



# ANALYSIS OF WILLINGNESS TO PAY FOR SLOPE FAILURE RECONSTRUCTION IN THE DEMOCRATIC REPUBLIC OF TIMOR LESTE: USING SURVIVAL TIME ANALYSIS

Yuki Minematsu<sup>1</sup>, Makoto Fujii<sup>1</sup>, Yuma Morisaki<sup>1</sup>, Yosuke Kon<sup>1</sup>, Junichi Takayama<sup>2</sup>

<sup>1</sup> Kanazawa University, Japan

<sup>2</sup> Komatsu University, Japan

## Abstract

The Democratic Republic of Timor-Leste has a rainy season and a dry season, and heavy rains cause numerous landslides and floods in the rainy season. In many cases, road capacity is reduced as a result of landslides, and accessibility between urban and rural areas is significantly reduced. In April 2021, Cyclone Seroja attacked Timor-Leste, causing enormous flood damage and landslides. Slope failure reconstruction work requires construction equipment, human resources, and financial resources. The Timor-Leste government has a plan for road maintenance in its Strategic Development Plan 2011-2030, but there is no mention of financial resources. Although it is necessary to establish a budget for road maintenance based on taxes from the public, there is no such system in place. In this study, we conducted a survey to determine the extent to which Timorese citizens are willing to pay for the reconstruction of roads. The purpose of this study is to determine the factors that influence the willingness to pay for road reconstruction by time period, and to identify trends in the willingness of Timorese citizens to pay for road reconstruction. Four patterns of recovery periods are assumed: one week, one month, three months, and six months for road reconstruction after a slope failure. As a result, we found that the longer the recovery period, the greater the difference in the probability of payment by gender, with the probability of payment tending to be higher for women. The probability of payment tends to be lower for the younger age group regardless of the recovery period.

*Keywords: Timor-Leste, survival time analysis, willingness to pay, road capacity*

## 1 Introduction

Timor-Leste has both rainy and dry seasons, and heavy rains cause numerous landslides and floods during the rainy season. In addition, road capacity is often reduced as a result of landslides, and accessibility between urban and rural areas is often severely impaired. Furthermore, road reconstruction takes an enormous amount of time, and road capacity has not been improved. In fact, as shown in Figure 1, large-scale slope failures have occurred on trunk roads connecting urban and rural areas, reducing road capacity. As a result, roads and bridges were damaged, making it difficult to transport goods and assess damage [1]. In the “Strategic Development Plan 2011-2030,”[2] the government of Timor-Leste has a plan for road maintenance and management, but there is no mention of financial resources. Although it is necessary to establish a budget for road maintenance based on taxes from the public, such a system has not yet been established.

A survey was conducted to determine the extent to which the people of Timor-Leste are willing to finance road reconstruction and the amount they are willing to pay for road reconstruction. The purpose of this analysis is to identify the factors that influence the willingness to pay for road reconstruction by the duration of road reconstruction, and to clarify the trend of the willingness to pay for road reconstruction by Timorese citizens, using the questionnaires that the authors administered in July and November 2023. Four patterns of road reconstruction are assumed: one week, one month, three months, and six months after the slope failure.



Figure 1 Slope failure along the main road

## 2 Overview of target area and questionnaire survey

### 2.1 Overview of target area

In this section, basic information on Timor-Leste is summarized. First, basic geographical and cultural information is shown below. Timor-Leste is a small country with an area of 14,000 km and a population of 1,340,000 [3]. About 99% of the population is Christian, and about 1% is Muslim. The official languages of East Timor are Tetum and Portuguese. The location of Timor-Leste is shown in Figure 2. As shown in Figure 2, Timor-Leste is located near the equator, with high temperatures throughout the year and rainy and dry seasons. The main industry is agriculture, which produces and exports coffee. In recent years, Timor-Leste has been exporting petroleum and natural gas jointly with Australia.



Figure 2 Location of Timor-Leste

## 2.2 Overview of questionnaire survey in July 2023

This section provides an overview of the survey conducted on July 11 and 12, 2023. The survey was conducted at shopping malls, restaurants, and other public gathering places in Dili Prefecture. The target population was limited to East Timorese, and the survey was conducted in the form of a street survey in which respondents wrote directly on the spot. The total number of responses was 101. Figure 3 shows the actual distribution of the questionnaires. The following is a basic tabulation of the survey conducted in July.



