

**The Lessons for the Reduction of
Loss of Human Lives from
the 2011 Great East Japan Earthquake and
Pre-disaster Preparedness in Tokyo Area**

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Agenda

(1) The Lessons for the Reduction of Loss of Human Lives

- **Analysis of Evacuation Behavior in
the 2011 Great East Japan Earthquake**

(2) Preparedness for expected earthquake in Tokyo Area

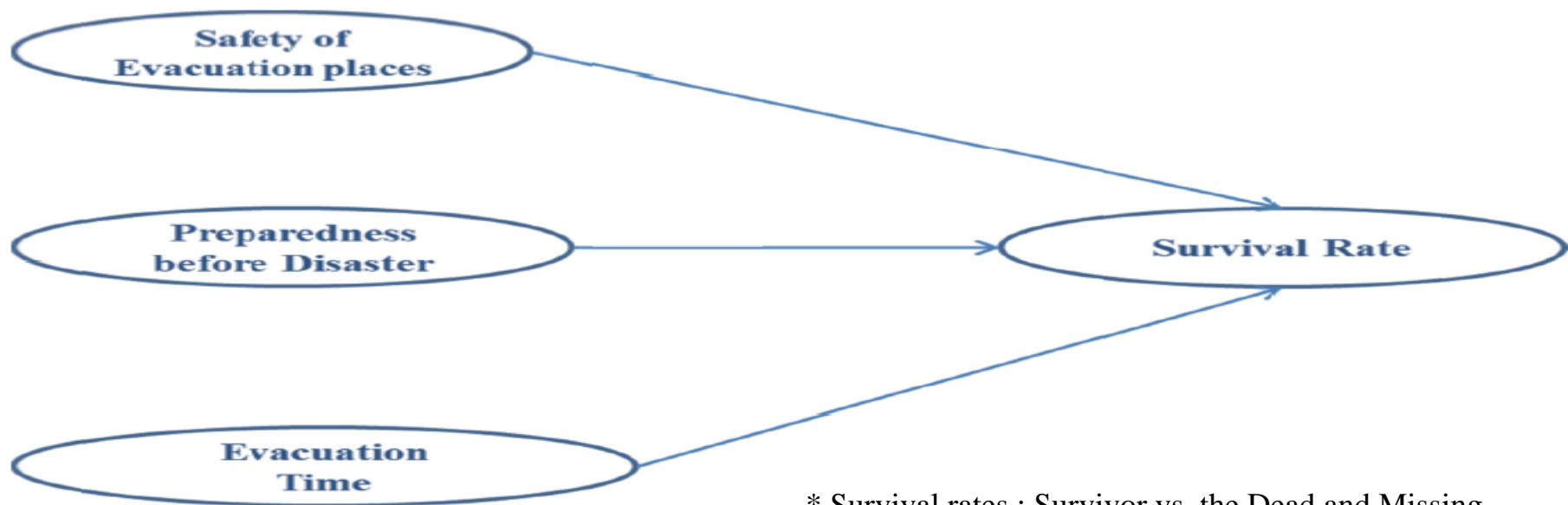
- **Current State of Disaster Preparedness of Residents
in Tokyo area**

Evacuation Behavior in the 2011 Great East Japan Earthquake

Research Questions:

- 1) **Evacuation place safety:** to what extent do deaths have structural causes?
- 2) **Preparedness before disasters:** what is the relationship between levels of disaster prevention education and survival rates?
- 3) **Evacuation time:** how do survivors and the dead and missing differ in the behavior of individuals in response to a warning or the ground shaking?

[Research Model]

