

EVACUATION BEHAVIORS IN THE 2011 GREAT EAST JAPAN EARTHQUAKE

Waseda University Student Member ○Nam-Yi Yun
Waseda University Regular Member Masanori Hamada

1. INTRODUCTION

The authors studied relationships between survival rate in the 2011 Great East Japan Earthquake and place and time of evacuation, preparedness before disasters, and evacuation behavior for both non-survivors and survivors. With a sample data number 1,153, this study's results showed that earlier evacuation was positively related to higher survival rate. This study also revealed that behaviors under the disaster differed by the survivors and death/missing people.

2. THEORETICAL BACKGROUND AND RESEARCH QUESTIONS

A mitigation of deaths and injuries is of a primary concern to all disaster prevention efforts (Spence et al, 2011). Human behavior plays a significant role in the disaster mitigation efforts, as well as structural and non-structural efforts (Hamada and Yun, 2011). Central Disaster Prevention Council reported that the evacuation rate was 57%, and that some hesitant evacuees went to an undesignated location (870 refugees, Iwate, Miyagi, and Fukushima prefectures). It indicates that it is important to place and time of evacuation, preparedness before disaster, and evacuation behavior, then this study examine that (1) safety of evacuation places: there was a greater number of survivors that escaped to a safer or higher place; (2) preparedness before disasters: there was a greater number of survivors within the people who had prepared before disasters; and (3) evacuation time: there was a greater number of survivors within the people who quickly evacuated. In addition, we investigated (4) difference of behaviors between group of the non-survivors and one of survivor (Fig.1).

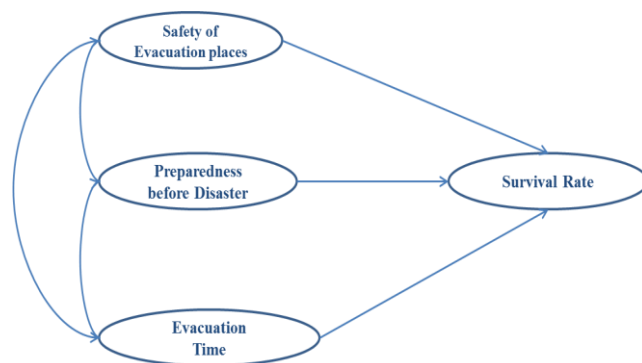


Fig. 1 Research Model

3. DATA AND PROCEDURE

To avoid redundant survey and to test research questions with a bigger sample size, we received two data sets from Weathernews and analyzed them. Weathernews, a company that specializes in dealing with disaster data, conducted several surveys and collected vast amount of data using the Internet and mobile web sites.

3.1 Data for research question 1, 2 and 3

5,298 data including 1,998 witness' statements for the death/missing people were collected (May 18 to June 12, 2011). Fully unanswered 1,153 data in an inundated area (522 of survivors and 631 of non-survivors) are used, regardless of it being inside a building or outside when the earthquake hit with major shaking being felt all around.

3.2 Data for research question 4

Information was gathered 88,604 witnesses from Tohoku to Kanto area (March 14 to May 10, 2011). At the first time, 9,136 data from Tohoku area of data were reviewed, but 6,549 data were excluded because there was no information about any behaviors.

4. RESULT OF THE ANALYSIS

4.1 Safety of evacuation places

It is critical for evacuees to go to a safe place. Because of no previous study, grades for evacuation place safety were conducted based on a guideline for tsunami evacuation buildings. As a result in Table 1, there is no clear difference among them.

Table 1 Safety of evacuation places result

Safety of Evacuation Places	Survivors (Ns=428, excluding 94)	Death/Missing (Nd=172, excluding 459)
Higher and specified	29%(122)	38%(66)
Higher & non-specified	32%(138)	23%(40)
Not higher & specified	15%(66)	20%(35)
Not higher & non-specified	24%(102)	18%(31)
Total	100%(428)	100%(172)

4.2 Preparedness before disasters

While the casualty is nearly 1,000 in Kamaishi and Kesennuma, 5 out of 3,244 children and 12 out of 6,054 students respectively are victims of the disaster, it reveals an importance of preparedness before disaster. There are not enough resources of knowing what people really do for preparedness before disasters to reduce death in future events. Since there was no existing scale to relate to the preparedness before disaster, a five-scale table was made based on their contents.

Table 2 Preparedness before disaster result

Preparedness (Ns=465, excluding 57, Nd=307, excluding 324)	Survival rate
Participate disaster prevention training	57%
Walk evacuation route	70%
Know evacuation route	55%
Know evacuation place	36%

Keywords: the 2011 Great East Japan earthquake, disaster mitigation, evacuation behavior, preparedness before disasters
Contact address: 3-4-1 Okubo, Shinjuku-ku, Tokyo, 169-8555, Japan, Tel: +81-3-5286-3406

The results are presented below in Table 2, walking evacuation routes was the most effective based on the data. It might mean that we need to consider the method of training in depth.