Figure 3 Questionnaire distribution (July 2023)

## 2.3 Overview of questionnaire survey in November 2023

This section provides an overview of the survey conducted on November 23, 24, and 25, 2023. The survey was conducted in shopping malls in Dili and at the National University of Timor-Leste. The survey was administered to Timorese only and was conducted using a Google form. Figure 4 shows the cover of the questionnaire form used. The number of distributed questionnaires was 500, and the number of respondents was 83, which is about 17% of the total number of respondents.



Figure 4 Distribution of vulnerable person in Komatsu City by town

## 3 Analysis of Timorese awareness of road capacity loss due to slope failure

The results of a questionnaire survey conducted in July and November 2023 are used to analyse Timorese perceptions of road capacity reduction due to slope failure. First, Figure 5 shows the level of dissatisfaction with the reduction in road capacity due to slope failure.

Among the 181 respondents, 100 (about 55%) were “very dissatisfied,” 41 (about 23%) were “dissatisfied,” 17 (about 9%) were “neutral,” 5 (about 3%) were “not very dissatisfied,” and 18 (about 10%) were “not dissatisfied at all. About 78% of the respondents responded, “very dissatisfied” or “dissatisfied,” suggesting that many Timorese are dissatisfied with the reduction in road capacity due to slope failure. About 10% of the respondents answered that they were “not at all dissatisfied,” suggesting that a small number of Timorese have become accustomed to the loss of road capacity due to slope failure.

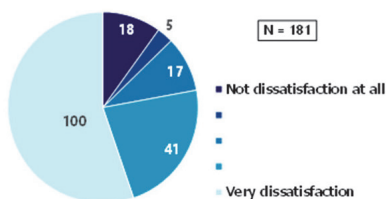


Figure 5 Inundation area for 90 minutes after the break of the levee

Next, in Timor-Leste, there are many areas where the risk of slope failure is high and road closures occur frequently, resulting in reduced road capacity. The survey asked the respondents how long they would like road reconstruction to take. The survey asked how long the people of Timor-Leste wanted the road to be restored. As shown in Figure 6, 71 respondents (about 41%) answered that they wanted restoration within one week, and 31 respondents (about 21%) answered that they wanted restoration within one month, indicating that many respondents want restoration within one month. On the other hand, 19 respondents (about 11%) answered that they did not expect the road reconstruction, suggesting that there may be a certain number of Timorese who have become accustomed to the collapsed road, as inferred from the level of dissatisfaction.

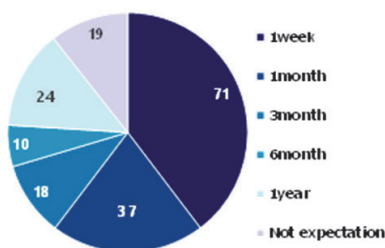


Figure 6 How long do you want the road reconstruction to take after the slope collapse?

## 4 Analysis of willingness to pay for slope failure restoration

Chapter 3 suggested that Timorese people are highly dissatisfied with the reduction of road capacity due to slope failure and that most of them hope for road reconstruction within one month. In this chapter, survival time analysis is conducted to understand the factors influencing the willingness to pay by the duration of road reconstruction using questionnaires administered by the authors in July and November 2023, and to clarify the trend of the willingness to pay for road reconstruction by the Timorese people. Four patterns of road reconstruction periods are assumed: one week, one month, three months, and six months after the slope failure.

## 4.1 Overview of analysis

### 4.1.1 Data used in analysis

This section summarizes the data used in the analysis of the willingness of Timorese to pay for slope failure restoration. Table 1 shows the data used. In this analysis, only the variables listed in the table could be used in the model due to the time constraints of conducting the questionnaire in person.

**Table 1** Overview of covariates used

Covariates used	
age	gender (women: 0, men: 1)
Using newspaper to gather disaster information (Yes: 1, No: 0)	Using bus (Yes: 1, No: 0)
Using TV to gather disaster information (Yes: 1, No: 0)	Using bike (Yes: 1, No: 0)
Hearing disaster information from others (Yes: 1, No: 0)	Using car (Yes: 1, No: 0)
Using the Internet to gather disaster information (Yes: 1, No: 0)	Frequency of travel between Dili and the rest of the country (More than 1 month: 1, Less than 1 month: 0)
How long do you want the restoration to take? (Less than 1 month: 1, More than 1 month: 0)	dissatisfaction (Very dissatisfaction: 5 ~ Not completely dissatisfaction: 1)