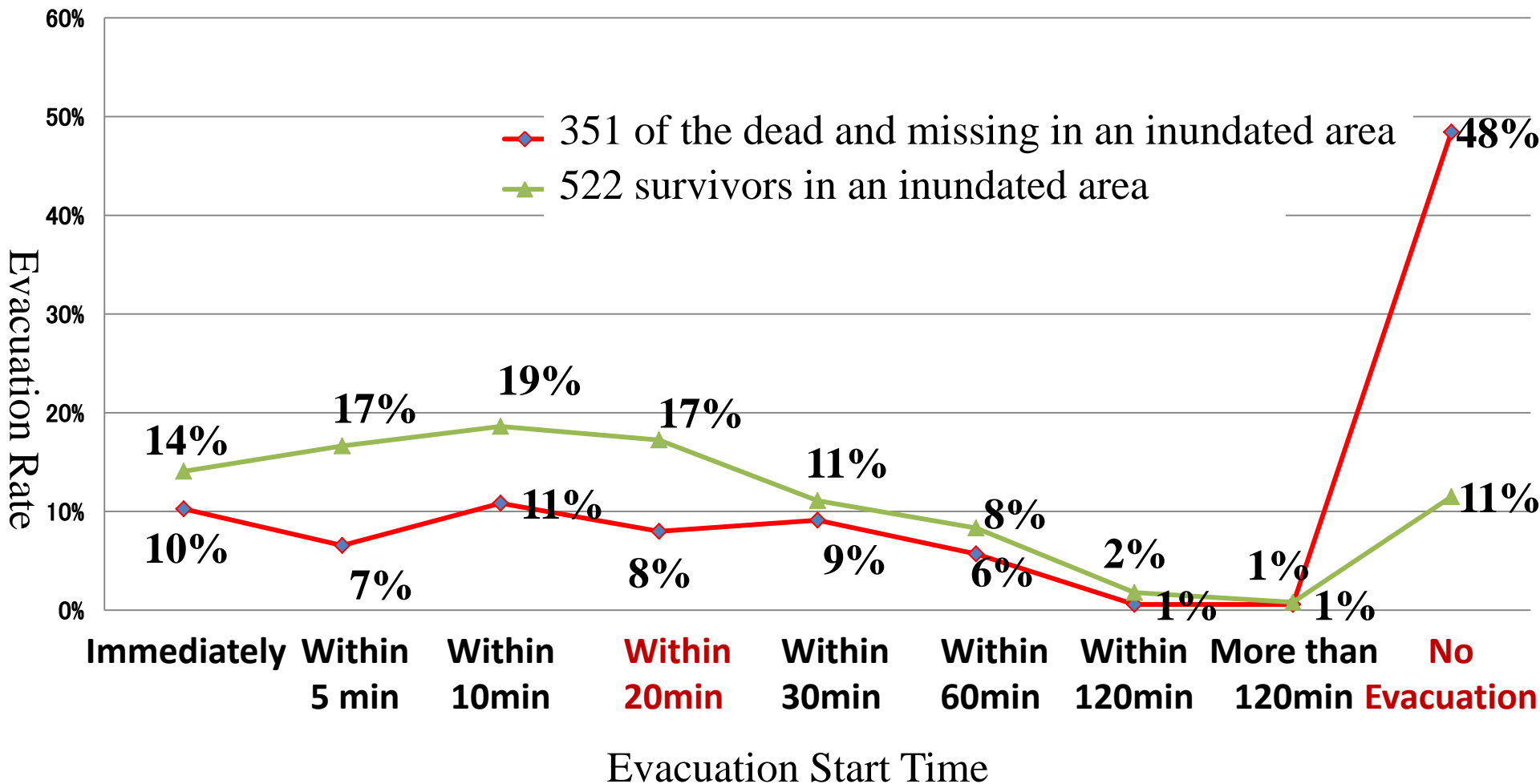


* Survival rates : Survivor vs. the Dead and Missing

$$\frac{\text{Number of survivor in inundated place}}{\text{Sum of survivor and the dead and missing in inundated place}}$$

Evacuation Behavior in the 2011 Great East Japan Earthquake

- (1) Even though 11% of survivors did not evacuate, more than 50% of the survivors evacuated **within 20 minutes**.
- (2) **48%** of the dead and missing did not or could not evacuate
One in two persons who died in inundated areas did not evacuate.



Evacuation Behavior in the 2011 Great East Japan Earthquake⁵

Evacuation Time, Evacuation Place Safety, Preparedness Before Disaster

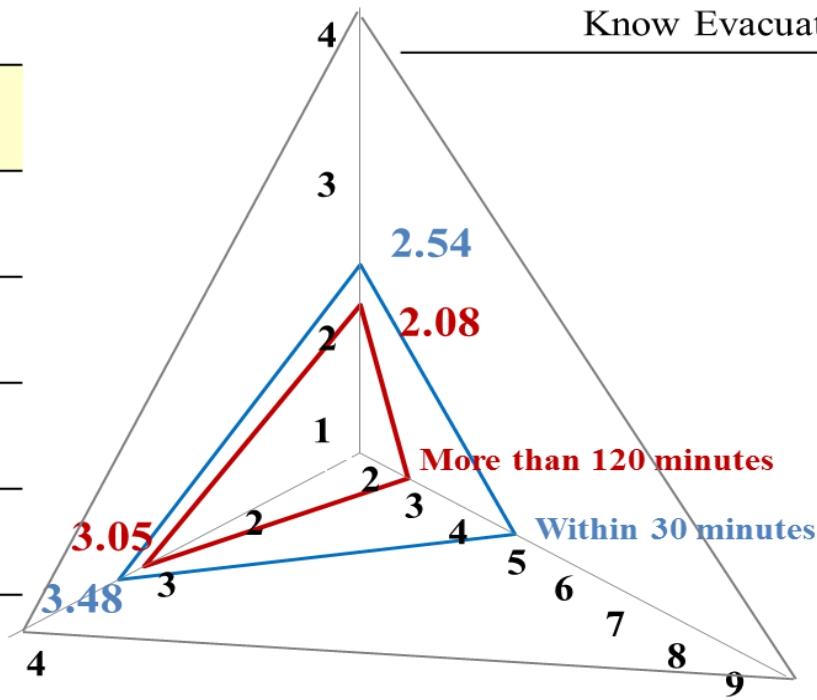
□ Mean of Survivors
□ Mean of Death/Missing People

**Preparedness
Before Disasters**

Preparedness before disasters	Scale
Participated Disaster Prevention Training	4
Walk Evacuation Route	3
Know Evacuation Route	2
Know Evacuation Place	1

Safety of Evacuation Places	Scale
Higher and Specified	4
Higher / non-specified	3
Not Higher / Specified	2
Not Higher / non-specified	1

**Safety of
Evacuation Places**



Evacuation Time	Scale
Immediately	9
Within 5 min	8
Within 10 min	7
Within 20 min	6
Within 30 min	5
Within 60 min	4
Within 120 min	3
More than 120 min	2
No evacuation	1

**Evacuation Time
(*reversed)**

Evacuation Behavior in the 2011 Great East Japan Earthquake

Quantitative analysis:

Differences in behavior between groups of non-survivors and single survivors

Rank	Evacuation-Disturbance Behavior (避難の妨げになった行動)	%
1	Be tied up on the road traffic jam	26.3%
2	Help other people	22.4%
3	Do work and duty for rescue	13.9%
4	Do not evacuate due to no/wrong information	13.7%
5	Find their family/relatives	9.7%
6	Ignore the warning based on the past experiences	8.9%
7	Leave from the assigned place	5.1%

Rank	Success-Induced Behavior (避難の助けになった行動)	%
1	Immediate Evacuate	52.5%
2	Follow other people direction	39.4%
3	Remember former disasters	8.1%

(1) **53%** of survivors “**Immediate Evacuate**”

