"What should we do?" The after-action review of village heads' information-seeking and decision-making during the unprecedented Kaohsiung blast

1. Introduction

On July 31, 2014, a number of massive underground explosions occurred in the Cianjhen and Lingya districts of Kaohsiung City, the second largest city in Taiwan. Thirty-two people died as a result of the explosions and three hundred and twenty-one were injured, and around 6 km of road was damaged. According to the indictment of the Kaohsiung district prosecutor (2014), the explosions were caused by 3.77 tons of propene leaking from a section of an underground pipeline operated by the neighboring petrochemical factory, LCY Chemical Corp. Although pressure abnormalities were detected as early as 20:00 on July 31 and several gas leaks from manholes were subsequently reported, the LCY pipeline was not shut down until 23:40, 16 minutes before the first explosion at 23:56.

Despite receiving warnings almost four hours before the explosions, the company and local officials made little effort to respond to the gas leaks. However, the five top city officials, including Mayor Chu Chen, were cleared of any wrongdoing. Nevertheless, the Control Yuan (2015) proposed that the mayor and top officials of Kaohsiung city government should implement a number of corrective measures, including taking responsibility for underground drainage culvert inspection, underground pipeline map data building, and emergency response.

The Kaohsiung gas explosions were an unprecedented disaster in Taiwan. Due to falling debris and the damage to the communication network, the villages in the area were isolated from one another and each village head had to work alone. In Taiwan, the village heads are important community leaders and serve as an administrative bridge linking residents and the district offices of the city government. Research has shown that the village heads in Taiwan are trusted by the residents and facilitate personal communication (Chou and Wu, 2014; Okada *et al*., 2013; Shepherd and van Vuuren, 2014). Thus, the Kaohsiung disaster provides an important opportunity for examining how the village heads in Taiwan implement emergency response measures, seek information, and make decisions. However, little research has focused on the actions of community leaders during disasters, especially unfamiliar events such as the Kaohsiung gas explosions. As such, the disaster enables us to compare the management skills of 13 village heads in exactly the same disaster. This

study constructs an overview of how the emergency response was implemented and to suggest future improvements.

2. Literature review

2.1 Village Heads in Taiwan

Following the Chi-Chi earthquake in 1999 and Typhoon Toraji in 2001, the central government of Taiwan launched an integrated community-based disaster management program to prepare selected communities to respond to disasters (Chen and Wang, 2010). Since then, community-based disaster adaption projects have been the main focus of the Taiwan central government. In addition to implementing the Hyogo Framework for Action 2005-2015, the government has initiated a number of disaster response plans (Chou *et al.*, 2015).

The village heads in Taiwan serve as the key figures and leaders in implementing disaster risk reduction measures (Chou and Wu, 2014). However, little research has examined the competences of these public officials in enacting disaster management procedures, or evaluated their performance. Because many of the recent disasters in Taiwan were unprecedented, their cases have not been included in the training program. This raises the question of how the leaders make sense of unprecedented disasters and make disaster management decisions. The case of the Kaohsiung gas explosions sheds some light on this situation.

2.2 Disaster Risk Deduction and the Effectiveness of Community Leaders

Leaders are important actors in disaster risk deduction. Leaders can serve as the first respondents (Deitchman, 2013), directors of community self-organization (Berkes and Ross, 2013), key persons in the affected community (Bankoff, 2015), pastors in faith-based organizations (Rowel *et al*., 2011), and administrative chiefs (Schoch-Spana *et al*., 2007). Public leaders (disaster management leaders and non-disaster management leaders) and non-public leaders play important roles in disaster risk deduction, and have been the focus of a number of studies (Buckland and Rahman, 1999; Chou and Wu, 2014; Jamshidi *et al*., 2016; Okada *et al*., 2013).

In studying how to increase the effectiveness of community leaders, most of the disaster research focuses on the characteristics that enable leaders to manage disasters. For example, using evidence from focus group meetings with jurisdictional medical directors, King *et al*. (2010) find that knowledge, skills, attitudes, behaviors, and personal characteristics contribute to the competence of leaders and their leadership attributes. Other studies have examined how to improve the knowledge and skills of leaders and cultivate the important components of their competencies

through training and drills. Boin *et al*. (2005) propose that public leaders have five critical tasks, namely, sense making, decision making, meaning making, terminating, and learning. Based on their findings, researchers have examined how to enhance leaders' skills. Hadley *et al*. (2011) find that leaders who develop high levels of self-efficacy based on their past successful experience are highly motivated and perform better. Jong *et al*. (2016) analyze 34 peer-reviewed articles based on the 5 tasks and find that the most of the articles focus on the "meaning making" and "termination" roles of mayors and governors.

This study examines village heads' responses during the six hours before and six hours after the Kaohsiung gas explosions. The two critical tasks of Boin *et al*. (2005), namely sense making and decision making, are applicable to this research setting. Sense making refers to a leader's abilities to recognize vague and contradictory signs and separate messages from noise during the early stages of a disaster. During a disaster, leaders have to make sense of the problem, take a position in a developing and unfamiliar event, and be alert to the worst-case scenarios.