### 4.1.2 Methods of analysis

In this analysis, the COX proportional hazard model, one of the survival time analysis methods, was used to analyse the willingness to pay of Timorese for slope failure restoration. As shown in Equation (1), the COX proportional hazards model is a multivariate analysis that calculates the hazard function (mortality rate) and can determine the effect of covariates (explanatory variables) on survival time (monetary amount) [4]. Through this analysis, the variables that affect the amount of willingness to pay for slope failure rehabilitation are clarified, and whether there is a trend regarding the amount of willingness to pay for slope failure rehabilitation among Timorese citizens.

$$\lambda(t|x_1, \dots, x_n) = \lambda_0(t) \exp(\beta_1 x_1 + \dots + \beta_n x_n) \quad (1)$$

In addition, the survival time analysis requires the determination of survival and mortality in the data used. Survival and mortality in this study is determined by whether the willingness-to-pay exceeds a certain value or not. Since the median willingness-to-pay for all recovery periods was \$10, we treated cases in which the willingness-to-pay was \$10 or more as alive and cases in which the willingness-to-pay was less than \$10 as dead.

## 4.2 Results of analysis of willingness to pay for slope failure restoration

This section shows the results of an analysis of the willingness of Timorese citizens to pay for slope failure restoration. The COX proportional hazards model focuses on the hazard ratio.

The hazard ratio is the ratio of the hazard when one covariate is 1 and the other covariates are 0 to the base hazard. A hazard ratio greater than 1 implies a decreased survival rate, while a hazard ratio less than 1 implies an increased survival rate. Survival rate is the probability that the subject is alive at a certain time, but in this analysis, it is the probability that the subject pays a certain amount of money. In other words, an increase in the survival rate means an increase in the probability that the subject will pay a certain amount of money. Table 2 shows the results of the analysis. We focus on the variables of “age” and “gender” for which the P-value is less than 0.15 in all cases except for the case where the recovery period is one month. First, focusing on the “age” variable, the hazard ratio is almost constant and smaller than 1 regardless of the recovery period. This indicates that age affects the survival rate regardless of the recovery period, and the younger the age group, the lower the survival rate. Next, we focus on gender. The longer the recovery period, the larger the hazard ratio. This indicates that the longer the recovery period, the larger the difference in survival rate by gender. Since the hazard ratio is larger than 1, the survival rate is higher for females.

**Table 2** Results of analysis by restoration period

Coariable name	Hazard ratio			
	1 week	1 month	3 months	6 months
Age	0.97	-	0.96	0.95
Gender (Women: 0, men: 1)	1.95	-	2.52	3.63
Dissatisfaction	1.32	0.84	0.82	-
Frequency of movement	0.45	0.55	-	-
Use of bus	3.40	-	1.52	0.70
Use of bike	-	0.79	0.35	0.39
Use of car	-	0.71	2.36	1.31
Use Internet to get disaster Information	0.66	-	0.82	0.76
Use newspaper to get disaster information	0.57	0.55	0.38	0.89
Use TV to get disaster information	-	1.77	-	-
Hear disaster information from other	0.50	0.69	-	0.67
How long do you want the restoration to take	0	-	0.49	0.76
<b>Concordance value</b>	0.79	0.61	0.74	0.72

## 5 Conclusion and future issues

In this study, in order to clarify the attitude of Timorese citizens toward the reduction of road capacity due to slope failure, we conducted a basic analysis on the level of dissatisfaction with slope failure and the amount of willingness to pay for slope failure reconstruction, using questionnaires conducted in July and November 2023. In Chapter 3, we conducted a basic analysis of the East Timorese people’s awareness of the decline in road capacity due to slope failure using questionnaires administered in July and November 2023. The results suggest that many Timorese are dissatisfied with the reduction of road capacity due to slope failure. A small number of East Timorese are accustomed to the reduction of road capacity.

In Chapter 4, the COX proportional hazard model was used to analyze the willingness to pay for road reconstruction in order to understand the factors that influence the willingness to pay by the duration of road reconstruction and to clarify the trend of the willingness to pay for road reconstruction among Timorese citizens. As a result, a model with a concordance value exceeding 0.70 was created for rehabilitation periods of 1 week, 3 months, and 6 months. Future issues include improving the accuracy of the model. In the model developed in this study, the highest concordance value was only 0.79 when the recovery period was one week, indicating that there is ample room for improvement. In addition, the P-values of the covariates of the models are small, with only 0~2 covariates being significant at 5% for each model. In the future, it is necessary to increase the number of variables that become more significant and improve the accuracy of the models through continuous questionnaires.

## References

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