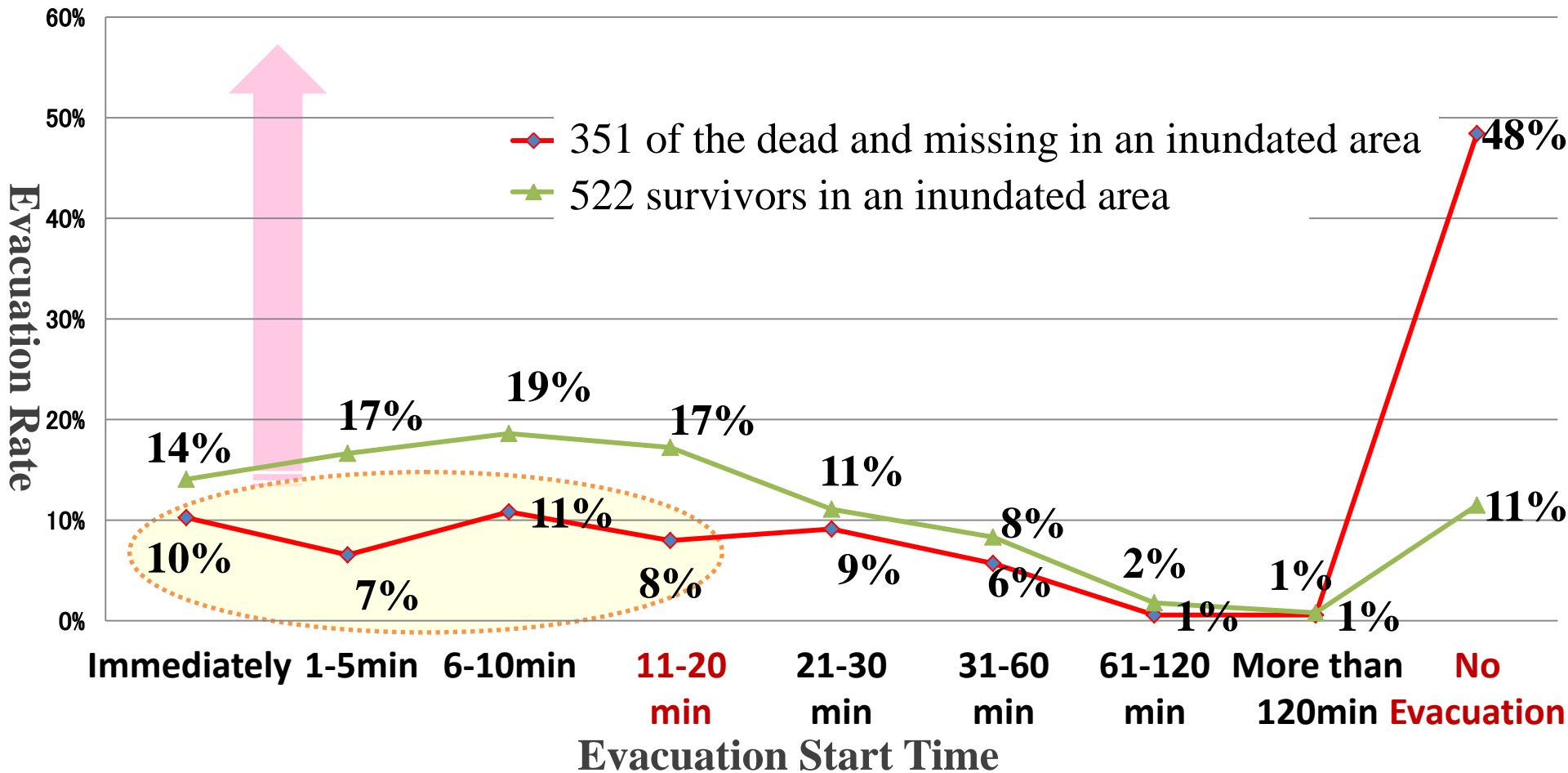
(2) Evacuation-disturbance behavior reminds us of the past lesson,

「津波てんでんこ(Tsunamitendenko)」 in order to protect lives from tsunami

**Tsunami Evacuation Behavior and
Effectiveness of Tsunami Evacuation Principles
in the 2011 Great East Japan Earthquake**

Evacuation Behavior in the 2011 Great East Japan Earthquake

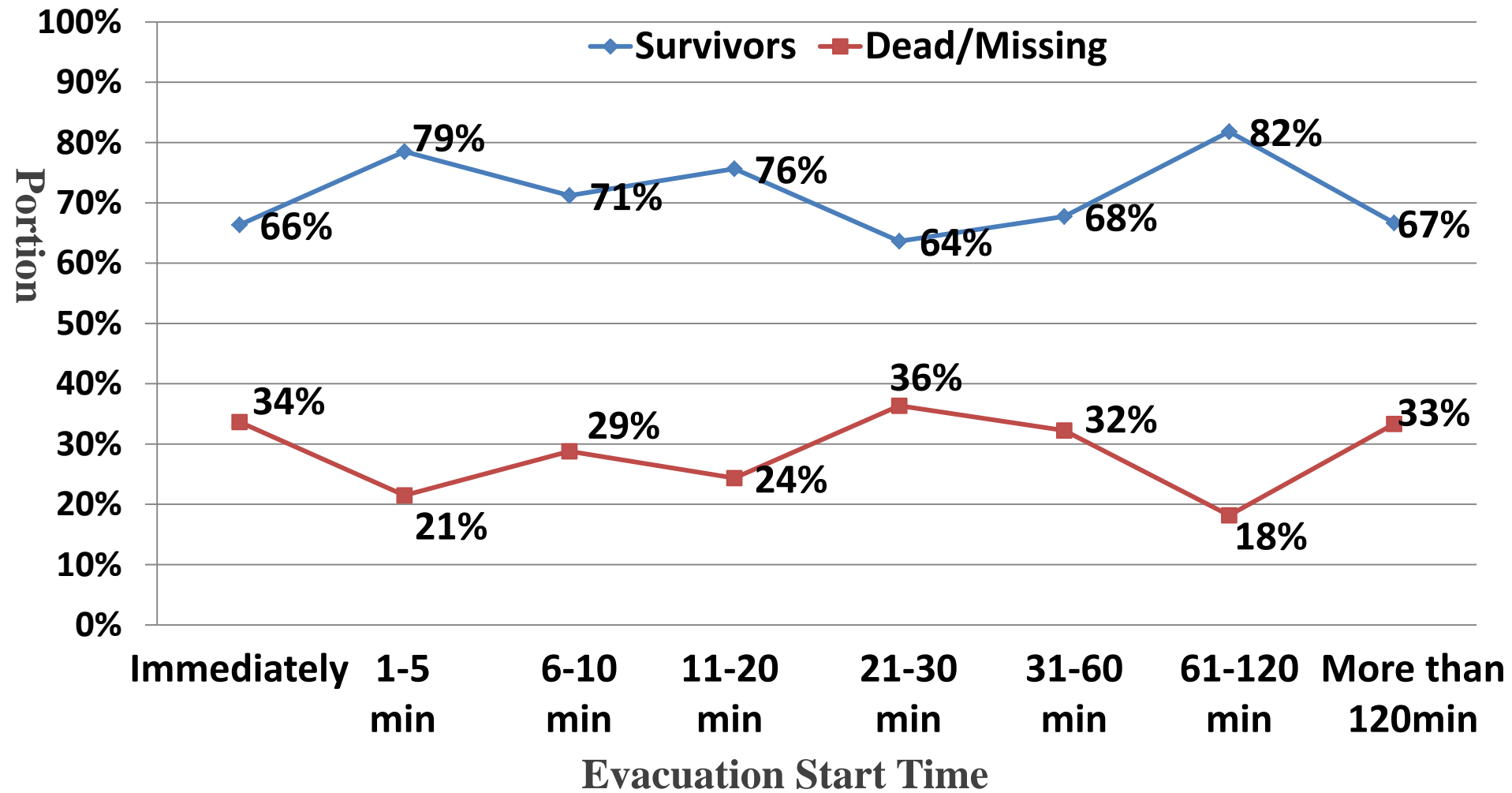
36% of the dead and missing evacuated within 20 minutes, but they died