Boin *et al*. (2005) further demonstrate the vulnerability of the disaster management process and propose the importance of seeking diverse types of information. Hadley *et al*. (2011) claim that information assessment and decision making are the two most researched behaviors in the literature. However, their study implies that information is accessible and ready to apply. Little research has focused on community leaders' struggle with the information vacuum during the onset of a disaster, and how they make decisions under these circumstances.

The Kaohsiung gas explosions offer a different scenario to those examined in the literature. First, the village heads in Taiwan are elected administrators and do not possess professional disaster management skills. Thus, it is not reasonable to expect them to have particular disaster management abilities. In addition, unlike the scenario studied by Hadley *et al*. (2011), during the Kaohsiung explosions, the village heads faced an unfamiliar disaster and thus were unable to draw on past experience. Third, most of the village heads worked alone before and after the explosions.

Moreover, most research has focused on the pre-disaster stage. Research has claimed that it is essential to review the actions conducted during and after a disaster. In this study, an after-action review (AAR) is conducted to examine the actions of the leaders during the post-disaster stage. AARs are designed to learn from the errors and successes of an action, and identity weaknesses that need to be corrected and strengths that should be followed, especially with respect to information seeking and decision making (Tami *et al*., 2013; Kim, 2013; Goralnick *et al*., 2015).

2.3 Information Seeking and Decision Making during Disasters

Before, during, and after disasters, residents are highly dependent on information for judging and responding to risks. Researchers have focused on the information itself and the information flow, such as message construction (Reynolds and Seeger, 2005), information seeking (White and Fu, 2012; Steelman *et al*., 2015), and the public's understanding of information (Parker *et al*., 2010).

Information seeking is the first stage in the communication system. Researchers and practitioners seek to learn the factors that motivate people to seek information (Griffin *et al*., 2008; Yang and Kahlor, 2013), who they seek information from and why (White and Fu, 2012; Ryan, 2013), and how they use this information to make decisions (Schultz *et al*., 2010).

However, the information-seeking models used in the traditional risk information seeking and processing approach are based on several unproven assumptions. First, the information is assumed to be accessible, correct, and useful. Second, people are assumed to display the same information-seeking patterns regardless of the type of disaster. Third, it is assumed that people can make decisions based on the information they obtain. In recent years, researchers have recognized that these assumptions are unproven and have sought to provide additional empirical evidence.

2.3.1 Is the information accessible, correct and useful?

Donahue and Tuohy (2006) compare four disasters and point out that numerous mistakes were repeated, including uncoordinated leadership, failed communications, weak planning, resource constraints, and poor public relations. Uncoordinated leadership refers to uncooperative, ineffective, unclear, multiple, conflicting, and isolated command structures, which may lead to failed communications. Donahue and Tuohy (2006) point out that awkward command structures may reduce the accessibility, correctness, and usefulness of the information they communicate.

Most studies do not take the problematic nature of the aforementioned assumptions into consideration when examining information seeking and decision making, regardless of whether the information is used to reduce the uncertainty or justify decisions (Griffin *et al*., 2008; Ryan, 2013; Mishra *et al*., 2014; Sommerfeldt, 2015). Steelman *et al*. (2015) study the desirable characteristics of satisfactory, useful, and trustworthy information sources from the recipients' perspective to avoid researcher bias. However, they still assume that the information is correct. In this study, the village heads were not familiar with the type of disaster they encountered. Thus, it is worth examining how they sought information and ensured the information was correct.

2.3.2 Variables that effect information seeking

Researchers have claimed that people tend to seek experts to obtain information to address their lack of knowledge or to reduce uncertainty, and have subsequently identified additional information-related variables. White and Fu (2012) find that "political trust" and "social trust" play important roles in information seeking and the need to find "credible sources," and propose an "iterative credibility-seeking model." From this perspective, people first seek information from authoritative channels and then reconfirm the information through personal communications or vice versa.

Mishra *et al*. (2014) propose a modified version of Wilson's problem-solving model in which people seek information to not only minimize uncertainty but also justify their decisions. Steelman *et al*. (2015) explore recipients' information seeking in relation to the information that was used, useful, and trustworthy in the responses to five large wildfires in 2009 and 2010. Unlike previous studies, they show that television was a greater source of information than family/friends/neighbors and newspapers. However, radio and newspapers are found to be trustworthier than television, and radio is seen as both useful and trustworthy. Interestingly, the authors find that family and friends are among the top five useful sources but are not among the top five trustworthy sources. They conclude that among the useful and trustworthy information sources, people tend to access and use more familiar and convenient sources during disasters.

Another variable worthy of attention is the disaster type. For example, people may use different information-seeking strategies in immediate disasters, such as tornados, and relatively slow disasters, such as typhoons. Ryan (2013) finds that during flash floods, people first gain information from others and then turn to television. In contrast, during slow-moving floods, people use the radio as a confirmation tool and then track the floods visually using Web-available river gauge systems.

In this study, the village heads were asked about their information-seeking strategies to determine which variables had the greatest influence on their information seeking during the gas explosion.

