Motorway Incidents Response Prioritization Models

1 Research Team

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2 Summary

Presently, Thailand has two routes including motorway numbers 7 and 9. The motorway number 7 links between Bangkok and Chonburi with 80 km in length. Additionally, the motorway number 9 serves traffic between Bang Pa in and Bangna with 64 km in length. The total length of this motorway network is 144 km. In 2014, Thailand's motorway has served 37 million trips, or 242,000 vehicles daily.

There are approximately 60 incidents occurred on the motorway network daily. During the holidays, the incidents increase more than 30 percent. Therefore, the motorway rescue division plays an important role in managing the incidents and keep the traffic on the motorway recovered as soon as possible. The motorway rescue division is composed of four rescue centers, each center coving approximately 30 km. There are two units on the motorway number 7 including Suvarnabhumi and Bangpakong rescue units. The motorway number 9 is responsible by the Khlong Luang and Ram Inthra rescue units. Each unit has 3 vehicles and 14 staff standby during each shift. When multiple incidents occur simultaneously, the dispatcher will determine which incident is more important and therefore dispatch the rescue vehicle to the incident scene. Since there is no written procedure regarding incident prioritization, it is possible that different dispatchers will make different decision resulting in inconsistency in managing the incident and potentially higher loss and higher traffic delay.

In this study, the researchers developed the incident prioritization support tool for the motorway's rescue units using the conjoint analysis and the ordered logit model. The preliminary interview revealed that type of vehicles, injury-involvement, type of accidents, and number of lanes blocked are the key factors in prioritizing multiple incidents. Using the orthogonal design, nine incident scenarios were developed by varying factor levels. The total of 149 rescue unit staff were interviewed and asked to rank the nine incident scenarios from highest priority to lowest priority. Based on the conjoint analysis and the ordered logit models, it is found that the injury status has the highest importance value, followed by type of accident and number of lanes blocked while the type of vehicle has the lowest importance value. The findings from this study can be integrated to the existing incident decision support system at the Motorway's Traffic Control Room which will significantly improve the incident response operations.

3 Aim of Research

This research aims to develop an incident prioritization decision support tool for the motorway's rescue patrol units using the conjoint analysis and ordered logit model to extract knowledge and judgement from the experienced dispatchers and rescue unit management-level staff.

4 Method of Research & Progression

Preliminary interview has been conducted to identify the key factors in prioritizing and managing incidents. By interviewing six rescue unit respondents, the researchers have identified the key factors in ranking the incidents including type of vehicles, impact on traffic, number of fatalities, number of injuries. Based on following multiple interview, the researchers utilized the orthogonal design technique to construct the questionnaire. The total of four factors have been included in the questionnaire. The first variable is injury status which has three levels including yes, no, and unknown. Types of accidents has three levels including crash, overturn or run off the road (RTOR), and fire. The number of lanes blocked variable has three levels including no lane blocked, 1 to 2 lanes blocked, and three or more lanes blocked. The last variable is types of vehicles which has two levels including car and truck. The total combination for all factor and all levels is (3x3x3x2) 54 sets. With the orthogonal design, only nine cards (Table 1) are required to determine the effects of each factor level. The cards (scenario) were used to construct the questionnaire. Table 2 describes the variables used to construct the models in this study.

Table 1 Nine Incident Scenarios

Card	Type of Vehicle	Type of Accident	Numbers of Lanes blocked	Injuries
A	Truck	Crash	1 - 2 Lanes	Yes
B	Car	Fire	1 - 2 Lanes	Unknown
C	Car	Overturned / ROTR*	No Lanes blocked	Yes
D	Truck	Overturned / ROTR*	≥ 3 Lanes	No
E	Car	Crash	No Lanes blocked	Unknown
F	Car	Crash	≥ 3 Lanes	No
G	Car	Overturned / ROTR*	1 - 2 Lane	No
H	Truck	Fire	No Lanes blocked	No
I	Car	Fire	≥ 3 Lanes	Yes

Note: ROTR = Run off the road

5 Results of Research

The researchers has asked 149 persons of the rescue staff to rank the nine scenarios from the highest priority (score = 9) to the lowest priority (score = 1). The result from the conjoint analysis is shown in Table 3. The weight of each attribute (importance value) is shown in Figure 1.