- (1) More than 50% of the survivors evacuated within 20 minutes.
- (2) 48% of the dead and missing did not or could not evacuate.

Evacuation Behavior in the 2011 Great East Japan Earthquake

No clear difference in the evacuation time between two groups, after excluding 'No evacuation'



Motivation and Used Data

Motivation of Research:

- 36% of the dead and missing in an inundated area evacuated within 20 minutes, but they died. (from the previous study, explain on next page)
- There is no clear difference in evacuation time between the survivor and the dead and missing after excluding 'no evacuation'.

Data:

To investigate behaviors of the two groups (both survivors and the dead and missing people), Weathernews data were used.

Survivors

- Period: March 14, 2011 to May 10, 2011
- **299 survivor's full-text/descriptive comments**
(7.2% of 4,450 survivors comments, excluding unrelated comments)

The Dead & Missing

- Period: May 18, 2011 to June 12, 2011
- **65 witnesses' statements about stories of the dead/missing**
in five Prefectures (50 comments from Miyagi, 8 from Iwate, 5 from Fukushima, and 2 from Chiba)

Evacuation Behavior in the 2011 Great East Japan Earthquake

- Before the disaster, evacuation with car was not officially recommended
- 「津波てんでんこ(Tsunamitendenko): well-known tsunami evacuation principle

Rank	Evacuation-Disturbance Behavior	%
1	Be tied up on the road traffic jam	26.3%
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Analysis

107 comments about
the dead and missing

Extraction

183 meaningful
words/sentences

Apply & Analysis

2,587 comments in
Data (Tohoku areas)

To Examine an Effectiveness Tsunami Evacuation Principle ¹²

– as a source of knowledge for proper evacuation -

Tsunami Evacuation Principle

Goal: Help to minimize negative consequences of the disaster with providing basic direction for evacuation

Effectiveness: **When residents follow and carry out what the evacuation principle guides**, it is meaningful

To test whether the recommended actions are really helpful for the residents to save their lives

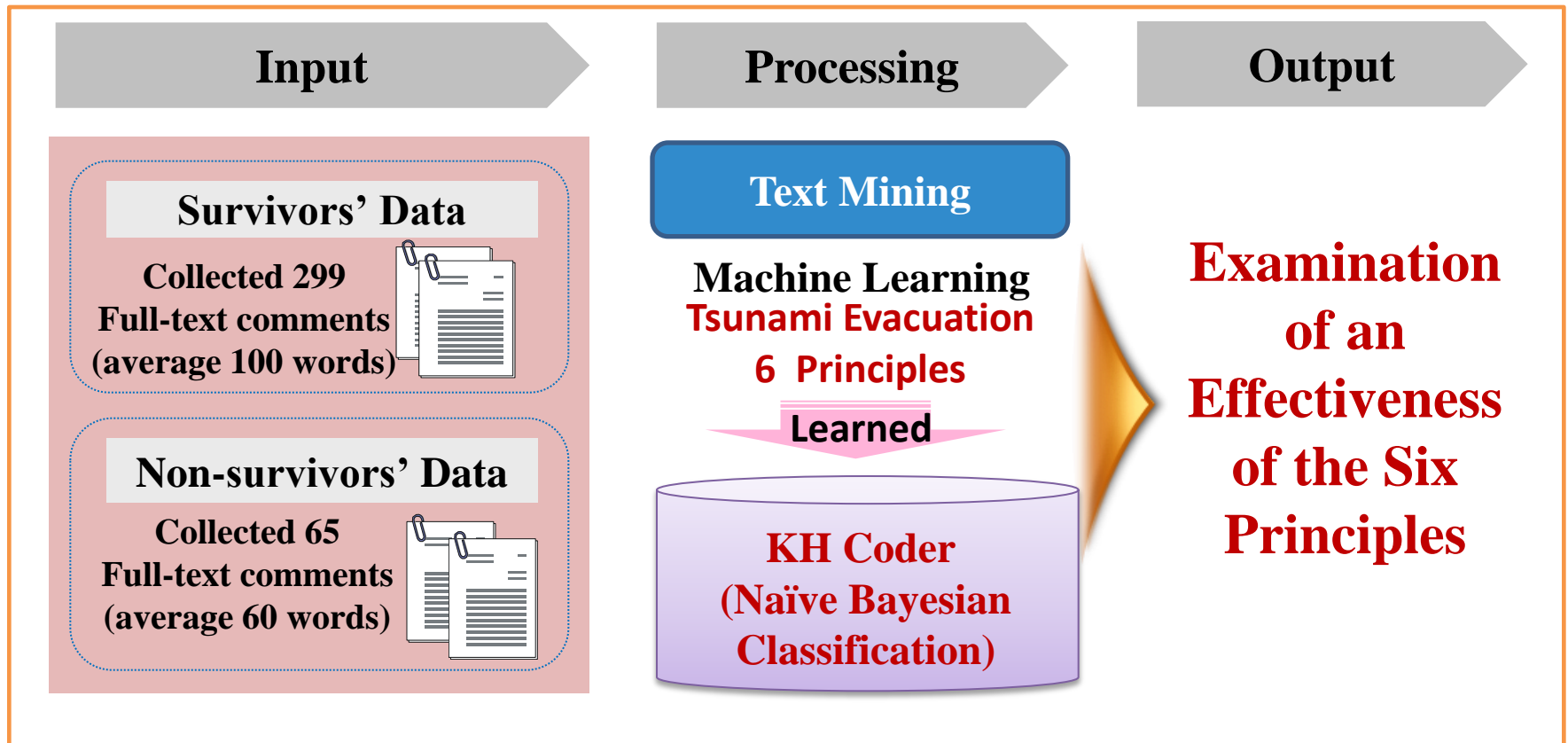
* Six Principles of tsunami evacuation by NPO e-FLAG