2.3.3 Variables that affect decision making

Residents' information seeking does not necessarily result in decisions. The decisions to take action or not are related to many factors, such as ethnicity, the level of received warning information, the attribution of responsibility, and personal attitude. Spence *et al*. (2011) examine the informational needs, responses, and preparation of Houston area residents after Hurricane Ike and find no differences across the demographic groups and narrowing knowledge gaps. However, knowledge gaps are

found to be associated with ethnicity. Minority groups may not make the right decisions after receiving information, and may wait for reconfirmation from their personal networks, which could put them in danger.

In a study of how people sought and used information during the 2009 Victorian bushfires, Choo and Nadarajah (2014) find that most of the residents were not aware of the official warning and did not become aware of the fires until they observed smoke, embers, and flames. Moreover, those who were aware of the official warning might not have taken action immediately because the residents were waiting for a "trigger for action" that would provide a timely warning and indicate the severity of the fires. Without this information, the residents tended to use "a form of normalcy bias" to interpret their situation as "normal." Because most of the residents ignored the immediate dangers of the bushfires, other residents might have maintained the same attitude.

Kellens *et al*. (2012) and McNeill *et al*. (2013) provide evidence that individuals' information needs do not routinely result in greater seeking intention. Kellens *et al*. (2012) show that responsibility may be the crucial variable in relation to finding information and taking action. For example, although residents may believe that they have insufficient information about a hazard, they place the blame on the government and ask for active communication to avoid taking the responsibility to seek information.

McNeill *et al*. (2013) examine the relationships between wildfire preparedness and the expectation that an official warning can be counted on and the expectation that utility will be lost during a wildfire. They find that the more people expect to rely on official warnings, the less prepared they are for a disaster.

Overall, the literature shows that residents affected by disasters tend to use personal communication networks to seek information relating to their evacuation and mitigation decisions, especially from those they trust. However, the current research is based on the assumption that residents deal with disasters they are familiar with or have experienced before. No studies have examined the actions of residents and community leaders in cases where the disasters are unfamiliar and unknown. Based on the literature review, the following four research questions are examined in this study.

1. How did the village heads seek information before and after the explosions?
2. How did they evaluate the correctness of information?
3. What decisions did they make before and after the explosions? And how did they make their decisions?
4. What problems did the village heads face before and after the explosions?

3. Research Methodology

The explosions occurred along the main roads, including Sanduo 1st Rd., Kaixuan 3rd Rd., Ersheng 1st Road, and Yixin 1st Rd, and severely impacted 14 villages (see Figure 1). In this study, in-depth interviews were conducted with 13 village heads and one officer of the district office from the most severely affected areas to determine the information-seeking strategies they used in the first 12 hours of the disaster. During the disaster, one village head took sick leave and resumed his duty 20 days after the explosions. One village was under the charge of an officer from the district office because the leader had passed away a few months before the explosions. Semi-structured in-depth interview questionnaires were used to collect data on the village heads' approaches to information seeking and decision making. The village heads were encouraged to talk in general about what happened before and after the explosions. All of the interviews were kept anonymous, and the numbers 1-14 were used to identify the 14 interviewees without revealing their affiliation or gender.

To prevent village heads from exercising self-presentation bias, another 15 residents (∗1-15) from the most affected areas were interviewed and the content of the interviews was verified based on analysis of documents from the Kaohsiung city government, Kaohsiung district prosecutors office, and the Control Yuan.

Insert Figure 1 here

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4. Results

On July 31, 2014, residents of Kaohsiung reported a gas leak at the intersection of Kaixuan 3rd Rd. and Ersheng 1st Rd. The heads of the villages near the intersection stated that residents had noticed bad smells before 20:00. The earliest report of a leak from a resident to a village head was around 18:00. The smell then progressively increased, and the first call to the 119 emergency hotline was reportedly received at 20:46 on July 31.

Although the fire bureau dispatched firefighters from several branches to control the leaks, their efforts were in vain due to the failure to identify the gas and take the appropriate actions to mitigate the effects of the leaks. The gas was only identified as propene at 23:20, and the LCY shut down the pipeline at 23:40, 16 minutes before the first explosion occurred at 23:56 (see Figure 2). In this context, the village heads' information seeking and decision making in the six hours before

the first explosion are likely to provide important information for helping the community to eliminate such hazards.

According to the indictment of the Kaohsiung district prosecutor (2014), immediately after the explosions, the Kaohsiung city government established an emergency operation center in the fire bureau at 00:20 on August 1, 2014. At 02:00, the city government launched an emergency evacuation and started emergency resettlement at 17:00, 10 hours after the first explosion (see Figure 2).

All of the village heads stated that they had no idea what to do when they learned of the leaks or when the explosions occurred. The leaders also stated that they were forced to take charge because few people and resources were sent to the affected areas. Although the village heads had learned about countermeasures for fires or gas leaks and knew how to contact the higher-level authorities, they did not make good use of these measures in dealing with the explosions.

Insert Figure 2 here

4.1 Uncoordinated Leadership Leads to Communication Failure

The emergency operation center was only opened after the explosions, and there was no organized command structure. Thus, the village heads had to seek information on their own (see Figure 3). Only one (#8) village head received a phone call from his/her supervisor, and #8 was the only leader who made a public announcement warning the residents about the gas leak.

