Mitigating simultaneous returning home after large-scale earthquakes: changing tourists’ intentions to stay through public support

K Sakai1*, Y Toyoda1 and H Kanegae1
1Ritsumeikan University, 2-150 Iwakura-cho, Ibaraki, Osaka 567-8570 JAPAN

*E-mail: sakaik@fc.ritsumei.ac.jp

Abstract. The difficulty in returning home in response to an earthquake is a serious problem for tourists, and it is necessary to understand the obstacles involved. The purpose of this study is to highlight factors that affect tourists’ intentions to return home or stay at the site during an earthquake disaster. Questionnaires were administered to tourists in Himeji Castle, and 467 valid responses were obtained. This study analyzed data by decision tree analysis using the tourists’ personal attributes, sightseeing style, and the degree of public support as independent variables and tourists’ behavioral intention as the dependent variable. In the situations related to public support, it became clear that proximity to one’s residential area and available transportation to Himeji had an influence. Further, it was found that public support strongly affected the behavioral intentions of tourists who came from afar. The results confirm that public support, tourists’ attributes, and sightseeing style affect intentions.

1. Research background
In the Great Eastern Japan Earthquake that occurred in 2011, about 5.15 million people in the metropolitan area had difficulty returning home. Due to the suspension of the railway service in the Tokyo metropolitan area, many difficulties with returning home were faced by commuters around the station. Furthermore, roads were extremely crowded with people going home on foot. The additional possibilities of traffic hindering emergency vehicles and the risk of crowd-based accidents emerged.

These issues during the Great Eastern Japan Earthquake occurred in areas with workers and students who usually commute to and from school. Conversely, tourism is different from commuting, with the frequency of tourists visiting the location being dramatically lower. Tourists will be less adept than daily commuters of eastern Japan if a disaster such as an earthquake occurs during sightseeing, because tourists do not have enough information about the area. In other words, when a disaster occurs, it is necessary to appropriately guide and support tourists who find it difficult to return home. It is critical to mitigate large numbers of tourists returning home simultaneously from popular tourist areas. However, research on these incidents is limited. In addition, it is important to sustain tourism through coexistence between travelers and local residents. The simultaneous return of tourists at the time of the disaster in relation to sustaining both tourism and disaster mitigation must be considered.

For this purpose, it is necessary to understand how tourists behave when earthquake disasters occur. Therefore, in this study, the purpose is to identify factors that affect tourists’ intentions to return home and stay during an earthquake disaster by decision tree analysis, factoring in public support.
2. Related works
First, we will describe related studies on tourism and disaster prevention. These are classified into seven types, shown in Table 1. “A” is research on disaster prevention awareness of tourists in a tsunami, pointing out the importance of educating tourists [1]. “B” is a study on evacuation. There is research on quantifying the number of tourists staying for evacuation guidance [2], on issues and proposals regarding evacuation routes [3,4], on tourism evacuation decision making and evacuation behavior characteristics [5,6,7,8], and on tourism evacuation using simulations [9]. “C” is a study about tourists returning home; these studies show factors for mitigating large numbers simultaneously returning home [10, 11].

“D” is research on an information provision system using ICT [12, 13]. “E” comprises studies on dark tourism and visits to a disaster area as a negative legacy [14, 15, 16]. “F” is a study on signs and pictograms on disasters [17, 18]. “G” is a study of economic damage to the tourism industry [19].

| Types                          | List          |
|--------------------------------|---------------|
| A Disaster prevention awareness | 1             |
| B Evacuation                   | 2, 3, 4, 5, 6, 7, 8, 9 |
| C Returning home               | 10, 11        |
| D Information provision system | 12, 13        |
| E Dark tourism                 | 14, 15, 16    |
| F Signs and pictograms         | 17, 18        |
| G Economic damage              | 19            |

Secondly, we will describe related work on returning home in the event of a disaster. Regarding intention to return home, there is considerable research relating to commuters. These studies can be roughly categorized by two investigation methods. The first one is conducting a follow-up survey on the behavior at the time of an earthquake of the commuters who were present at the site of the disaster [20, 21, 22]. The second is a study on the intentions of commuters who had assumed a disaster that did not actually happen [23, 24]. However, these findings cannot be directly applied to tourists because their knowledge of the location in question is generally lesser than that of commuters.

Regarding temporary visitors such as shoppers in the city center, who are thought to have little knowledge about the location, one study revealed intended actions assuming a large-scale earthquake disaster [25]. However, in this research, only one hypothetical scenario among possible large earthquake situations is presented, so intentions in response to various situations are not considered. In addition, there are studies on tourists’ behavioral intentions at the time of an assumed large earthquake [10, 11]. Although these studies have made clear the intentions in response to each factor, they do not consider possibilities in which several factors have a simultaneous influence.