- (P1) Check the fire sources, when an earthquake occurs
- (P2) Regardless of any situation you are in, evacuate to the hills or higher grounds
- (P3) Actively and autonomously evacuate
- (P4) Respond properly depending on the situation despite previous experiences
- (P5) Don't think that one specific place and choice is the best
- (P6) Cooperate during evacuation

Based on collect scattered survivors' story, legend, folklore, etc. on tsunami disaster prevention in the past earthquake induced tsunami in Japan, including three principles by Prof. Katada at Gunma Univ.

Rank of the tsunami evacuation principles taken by the residents

There is a difference in choice of among the six tsunami evacuation principles between survivors and the dead and missing: Based on the frequency of the six evacuation principles taken by the survivors (or by the dead and missing), which evacuation principle was utilized the most (being one) and the least (being six)?

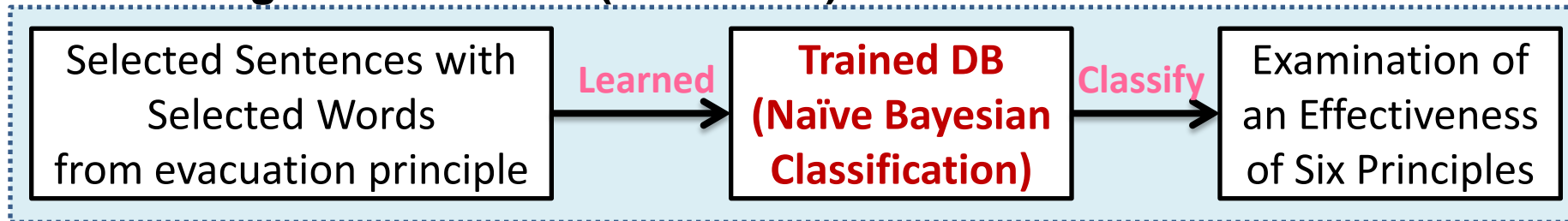


Process of Data Analysis (2/2)

Used Software for Analysis:

KH-Coder (text mining tool, Japanese Dictionary embedded)

Text Mining Process Flow (KH-Coder) :



[Example]

とにかくすぐに高台に逃げる

	Word (Frequency)
Noun	高台 (1)
Verb	逃げる(1)
AdVerb B	する(1),とにかく(1)

Similar sentences of the principle

すぐに高いところへ避難する
速く指定高所へ避難

:

すぐに指定避難所の小学校に向かいました。

Input

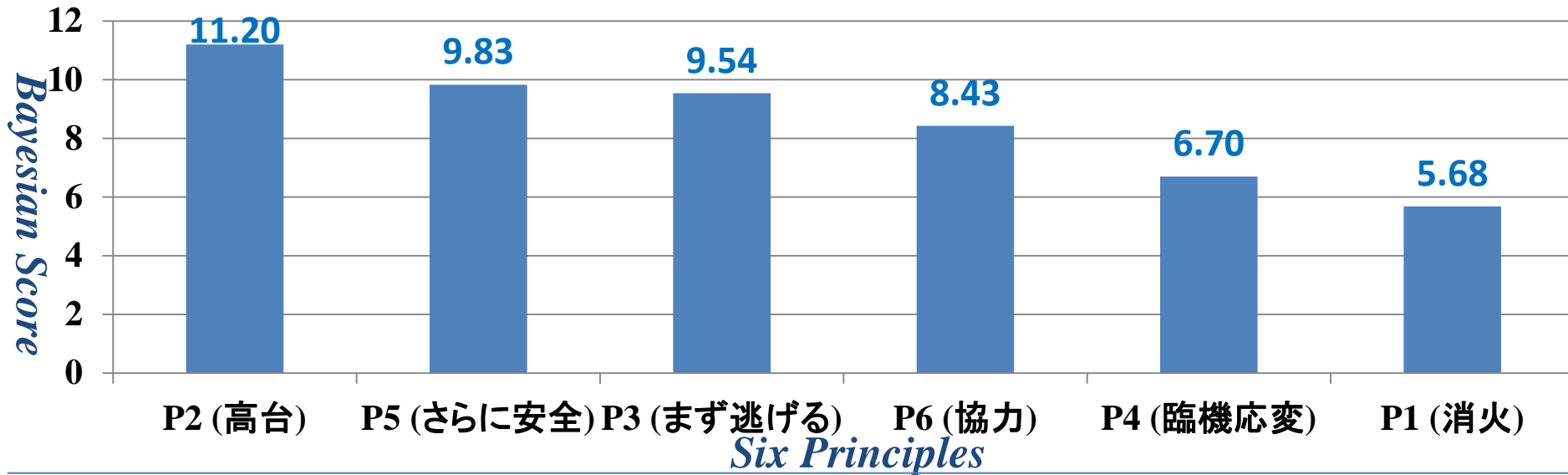
Trained DB (Naïve Bayesian Classification)