Nearly 20 minutes before the first explosion, #7 received a phone call from a friend, a voluntary firefighter, who was on duty near the intersection of Kaixuan 3rd Rd. and Ersheng 1st Rd. The friend told #7 that the situation was severe and out of control, and advised him/her to stay at home. Although #7 had the opportunity to give personal advice to his/her relatives and close friends, without a warning from the authority, he/she hesitated to make public announcements.

Heads #1, #2, #6, and #12 were the only ones to actively seek information. However, except for #2, the rest turned to convenient and familiar channels, calling the 1999 citizen hotline, 119, and the local police stations. Unfortunately, the staff of those channels had not received any information about the gas leaks and were unable to give correct information. Head #1 complained about the carelessness of the 1999 hotline staff and their lack of professional knowledge.

> They (the 1999 staff) said that they had already passed the information to the Fire Bureau. But I told them one hour had passed. The smoke was getting more and more. The smells were unbearable. The city government needed to shut down the pipes immediately. One staff

member said it was impossible to shut down the pipes which influenced the economy and so many aspects … can you imagine that two minutes before the Blast, another staff member told me it had been solved and we were safe now. (#1)

Head #1 only told the residents who went to his/her office to get information that the gas was leaking and that people should be careful while cooking. Although #1 urgently sought to find the reasons for the leak, he/she did not make any public announcements and hesitated to make decisions without receiving any commands from the authorities.

Although the village of head #2 was not close to the intersection, he/she still smelled the gas and decided to ride his/her scooter to the intersection, where he/she obtained some information from a supervisor from another district office. However, #2 admitted that his/her judgments were wrong and that he/she thought the intersection was far away from the village and did not do anything before the explosion.

Head #6 recalled that he/she did not think the leak was serious because there used to be a chemical factory near the village and he/she had gotten used to the unusual smells. This case suggests that the community context plays an important role in disaster management.

It is worth noting that none of village heads thought that self-help was important or asked the residents to take action when there was evidence of a gas leak. Consequently, many residents were hurt by flying shards and debris, which could have been prevented by predicting possible outcomes and take countermeasures.

Insert Figure 3 is here

The Kaohsiung city government did not implement the command system immediately. Moreover, because the village heads failed to receive the information they needed to make the appropriate decisions, they turned to the convenient and familiar channels used by lay people. Surprisingly, the village heads had received training on how to deal with earthquakes, floods, and typhoons. However, why did they not follow the disaster command system designed for common disasters? This question is discussed in the following section.

4.2 Factors that Stopped Information Seeking and Decision Making

Why did the village heads not turn to the district office or key persons for information? Why did they hesitate to make decisions? Based on the recollections of

the village heads, three main factors were at play.

First, some of the heads thought that gas leaks were quite common in Kaohsiung, the biggest industrial city of Taiwan. To begin with, they ignored the incident. After the smell increased and smoke began to appear, they were still unfamiliar with the nature of the hazard and did not make any moves to respond. In addition, because the response center had not been established at this stage, the degree of urgency might have been easily overlooked.

Second, the village heads relied on government information and services. As mentioned previously, some of the village heads hesitated to call for an evacuation or other actions because the government had not issued any warnings. Ironically, in this case, it was determined that evacuation might have caused more casualties. The interviewed residents recalled the uncertainty and risk they faced.

> Before the blast, there were very bad smells in our areas. The village head didn't know what to do because he had no information from the district office. We decided to stay at home … then it turned out that the road in front of us exploded and was later ruined. If we had been evacuated, we would have died because the road was the only way to leave this area. (#3)

Another way the heads relied on government services was that once they saw the firefighters dealing with the leaks on the sites, they felt relieved and stopped their information seeking and decision making.

> As soon as I saw the firefighters and police officers blocked the leaking areas, I was so released. They took the hot potato over. I didn't feel any responsibility at all. They were all in charge. (#5)
>
> They are experts and they gathered around. If something did happen, they absolutely would have informed us and asked the residents to evacuate. I had been waiting for a message. No news is good news. (#10)

The village heads were so dependent on the authorities and firefighters that they were unable to make basic decisions, such as warning the residents and asking them to take suitable measures to protect themselves at home.

Third, the village heads did not have access to confirmation tools, such as the media, that often exist during common disasters. During the period before the first explosion, the village heads were only able to obtain information such as "gas leaking" from the media. The village heads' offline and online networks provided even less information than the media, which created the impression that the leak was not serious, especially for those who lived some distance from the site of the leaks.

4.3 Factors that Motivated Actions after the Explosions

Three factors are recognized as having motivated the village heads to act. The first common factor was that the village heads were worried about the impending hazards. Immediately after the explosions, #2, #4, and #8 decided to evacuate the

residents because many natural gas lines had been installed in the new buildings in their villages. Head #10 asked the residents to turn off their gas for safety and suggested that people who lived near gas station should leave (see Figure 4). These village heads, except #4, did not receive orders from the district officers or village officer but made action plans based on their judgments of the possible hazards.

The second factor was that the village heads became concerned about possible injuries due to the debris and decided to take action. Head #2 organized residents to conduct traffic control to prevent accidents during the blackout. In addition, the village heads who received help from volunteers, such as #4 and #10, tended to initiate more actions to protect their communities.