In this research, by using a decision tree analysis with tourists’ behavioral intentions as the dependent variable, we can identify the factors with strong influence on intentions. These factors can include tourist attributes, tourism style, and the conditions of public support.

3. Survey summary
In this study, we will quantify the intentions of tourists to return home or stay after an earthquake. Additionally, we will establish how much public assistance and the attributes of tourists affect the intention to stay. Himeji Castle has been used as the site to distribute and collect the questionnaire because it is a famous world cultural heritage site in Japan, with approximately 2 million tourists visiting each year. This area is also at risk of a large-scale earthquake. Follow-up surveys were difficult as tourism is occasional or seasonal. We therefore asked tourists to imagine that a major
earthquake was occurring at the time of the survey and what their intentions would be. At that time, since the maximum assumed seismic intensity around Himeji Castle is an upper 6 on the seven-point Japanese scale according to Hyogo Prefecture, we showed the respondents the explanation about the situation of the seismic intensity of upper 6.

We asked tourists to select one of three choices: “Go home,” “Stay around Himeji Castle,” or “Other” for each situation. When a private car user selects the option to stay instead of going home, it means that the occurrence of heavy traffic congestion can be eased. If a tourist who used public transportation chooses “Stay around Himeji Castle,” it means that the mass wave of tourists around JR Himeji Station can be decreased. Table 2 shows the survey overview, including the public assistance, tourist attributes, and sightseeing style considered to affect intentions in this study. Table 3 shows descriptive statistics of each variable.

| Table 2. Survey overview of the domestic tourist |
|-------------------------------------------------|
| Date of Survey                                  | 17th and 18th December, 2016                     |
| The scope of survey                             | Tourists at Himeji Castle                        |
| The number of valid responses                    | 467                                              |
| Survey method                                   | Questionnaire                                    |

Contents of variables

1. Type of disaster (Earthquake, Tsunami, Flood, Landslide, Storm, Tornado, Eruption)
2. Number of visits (1, 2, 3, 4, 5 or more)
3. Accompanying person A (Family, Friend, Alone, Tour, Other)
4. Accompanying person B (Baby, Elementary school student, Junior high school student, High school student, Aged person)
5. Number of days in stay
6. Residential area
7. Transportation to Himeji (Walking, Private car, Bus, Train, Taxi, Tour bus, Other)
8. Age
9. Gender
10. Behavioral intention
   1. with no information
   2. public transportation is cancelled
   3. roads become damaged
   4. public transportation resumes operation
   5. public transportation will be resumed tomorrow
   6. water and food are provided
   7. water and food are not provided
   8. facilities for tourists to stay are provided
   9. facilities for tourists to stay are not provided
| Variable                        | Answer                                                   | Samples |
|--------------------------------|----------------------------------------------------------|---------|
| Disaster experience            | Earthquake: Experience 49.0%, No experience 50.9%      | 453     |
|                                | Tsunami: Experience 1.5%, No experience 98.4%          | 453     |
|                                | Flood: Experience 6.6%, No experience 93.3%            | 453     |
|                                | Landslide: Experience 2.2%, No experience 97.7%       | 453     |
|                                | Storm: Experience 16.1%, No experience 83.1%           | 453     |
|                                | Tornado: Experience 2.4%, No experience 97.5%          | 453     |
|                                | Eruption: Experience 0.6%, No experience 99.3%         | 453     |
| Number of visits               | 1 visit: 49.1%, 2 visits: 22.6%, 3 visits: 11.7%, 4 visits: 0.31%, 5 or more visits: 13.3% | 450     |
| Accompanying person A          | with family: 47.3%, with friend: 30.1%, alone: 12.2%, Group tour: 3.2% | 465     |
| Accompanying person B          | With infant: 6.2%                                      | 433     |
|                                | With elementary school student: 8.3%                   | 432     |
|                                | With junior school high student: 3.6%                  | 433     |
|                                | With high school student: 1.3%                         | 432     |
|                                | With aged person: 26.3%                                | 433     |
| Number of days of stay         | 1 day: 38.6%, 2 days: 61.3%                            | 430     |
| Residential area (Distance)    | Average: 887.1, S.D.: 2357.3                            | 453     |
| Residential area               | Himeji City: 3.3%, Outside of Himeji City and in Hyogo prefecture: 10.5%, Outside of Hyogo prefecture: 80.3%, Foreign country: 5.7% |     |
| Transportation to Himeji       | Walking: 16.7%, Private car: 30.3%, Bus: 7.2%, Train: 35.6%, Taxi: 1.9%, Tour bus: 5%, Other: 2.1% | 455     |
| Age                            | Average: 49.6, S.D.: 14.7                               | 454     |
| Gender                         | Female: 49.3%, Male: 50.6%                             | 452     |
4. Results

1.1. Using decision tree analysis to extract factors of behavioral intentions
Decision tree analysis is a data mining technique in which a tree-shaped model is used to analyze factors, and from the analysis results, a borderline is sought and prediction made. In this research, the statistical analysis software package R was used for analysis.