Classify

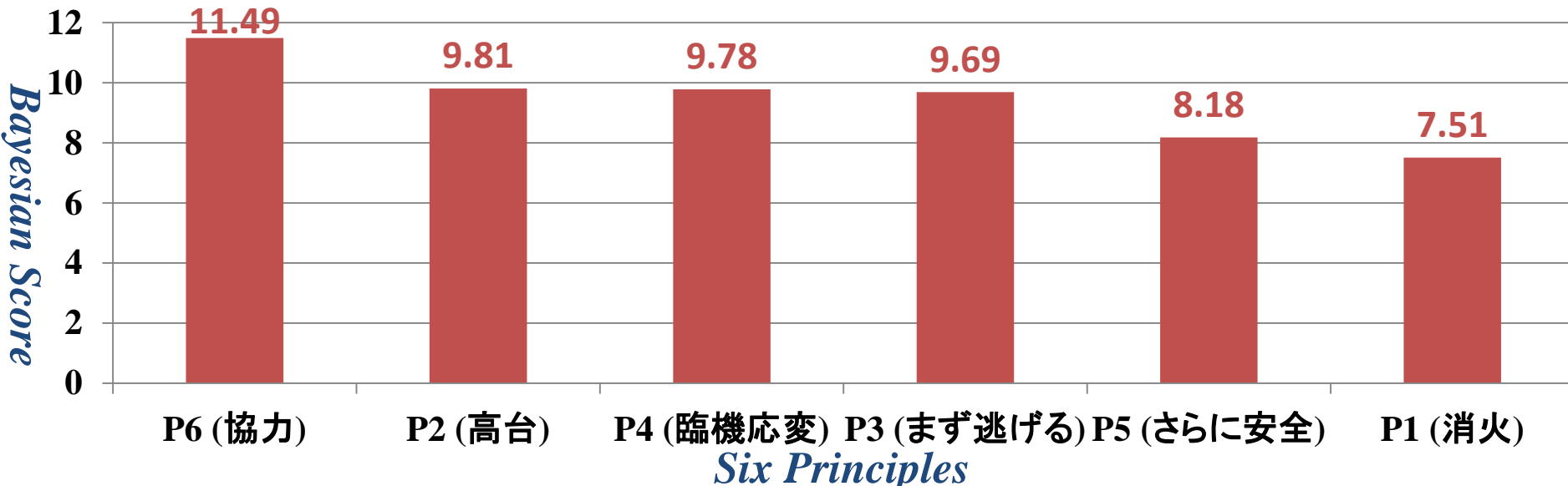
- Check the fire sources, when an earthquake occurs
- Regardless of any situation you are in, evacuate to the hills or higher grounds
- Actively and autonomously evacuate
- Respond properly depending on the situation despite previous experiences
- Don't think that one specific place and choice is the best
- Cooperate during evacuation

Results: Rank of the Principle

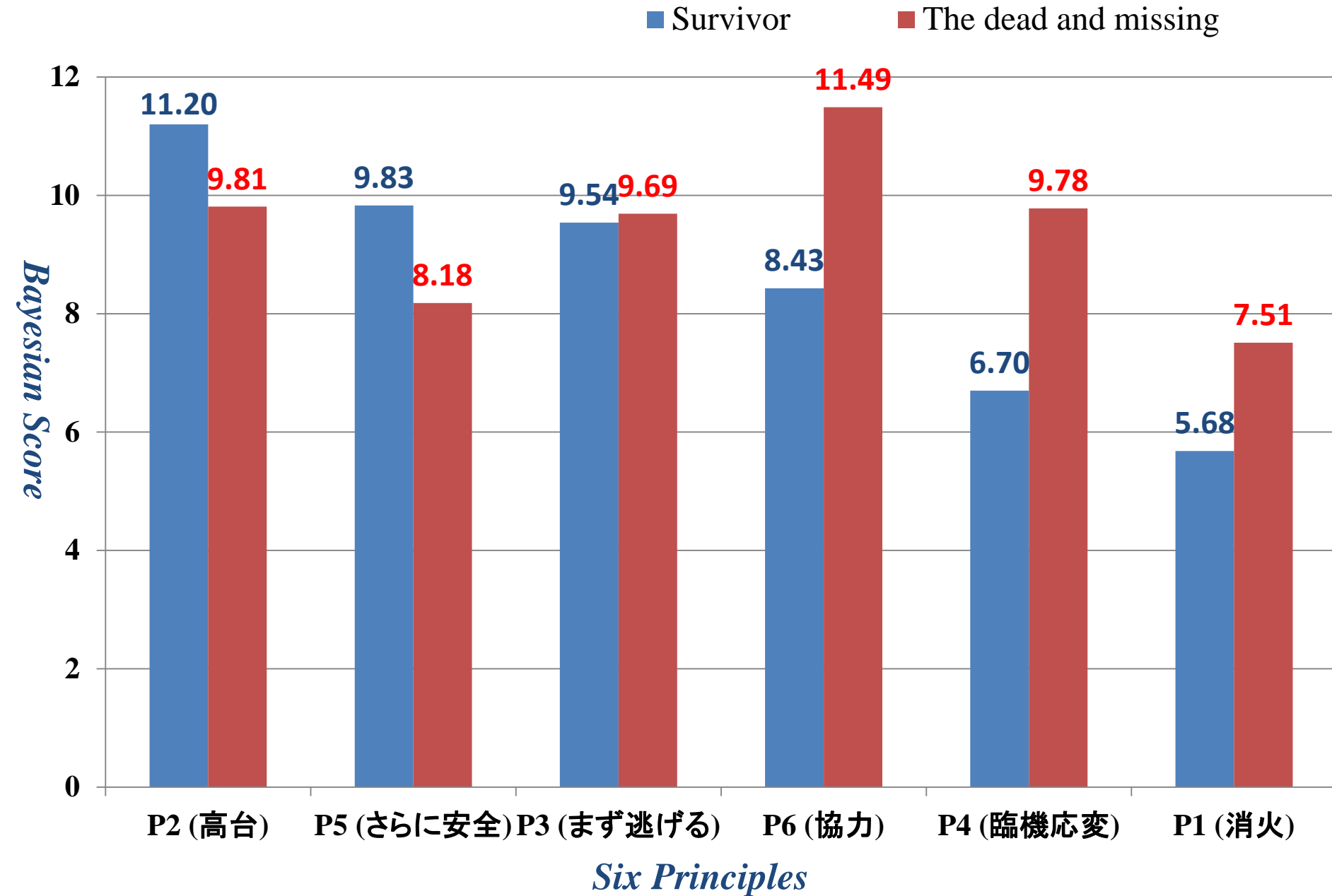
Results of the survivor



Results of the dead and missing



Results: Rank of the Principle



Conclusion and Discussion

- Reports the differences of actions taken among the six principles for tsunami evacuation between the survivors and the dead and missing in the 2011 Great East Japan Earthquake
- **The survivors** used the top 3 choices from the six principles in which there three include contents about **how or where persons do evacuation.**
- **The dead and missing** reported ‘[P6] Cooperate during evacuation’ as the most followed principle. Although ‘helping others’ is recommended as part of the evacuation method in Japan, it is viewed as a controversial behavior that could hold up or hamper a person during the evacuation that leads to failing to protect his or her own life.
- ‘**[P1] Check the fire sources when an earthquake occurs**’, was selected and followed by the fewest persons in both of the two groups.
- Based on the results, proposal of **Guideline for Actions which help to survive**

Develop Ontology of Evacuation: Attributes Analysis

Attributes Analysis

Collected Mass Data



Extracted Attributes

User (Gender, age..)