> After the blast occurred, people started to gather in front of my office and tried to find out what happened. Then we started to discuss what we could do to mitigate the secondary harm. We decided to fix the manholes first. (#4)
>
> There are lots of complex buildings in my village. There might be more than 50 households in one building. I was so worried about the residents' safety. I consulted with neighborhood chiefs, officers, and volunteers and then decided to go door by door and ask the residents to turn off their electronic equipment for safety. (#10)

These three village heads initiated relatively large scale self-help measures in their communities based on their risk awareness.

The third factor that made the village heads take action was establishing or restoring communications with officers and supervisors. Except for #14, who did not have any communication with officers or supervisors before and after the blasts, those who made self-help or evacuation plans had the opportunity to engage in either phone or face-to-face communication with officers and supervisors before (#2 and #8) and/or after the blasts (#2, #4, #5, #6, and #10).

Insert Figure 4 here

4.4 The Urgent Need to Revisit the Current Disaster Plans

Most of the village heads complained that they felt like orphans until the sun rose at around 06:00 on August 1, 2014. Although the city government launched disaster services immediately after the explosions (see Figure 5), the village heads did not receive any help or resources. The shelters that the city government assigned were far from the villages and the debris hindered the evacuation of the residents. Thus, some village heads (#2, #4, #5, #6, #8, and #14) chose to use the nearest schools as shelters, and found water and resources in the first few hours on their own. This shows that the disaster plans that were in place were inappropriate.

After the blasts, we were in panic. The window was torn to pieces. There was glass and debris on the ground. We couldn't see anything and tried to escape from our apartment … There was nowhere to go. The road had exploded. A lot of neighbors came out like us and we didn't know what to do and gathered around in the parking lot behind our apartment. (#7)

In the very beginning, we gathered in the park nearby. Hours later, the village heads said there were shelters open in the Chung Cheng vocational school and there would be some food and water provided. But it was too far from our place. We would have been at risk when travelling to the shelter. (#11)

Insert Figure 5 here

Although the Kaohsiung gas explosions led to 32 deaths, 321 injuries, and enormous property loss, the village heads were confident that similar incidents would never happen again. Thus, none of them made disaster plans for the near future. Thus, the disaster authority must pay attention to the normalcy bias that prevails in the affected areas. For example, #12 provided the following opinions on why the residents were so confident.

Chen Chu encouraged residents to choose subrogation rights rather state compensation to avoid responsibility. Under this logic, who would think a disaster would happen again? ... Given that the city government has never provided a disaster plan, I don't have any either. (#12)

5. Discussion

This study found that the village heads' personal attributes (actively or inactively seeking information and responding to the disaster), command authority (in this case, no formal command system was available in the first 12 hours after the discovery of the leaks), and knowledge (with or without) played important roles in their decision making around the time of the explosion. Although the active leaders with knowledge received no commands from the authorities, they adapted what they had learned to reduce the possible and unknown risks. For example, #2, #4, and #10 not only launched large scale self-help measures and asked their residents to refrain from using fires, but also organized the residents to help prevent secondary harm (see Figure 6).

Insert Figure 6 here

In contrast, the inactive village heads with knowledge only initiated small-scale self-help initiatives among family members and close neighbors, which provided minimum protection, whereas the inactive heads with no knowledge (such as #3, #9, #11, #12, and #13) acted like lay people (see Figure 7). Therefore, knowledge seems to have served as the last secure mechanism for keeping the residents from risk. The more knowledge the village leaders had, the greater amount of action they took. Moreover, some of the village heads mentioned that they used the knowledge they had acquired from the fire and chemical drills to make the necessary decisions.

It parallels to Scolobig *et al*. (2012) challenge to the common assumption in risk awareness and disaster preparedness. They defy that lower risk awareness leads to less disaster preparedness, and demonstrate that those who do not adopt household preparatory measures are willing to take self-help actions in preparing for disasters. This study also found that some village heads initiated the minimum self-help measures to ensure the safety of their family members and neighbors. Although these self-protection actions were not as tangible and clear as the emergency responses and precautions for typhoons and earthquakes, they did help reduce the harm from the gas explosion.

Insert Figure 7 here

In addition, it is worth noting that the leaders tended to use convenient and familiar communication channels, such as the 1999 citizen hotline, which has since become a communication hub during disasters. However, the 1999 hotline was not designed for disaster management. In Kaohsiung, the operators of 1999 are not government officials, but contract-based employees from disadvantaged groups. Most of the operators are anonymous and unidentifiable. The main duty of the staff is to dispatch citizens' questions and complaints to the relevant departments of the city government. Without receiving further information, the operators would have had no idea how the case was being managed. Thus, the 1999 hotline clearly did not serve as a good communication channel for confirming information.

In this case, the village heads did not follow the procedures for dealing with earthquakes or typhoons and connect with the disaster authority. Instead, they acted like common residents in seeking information from the 1999 hotline, 119, and local police stations. Even worse, no suitable people were available for them to reconfirm the information, which caused late or no responses.

The actions taken in the six hours after the explosions were also disordered. Most of the village heads did nothing until the staff from the district office reached them. Significantly, they did not apply the common types of disaster management

procedures to this unprecedented event to achieve minimum safety. Thus, the community-based disaster management plans for first-level disaster management staff must be re-examined.

