3–4 seconds after the first P-wave detection.
On the contrary, Picozzi et al. (2015) have found the Italian Accelerometric Network (IAN), which consists of about 500 stations installed over all the active seismic zones, as well as many cities and strategic infrastructures in Italy, has the potential to serve as a nationwide early warning system. They suggest that an EEWS could potentially assist the population in taking basic protective measures (e.g., duck and cover, move away from windows or equipment) many municipalities of Italy affected by large ground shaking (Picozzi et al., 2015: 2464).

Wachter et al. (2012) suggested the Boxing Day Tsunami in 2004 triggered various international efforts focused on tsunami early warning for the Indian Ocean Basin. The warning system architecture has been specifically addressed in two complementary projects. One is the German Indonesian Tsunami Early Warning System (GITEWS), funded by the German Federal Ministry of Education and Research BMB. Another is the Distant Early Warning System (DEWS), which is a European project initially co-funded under FP6 and continued by the FP7 large-scale integrated project of Collaborative, Complex and Critical Decision-Support in Evolving Crises (TRIDEC). In addition, Papadopoulos (2016) stated that the most important regional system is the North East Atlantic and Mediterranean Tsunami Warning System which is based on a number of national tsunami warning centers and is coordinated by the ICG/NEAMTWS/IOC/UNESCO with the active collaboration of more than 30 country-members.

Recognized that California is under siege from increased wildfire, severe weather, and ever-present earthquake hazards, Smith et al. (2016) took an integrated network approach to develop the multi-sensor early warning system that was built upon a robust communication network, inter-agency cooperation, public-private partnerships, and integrating high-speed regional sensor networks to address effective early warning of multi-hazards.

III. The Experience of IPAWS from the US

During the early stage, the Emergency Alert System (EAS) remained an important alert and warning tool for emergencies in the US, however it had exhibited longstanding
weaknesses in providing the public with life-saving information quickly. According to GAO’s Report, several weaknesses with EAS include: lack of reliability of the message distribution system; gaps in coverage; insufficient testing; and inadequate training of personnel. Additionally, EAS provided very little capability to alert specific geographic areas and also did not ensure message delivery for individuals with hearing and vision disabilities, and non-English speakers (GAO, 2009: 7-10).

By the Executive Order 13407 of President Bush Jr., the modernization of EAS began with the Federal Emergency Management Agency (FEMA) adoption of a new digital standard for the distribution of alert messages to EAS participating broadcast community. IPAWS is a modernization and integration of national-level alert and warning infrastructure. The system uses the Common Alerting Protocol (CAP) standard and new distribution methods to make the EAS more resilient and to provide enhanced alerting capabilities. Also, IPAWS utilizes multiple types of Emergency Alert System devices that include NOAA Weather Radio, a variety of commercial encoder/decoder devices, and alerting technologies for persons with disabilities, monitor the IPAWS-OPEN system for CAP messages with the appropriate content to trigger equipment based on the message types and geo-location information contained in the messages. Refer to Figure 1 for details.
FEMA and its federal partners, the Federal Communications Commission, the National Oceanic and Atmospheric Administration's National Weather Service and the DHS Science and Technology Directorate are working together to transform the national alert and warning system to enable rapid dissemination of authenticated alert information over as many communications channels as possible (FEMA, 2010). The IPAWS, in close coordination with private sector partners, especially several commercial mobile carriers, has made one important advancement to the integration of public alert and warning systems in 2012. Refer to Figure 2 details Emergency Alert by Commercial Mobile Carriers in the US.

![Figure 2. Emergency Alert by Commercial Mobile Carriers in the US](source: News in my business website (2013))

**IV. The Experience of REIS from Japan**

Japan had made great efforts to develop an Earthquake Early Warning System (EEWS) after Hanshin-Awaji Earthquake in 1995. As to the development of a nationwide
EEWS, the Japan Meteorological Agency (JMA) and the Railway Technical Research Institute worked together to design a so-called the Nowcast Earthquake Information System. The National Research Institute for Earth Science and Disaster Prevention (NIED) also developed the REIS. Since October 2007, the combined results of a REIS and Nowcast system have merged as the EEWS to disclose emergency alerts to the general public in Japan.

The REIS typically uses the real-time data of Hi-net which is a seismic network comprised of 800 highly sensitive seismometers installed across Japan with an interstation spacing of 20–25 km and situated in bore holes deeper more than 100 meters (Okada et al., 2004). The system is capable of analyzing and determining earthquake parameters and then transmit the results to the JMA for issuing an earthquake early warning, which is also the first nationwide EEWS in the world (Nakamura et al., 2009: 4).