1.2. Tourists’ behavioral intentions in transportation situations
First, focusing on the transportation situation, we conducted a decision tree analysis using the intention as a dependent variable. We excluded data not answering as to the intention. Figure 1 and Figure 2 show the behavior model diagram obtained from the decision tree analysis and the degree of influence (Gini coefficient) of each factor. The prediction accuracy of this model is 74.0%. In this analysis, the most important factor is “Status of public transportation,” the next most important being “Status of road damage,” highlighting the importance of the transportation situation.

For example, in a situation where public transport is running, the status of roads is unknown and the tourist came from outside of Himeji City; it is possible to predict behavior with the following probabilities: “Go home,” 0.27, or “Stay around Himeji Castle,” 0.72.

![Figure 1. Intention model showing transportation situations](image)

![Figure 2. Influence of each factor regarding transportation situations on the intention (Gini coefficient)](image)

1.3. Tourists’ behavioral intentions affected by temporary facilities for tourists to stay
The decision tree analysis was then conducted using behavioral intention as a dependent variable in the situation that there are temporary facilities to stay. Figure 3 shows the result; the prediction
accuracy of this model is 64.1%. Important factors in temporary facilities are “provision of facilities” and “distance to home.” For example, in the situation that there is provision of temporary facilities to stay and distance to home is over 85 km, it is predicted that “Stay around Himeji Castle” will be selected with a probability of 0.62.

![Intention model regarding temporary facilities for tourists to stay and Gini coefficient](image)

**Figure 3.** Intention model regarding temporary facilities for tourists to stay and Gini coefficient

### 1.4. Tourists’ behavioral intention depending on provision of water and food

Finally, a decision tree analysis was conducted on situations depending on the provision of water and food. The prediction accuracy of this model is 68.7%; the results are shown in Figure 4. In this situation, “Distribution of food and water to tourists” and “Residential area” are important factors. For example, in a situation where food and water are provided, tourists came from outside of the Hyogo prefecture; it is possible to predict behavior with the following probabilities: “Go home,” 0.34, or “Stay around Himeji Castle,” 0.65.

![Intention model showing provision of water and food and Gini coefficient](image)

**Figure 4.** Intention model showing provision of water and food and Gini coefficient

### 5. Discussion

Regarding the situation of transportation, it became clear that the information on transportation, the damage to roads, the place of residence, and the transportation to Himeji affected decision making. Of special importance is the operation of transportation. In Figure 1, “Go home” is chosen with the probability of 0.89 in the case that transportation has resumed operation. Providing correct information
is needed to avoid the confusion of tourists simultaneously returning home en masse. Even in the information on road status, “Go home” is selected with the probability of 0.82 when the car user gets information that the road is not damaged.

Regarding temporary facilities, if facilities are not provided, a tourist selects “Go home” with a probability of 0.67. However, in the case that facilities are provided and the distance to a tourist's residence is 85 km or more, they will select “Stay around Himeji Castle” by a probability of 0.62. In other words, it is an effective measure for the tourists who live far away.

Additionally, regarding the distribution of water and food, “Go home” is chosen with a probability of 0.76 when water and food are not provided. However, in the case that water and food are distributed, this measure encourages tourists who came from outside the Hyogo prefecture to choose “Stay around Himeji Castle.” This is also an effective measure for tourists coming from afar.

We found relevance to all three factors in the location of the residential area. There are branching conditions of “Himeji City” regarding transportation status, “Under 85 km” regarding temporary facilities to stay, and “Inside Hyogo prefecture” regarding water and food distribution. Because of these findings, improving guidance and information for each residential area can be expected to effectively mitigate simultaneous returning home for the purposes of both disaster management and tourism.

6. Concluding remarks
Through the decision tree analysis, this study shows that public support in the forms of “information provision,” “provision of facilities to stay,” and “provision of water and food” can affect tourists’ behavioral intentions and mitigate their simultaneous returning home.

Although previous studies have shown that it is possible for public support to affect the intention to stay or go home, the relevance of tourist attributes and sightseeing style was not mentioned [10]. By using decision tree analysis in this research, we established the influence of public support on intentions, factoring in tourist attributes and sightseeing style such as residential area and transportation to Himeji. This study shows that it is possible for public support to effectively reduce the number of tourists returning home simultaneously, contingent on the place of residence. This can contribute to sustainable tourism through the coexistence of tourists and residents during disaster time.

However, in this research, we asked about only one scenario among situations such as “information provision,” “provision of facilities to stay,” and “provision of water and food.” This study does not examine the intention in multiple situations combined. In future research, it will be necessary to generate more practical knowledge by considering the intention in varying conditions.

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