Table 2 Variables And Their Values

Attributes	Level	Value	
Type of Vehicle	Car	tov = 0	
	Truck	tov = 1	
Type of Accident	Crash	toa_1 = 0	toa_2 = 0
	Overturned / RTOR*	toa_1 = 1	toa_2 = 0
	Fire	toa_1 = 0	toa_2 = 1
Numbers of Lanes blocked	0	lb_1 = 0	lb_2 = 0
	1 - 2 Lanes	lb_1 = 1	lb_2 = 0
	≥ 3 Lanes	lb_1 = 1	lb_2 = 1
Injuries	Unknown	inj_1 = 0	inj_2 = 1
	Yes	inj_1 = 1	inj_2 = 0
	No	inj_1 = 0	inj_2 = 0

Note: ROTR = Run off the road

Table 3 Utility Value For Each Factor Level From The Conjoint Analysis

Attributes	Levels	Utility (Severity)	SD
Type of Vehicle	Car	0.715	1.066
	Truck	1.430	2.132
Type of Accident	Crash	-0.687	0.711
	Overturned / ROTR*	-0.700	0.711
	Fire	1.387	0.711
Numbers of Lanes blocked	0	0.790	0.616
	1 - 2 Lanes	1.579	1.231
	≥ 3 Lanes	2.369	1.847
Injuries	Unknown	-0.479	0.711
	Yes	1.687	0.711
	No	-1.208	0.711
Constant		2.468	1.946
		Pearson's R (sig)	0.925(0.000)
		Kendall's Tua (sig)	0.889(0.000)

Note: ROTR = Run-Off-The-Road Accident

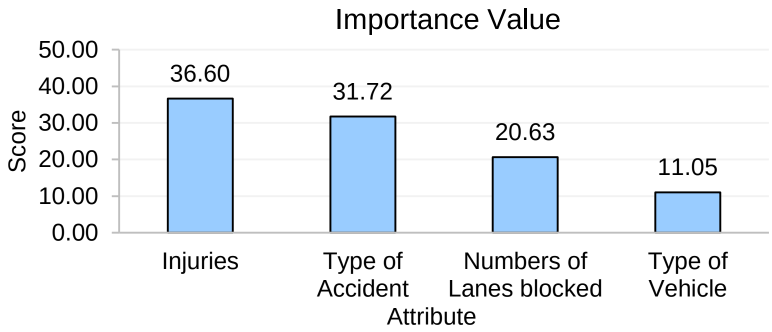

Figure 1 Importance Value – Conjoint Analysis

The conjoint analysis yielded the importance value of each factor. The variable "injury status" has the highest importance value, followed by type of accident and number of lanes blocked. The "type of vehicle" variable has the lowest importance value. That is, the rescue staff considered injury status as the most important factor among the four factors. Furthermore, the researchers have used the same ranked dataset to develop an ordered logit model. The results are shown in Table 4

Table 4 Utility Value For Each Factor Level From The Ordered Logit Model

Variable	Coef.	S.E.	Wald Z	Pr (>|Z|)
tov	0.4172	0.1035	4.03	<0.0001
toa_1	0.0696	0.1194	0.58	0.56
toa_2	2.21	0.1313	16.83	<0.0001
lb_1	1.7385	0.1188	14.63	<0.0001
lb_2	-0.0757	0.1108	-0.68	0.4941
inj_1	3.0729	0.1494	20.57	<0.0001
inj_2	0.5236	0.1173	4.46	<0.0001

According to the ordered logit model, it can be concluded that injury status has the highest coefficient weight, followed by type of accident and number of lanes blocked. Type of vehicle has the least priority among the four factors. The results from the ordered logit model are consistent with those from the conjoint analysis.

6 Future Areas to Take Note of, and Going Forward

The future research could take into account of the time of the incident (day/night), the traffic congestion level, and location of the incident (mainline vs. ramp and interchange) in the analysis. The results from this research will be integrated into the existing decision support system used by the operators of the motorway traffic control room. The incident management practice would be more consistent across the incidents and rescue staff.

7 Means of Official Announcement of Research Results

Once the developed model has been integrated into the decision support system, the researchers will hold a training session for the motorway's control room operators and the rescue units.