There are two major technologies for disseminating emergency alerts: J-ALERT which is a wireless radio system and Cell Broadcast Services (CBS). Since 2008, the JMA has cooperated with three domestic telecommunication corporations (NTT docomo, KDDI au, and Softbank Mobile) to provide CBS. During Tohoku Earthquake in 2011, both J-ALERT and CBS had been proven to be useful in disseminating earthquake and tsunami alerts to the public. Refer to Figure 3 for an example of Earthquake Early Warning by SoftBank in Japan.
V. The Development of CBS in Taiwan

Taiwan took the initial step to develop Cell Broadcast Services (CBS) after the 311 Tohoku Earthquake in Japan. Mainly drawing the experience from the US and Japan, the emergency warning system in Taiwan has adopted the Common Alerting Protocol (CAP) same as IPAWS of the US, but mainly use the Cell Broadcast Entity (CBE) similar to Japan in disclosing emergency alerts to the public. The Central Disaster Prevention and Response Office (CDPR) is designated under the Executive Yuan to implement the policy for public warning system in Taiwan. Also, CDPR is supposedly to work closely with the partners, both National Communications Commission (NCC) and National Science and Technology Center for Disaster Reduction (NCDR) in developing the
national warning system framework to enable rapid dissemination of authenticated alert information to the general public.

So far, there are seven central agencies responsible for issuing disaster alert messages, including the Central Weather Bureau (for big thunderstorm, earthquake warning and report), Directorate-General of Highways (road closed information), Water Resources Agency (reservoir discharge alert), Soil and Water Conservation Administration (mudslide alert), Directorate-General of Personnel Administration (stop working and school close information), Center for Disease Control (infectious disease and international tourism epidemic), and Civil Defense Command and Control Center (air defense alert). Figure 4 details for CBS Framework in Taiwan.

Since May 2016, the Central Weather Bureau had begun to issue earthquake alerts with magnitude larger than 4.5 occurring in and around Taiwan. Refer to Figure 5 for Earthquake Alerts by CWB. However, during the early stage, people are often complaint...
about the problems with receiving the message too late, repeat receiving, or no receiving at all (Chang et al., 2016). Receiving the alert too late is partially due to the problem of “blind zone”, or mainly because Taiwan is still lack of ability in delivering real-time earthquake early warning.

The CBS system has improved significantly after July 2016 when Typhoon Nebraska came to affect many parts of Taiwan. The Directorate-General of Highways successfully broadcasted road closed information for Su-Hua Highway; the Soil and Water Conservation Administration disseminated mudslide alerts to 262 disaster-prone villages; the Water Resources Agency also announced reservoir discharge alert; and the Center for Disease Control delivered epidemic notices in Taitung County by CBS.

![Figure 5. Earthquake Alerts by CWB in Taiwan](source: Chang, Zi-Ying et al. (2016))

**VI. Implementation Evaluation of Taiwan CBS**

An effective early warning system focuses on people-centered and comprises the following four elements: risk knowledge, technical monitoring and warning service, dissemination and communication of warnings, and community response capability
(UNISDR, 2006). Also, several cross-cutting issues of effective warning systems that national governments and community organizations can refer to while developing the early warning systems. These key issues are described as follows: (1) effective governance and institutional arrangements; (2) a multi-hazard approach to early warning; (3) involvement of local communities; and (4) consideration of gender perspectives and cultural diversity (UNISDR, 2006: 3).

Overall speaking, Taiwan has made some progress in recent years with the development of CBS for public alert and warning. First, the technology of cell broadcast finally comes in place, and Taiwan no longer relies solely upon the old system for emergency alerts. Second, CBS deliver emergency alerts to the public through mobile/cellular-phones where this country truly enjoys great coverages. And finally, CBS transmit a great amount of emergency alerts at once to mobile-phone users through base stations of Commercial Mobile Carriers. This would not only disseminate the alerts very quickly but also save a lot of text message costs.

However, several weaknesses and limitations still encounter to be resolved in the future. First and most important, there is no true competent authority responsible for the development and operation of CBS in Taiwan. And CDPR has often failed in coordinating the policy for emergency alerts, probably because it’s only an auxiliary agency under the Executive Yuan. In addition, unlike IPAWS-OPEN of the US that typically acts as alert aggregators or gateways and is also under control by FEMA, CBS in Taiwan still lack of full integration and central control that several agencies can decide individually to issue emergency alerts. Finally, emergency alert and warnings a in Taiwan are limited to disaster or weather-related messages, while IPAWS in the US also include broadcasting kidnapping and abduction, radiation, and non-weather information.
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