Evacuation Behavior (time, place, car..)

Others..

[Example]

Extracted Attributes

User (Gender, age..)

Considering personal attributes such as gender (male and female), age (the old, children, babies), dependent on care (babies, handicapped people, sick people, pregnant), and others (mothers, living alone, students, difficult to return home, and so on), this part analyzes characteristics and differences among categorized groups.

[Example in Japan]

森 伸一郎・鵜久森 潤「新聞記事分析による東北地方太平洋沖地震時の住民の津波避難行動」

*** 属性12 項目** [0] 氏名(主体の代表者名): 及川 将 / [1] 年齢(代表者の年齢): 26歳 / [2] 性別(代表者の性別): 男 / [3] 立場(代表者の立場): 漁師 / [4] 地震時にいた場所: 職場 / [5] 地震時に誰といたか: 上司(および同僚) / [6] 地震時にいた地域の県名: 岩手県 / [7] 地震時にいた地域の市町村名: 大船渡市 / [8] 地震時にいた地域の町村, 地区名: 末崎町 / [9] 地震時にいた地域の詳細な場所: 第2市場 / [10] 主体に含まれる行動者数: 1名(とした) / [11] 記事掲載時の主体の属性: 被インタビュー者

*** 行動16 項目** [1] 避難の有無: 避難した / [2] 避難の成否: 避難成功 / [3] 避難行動の結果(生/死): 生 / [4] 避難開始のきっかけ: 呼び掛け(上司の指示) / [5] 避難開始の時期: 地震直後 / [6] 最初に避難しようとした場所: 高台 / [7] 避難した場所: 高台 / [8] 避難した建物の階数: 該当せず / [9] 避難手段: 車 / [10] 避難しなかった理由: 該当せず / [11] 津波に遭遇した場所: 該当せず(遭遇なし) / [12] 被災の度合い: 津波で濡れていない, 無傷 / [13] 自宅で遭遇した場合: 該当せず / [14] 避難行動の種類: 直後避難 / [15] 避難呼び掛け(する/される/両方/なし): される / [16] 避難呼び掛けの種類: 直接

Pre-disaster Preparedness in Tokyo Area

Current State of Disaster Preparedness of Those who live in Tokyo Area

[Purpose of Survey]

Investigation a current state of preparedness for predicted earthquake in Tokyo area for those who live in the Tokyo area.

[Survey period and Target areas]

- June 12, 2012 – July 9, 2012 (for Off-line) / August 20, 2012 – September 5, 2012 (On-line)
- Tokyo Metropolis and four prefectures (Kanagawa, Chiba, Saitama, and Ibaraki)

[Research Questions]

* Disaster Preparedness Behavior : Keeping supplies (food, water, first-aid kit, clothing, etc.), Stabilizing furniture, Getting hazard-related information, Making a family reunion plan and other plans for when disaster occurs, Structurally strengthening the building

(1) Disaster Prevention Training :

Hypothesis 1-1: Disaster preparedness behavior is shown more in the participants versus non-participants in the disaster prevention training.

Hypothesis 1-2: There is existing difference when comparing those who participated and did not participate in the disaster prevention training for disaster preparedness behavior.

(2) Experience of Damages by the 2011 Great East Japan Earthquake

Hypothesis 2: Those who experienced damages by the 2011 Great East Japan Earthquake are more willing to take the disaster preparedness behavior compared with the group that did not.

Conducted Survey

[Survey period, target areas]

A field survey was carried out in Tokyo Metropolis and the four Prefectures - Kanagawa, Chiba, Saitama, and Ibaraki - to investigate three parts for measuring the following

[Questionnaires]

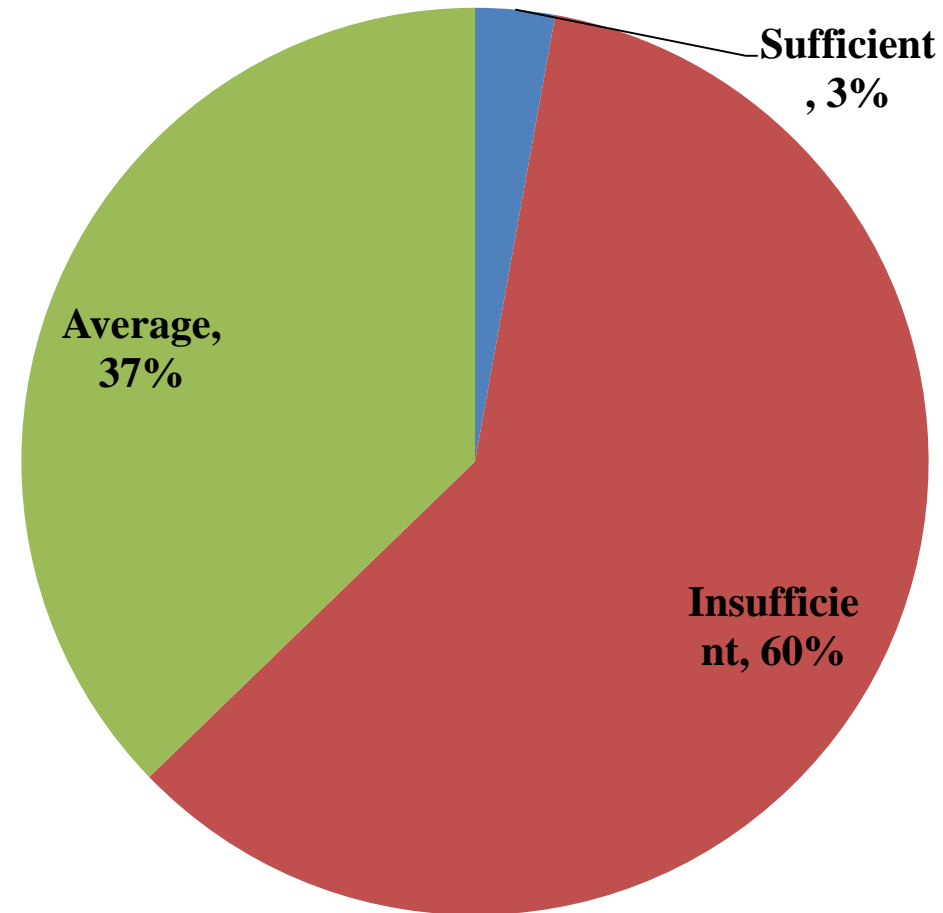
- We would like to ask you that when the earthquake occurred on March 11, 2011 (10 items)
- Disaster Preparedness (14 items): awareness & knowledge, countermeasure in house & furniture, family reunion plan, supplies, disaster prevention training
- Disaster preparedness for outside a home (3 items): reaction of disaster on train, possibility of becoming a person who has a difficulty in returning home, emergency supplies