4.3 Evacuation time

Evacuation actions taken by residents are fundamental to human damage mitigation measures against disasters. The present study deals with research concerning evacuation time that means start time of evacuation, and its resulting positive or negative effect on the survival rate. Table 3 presents the two groups' evacuation starting time. 48% of the death/missing people did or could not evacuate. Among the survivors, 11% of the people were no evacuees. According to this survey data, the main reason why they could have been saved without evacuation was just good luck.

4.4 Evacuation behavior between survivors and non-survivors

Distinguished behaviors' (types and frequency) of between the non-survivors and the survivors can be involved as potential factors explaining why some more than others become victims by disaster. Therefore, it considers the role of behaviors explanation and tests those, and negative behaviors in this study are defined as someone who had that action in which it led to his/her death. Otherwise, it means that people had positive behaviors.

Table 3 Evacuation time result

Evacuation Time	Survivors (Ns=505, excluding 17)	Death/Missing (ND=351, excluding 280)
Immediately	14% (71)	10% (36)
1-5 minutes	17% (84)	7% (23)
6-10 minutes	19% (94)	11% (38)
11-20minutes	17% (87)	8% (28)
21-30minutes	11% (56)	9% (32)
31-60minutes	8% (42)	6% (20)
61-120minutes	2% (9)	1% (2)
More than 120 minutes	1% (4)	1% (2)
No evacuation	11% (58)	48% (170)
Total	100% (505)	100% (351)

Table 4 Ranking of the negative behaviors and ranking of the positive behaviors

Rank	Ranking of the Negative Behaviors	Frequency	Rank	Ranking of the Positive Behaviors	Frequency
1	Tied up on the road (traffic jam)	26.3%	1	Immediately evacuated	52.5%
2	Help other people	22.4%	2	Follow other people's direction	39.4%
3	Do work and duty for rescue	13.9%	3	Remember former disasters	8.1%
4	Do not evacuate due to no/wrong information	13.7%			
5	Find family/relatives	9.7%			
6	Ignore warnings based on past experiences	8.9%			
7	Leave the assigned place	5.1%			

Based on Table 4, it is clear that early evacuation is vital for safe state from tsunamis. Although tsunami warning was announced, many people who were in plains did not have time to evacuate to higher places. Furthermore, it is important to stay in safe and assigned places as well. After the tsunami alarms, people relocated into refuge, but they went back to their houses before the tsunami completely came to an end. However, these negative behaviors led to irreversible risk.

5. CONCLUSIONS

Drawn from points of convergence from prior mitigation efforts, the first was to examine the effect of place safety, disaster preparedness, and evacuation time on survival rate. People who started evacuation within 30 minutes reported greater survival rate (see Fig.2). However, safer evacuation place and better preparedness before disaster have no positive effect on the survival rate in this study. It indicates the most important thing is not just to know, but really to act. Moreover, almost all the drills had focused to earthquake and fire (Goto, 2012), to review the content of disaster preparedness drill contents in more detail manner is necessary. The second was to investigate the difference of behaviors between groups of death/missing people and one of the survivors. It results that there were some distinguished behaviors in survivors and non-survivors. Instead of relying on hardware approach such as improving and strengthening buildings, disaster prevention emphasizes on software approach like improvements to warning systems and a more thorough evacuation on education. It is difficult to change human behaviors, but the rewards are worth the effort.

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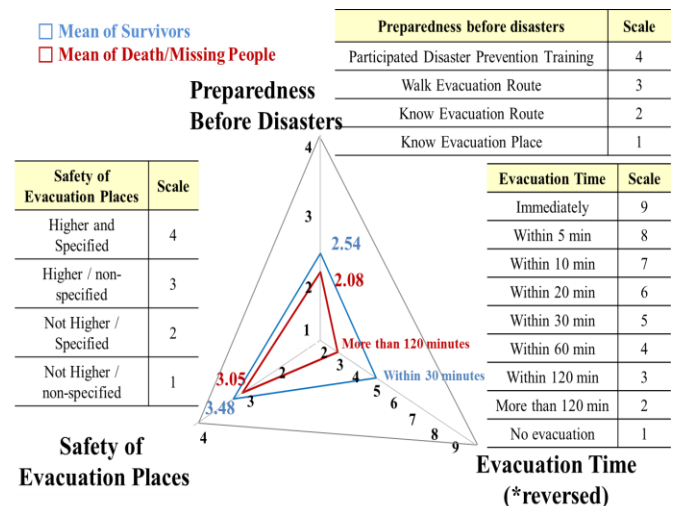


Fig. 2 Research result