6. Conclusions and Recommendations

In conclusion, the Kaohsiung explosion was a rare type of disaster that had never occurred in Taiwan before. Thus, this case produced a number of new lessons. Accordingly, the Taiwan disaster authority is urged to study the incident thoroughly and to design disaster information and action plans accordingly. This study showed that the village heads played important roles as information hubs for the residents. However, few studies have examined the information seeking of first-level disaster management staff and their consequent decision making. In Taiwan, the village heads are elected administrators who do not have professional disaster management skills. It is worth paying more research attention to the role of leaders in disaster management.

This study suggests three initiatives for improving community-based disaster risk reduction. First, this study confirms that the leadership research should take different categories and levels of leaders into consideration to distinguish public leaders from non-public leaders, professional disaster risk reduction leaders from non-professional leaders, and higher authorities from basic levels of government. The findings from this study provide a basis for the rational design of the job descriptions of village leaders.

Second, basic self-help and community help mechanisms can provide essential relief in communities facing unknown types of disaster in the future. Thus, this study not only proposes the implementation of discussion-based debriefing (Kim, 2013), but also suggests that village heads should provide bottom-up scenario scripts and countermeasures in disaster drills that fit their contexts and knowledge.

Third, to enhance the knowledge and social capital of village heads in preparation for future unexpected disasters, the disaster management authority should regularly examine the current disaster plans, drills, and simulations using a knowledge management approach. This would ensure that the disaster data are improved and validated by different actors (knowledge creation) and contribute to the faster, open, and more reliable flow of knowledge among actors (knowledge transfer). This would also ensure that disaster cases and lessons are compiled and repositioned such that the actors can understand the rationale of the disaster procedures (knowledge reuse) (Chua *et al*., 2007). This, in turn, would enable the development of situated knowledge on disaster management.

To sum up, with the increasingly common occurrence of unprecedented disasters, researchers and practitioners need to study how community leaders react differently to different disasters and how their authority, knowledge, and social capital interact. Accordingly, the disaster management authority should tailor suitable disaster plans to enable adaptive and flexible first responses. The drill format should be bottom-up and sufficiently flexible to meet the needs of different communities.

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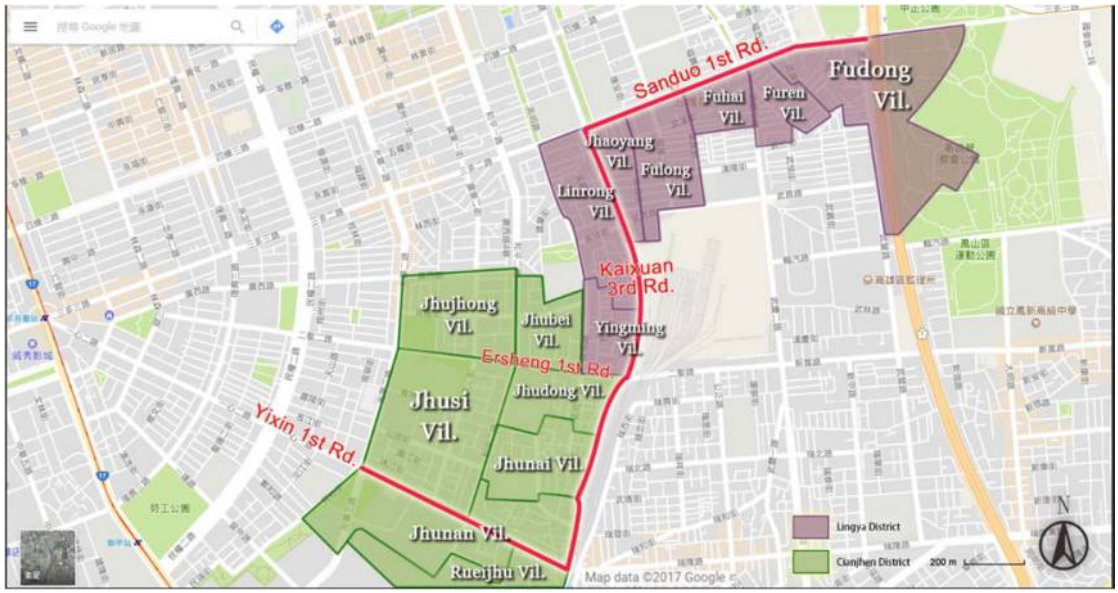
Figure 1. Affected villages in Kaohsiung Blasts



Red line: The main explosive roads including Sanduo 1st Rd., Kaixuan 3rd Rd., Ersheng 1st Road, and Yixin 1st Rd.