Results of Off-line Survey (1/3)

Residents are **not sufficiently prepared** for the disasters

Q) Do you think that your preparedness before disaster activities are enough?

	Percentage (Hit)
Sufficient	3% (7)
Insufficient	58% (148)
Average	36% (92)
(Blank)	3% (9)



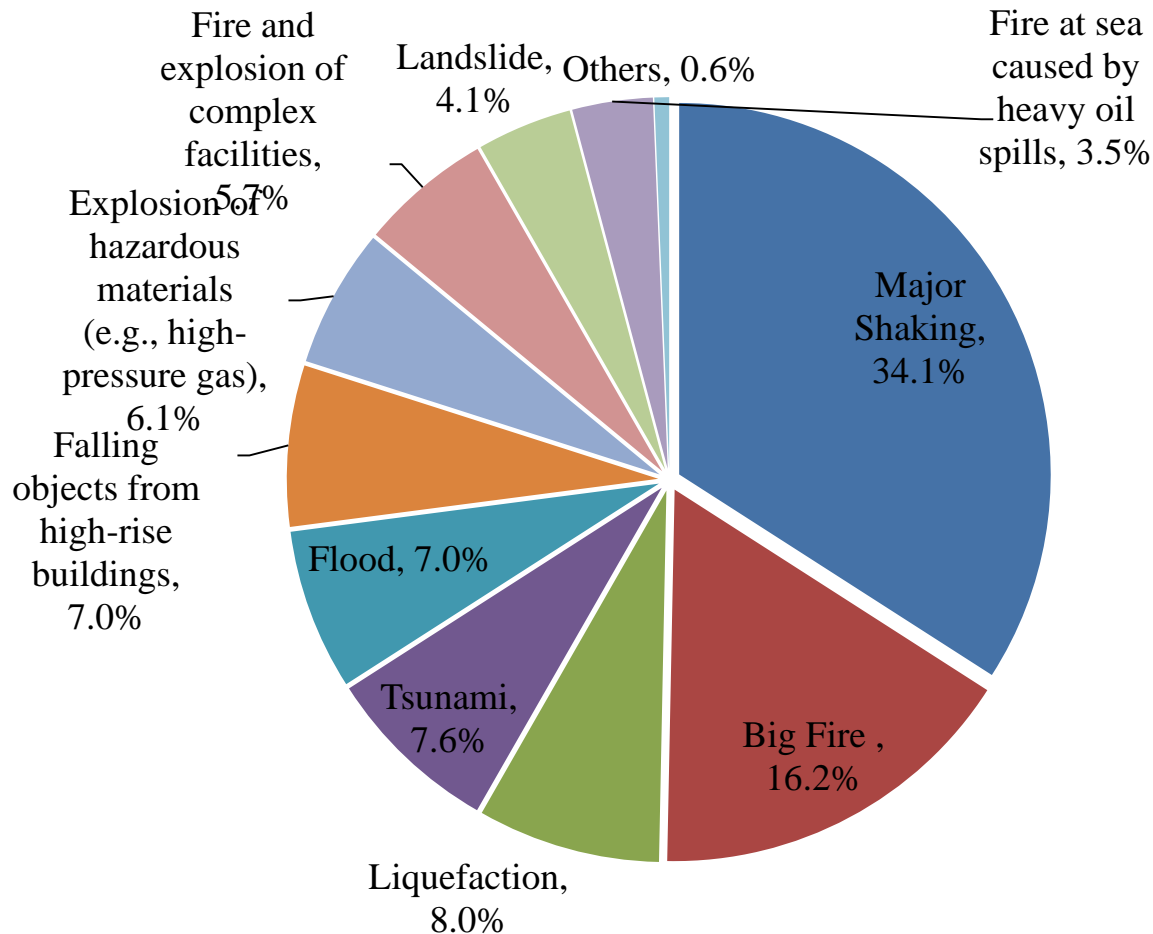
- * 256 data (a response rate: 51%)
- * males (73%) & females (27%)
- * Average Age (45 years old)

Results of Off-line Survey (2/3)

34% of the persons worry about the major shaking by the earthquake
16% chose the **big fire** considering the 1923 Great Kanto Earthquake

Q 15) Which of the following risks by the expected earthquake would happen on your living place? (Multiple answers)

- ① Major Shaking (34.1%)
- ② Big Fire (16.2%)
- ③ Liquefaction (8.0%)
- ④ Tsunami (7.6%)
- ⑤ Flood (7%)
- ⑤ Falling objects from high-rise building (7%)
- ⑥ Explosion of hazardous materials (e.g., high-pressure gas) (6.1%)
- ⑦ Fire and explosion of complex facilities (5.7%)
- ⑧ Landslide (4.1%)
- ⑨ Fire at sea caused by heavy oil spills (3.5%)
- ⑩ Others (0.6%)



Results of Off-line Survey (3/3)

The residents are not sufficiently prepared for it: **Nothing special 59%**
Estimated 5.17 million persons who had difficulties going back to homes
5.15 million persons who had difficulties going back to homes on March 11, 2011

Q) There is any preparation for difficulty of returning homes by the expected earthquake?

	Hit	%
Nothing special	127	59%
a pair of sports shoes	65	30%
food supplies	17	8%
fordable bike	3	1%
extra clothes and blankets	3	1%
Total	215	100%