Figure 2. Timeline of Kaohsiung blasts

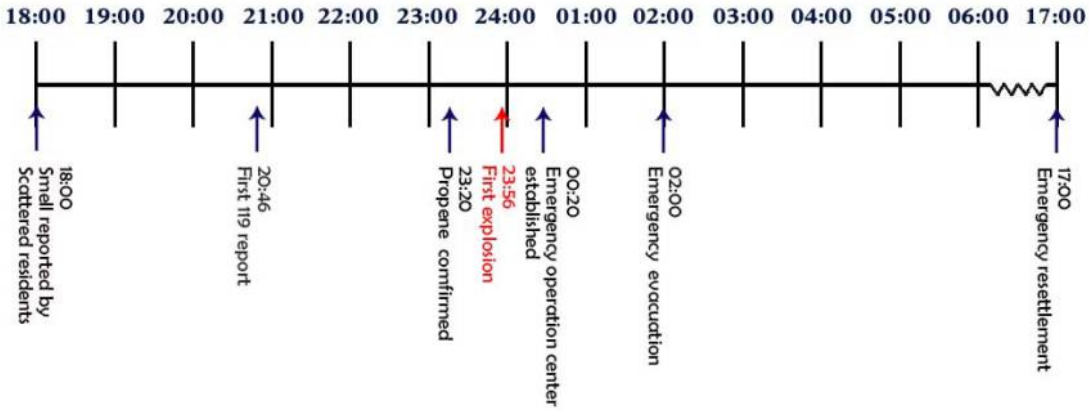


Figure 3. Information seeking strategies before the first explosion

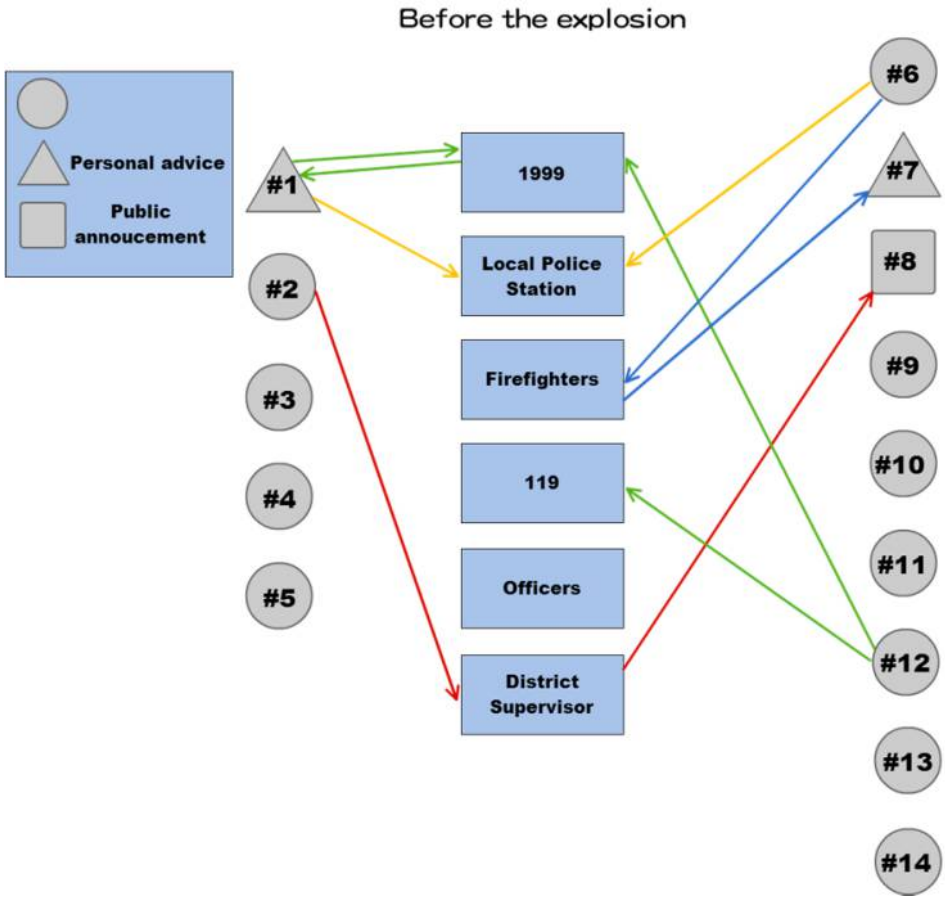


Figure 4. Information seeking strategies in 6 hours after the first explosion

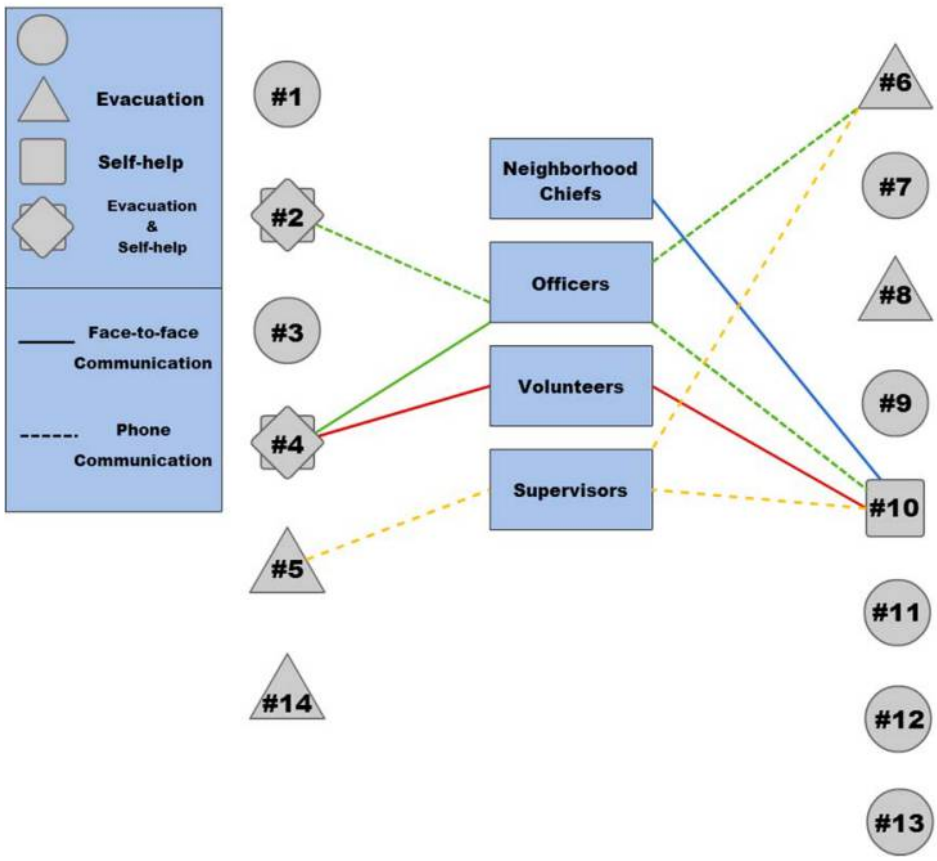


Figure 5. Timeline of selected decision-making during first 12 hours of crisis

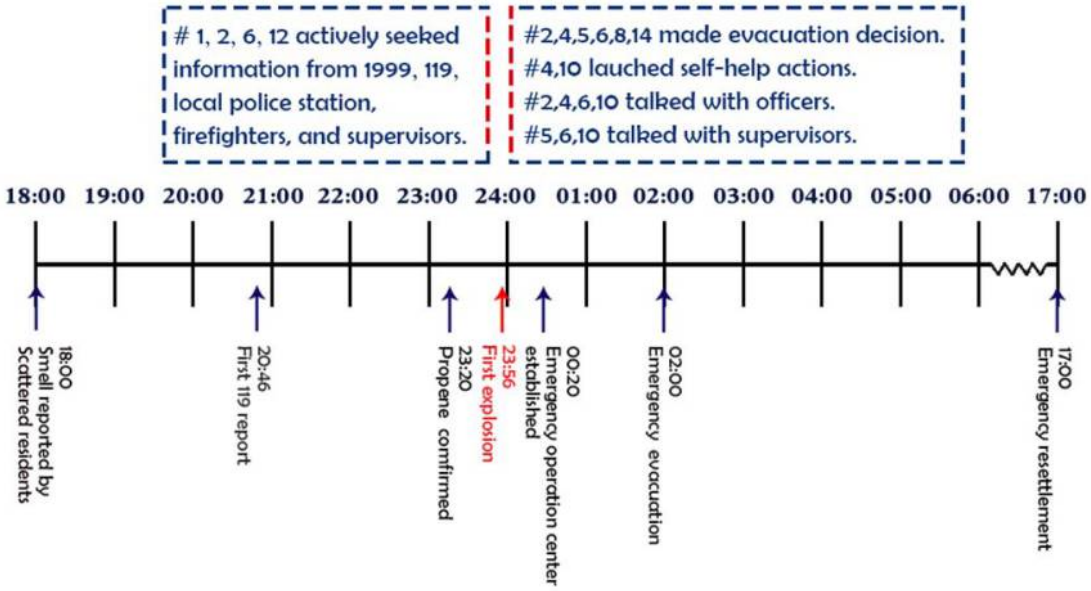


Figure 6. Active village heads' decision-making procedures

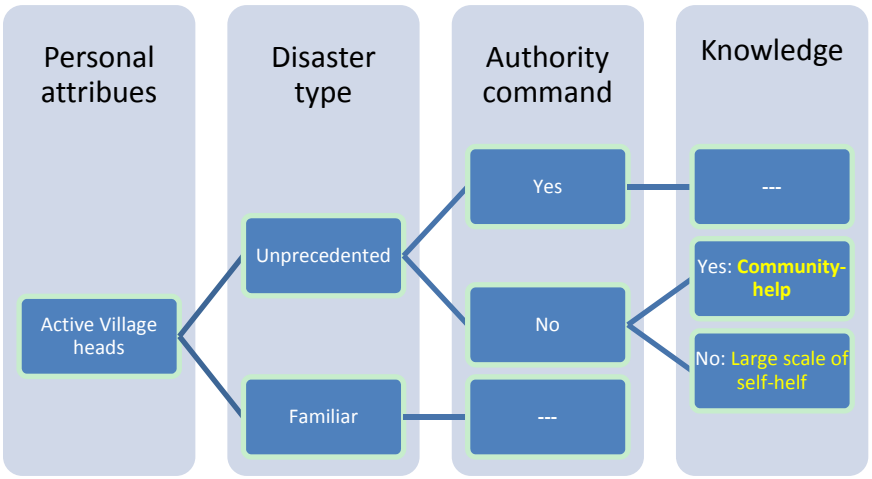


Figure 7. Inactive village heads' decision-making procedures