

# In-depth Accident Investigation: Case Studies in Motorway of Department of Highways Thailand

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**Abstract**—Accident investigation (AI) aim to answer what, how, why, when of accident happens. Moreover, we need to know what can be done to prevent a reoccurrence and what can be done to minimize accident consequences. Thirteen serious accidents were in-depth investigated by an expert team. Almost accident factors were human errors which occurred in daytime. Human errors are doze off, lack of driving experience, speeding and suddenly brake and lane changing of passenger drivers and pickup drivers. Accident causes by vehicle defects are related with wheel system such as exploding of tire and malfunction of braking system. Severity level could be reduced by fasten seatbelt, lower speed, non-illegal parking, truck protection system, reinstall and redesign of guardrail, crash cushion providing and budget allocation. We suggest engineering, education and law enforcement to minimize accident consequences.

**Index Terms**—accident investigation, inter city motorway, safer road

## I. INTRODUCTION

Thailand is ranked as the 2<sup>nd</sup> of road safety loss due to the road accidents as 24,237 fatalities in 2012 or 36.2 deaths/hundred-thousand population [1]. Even Thailand still does not have the regular inspections of existing road infrastructure but the Inter City Motorway Divisions, Department of Highways (DOH) has placed intention on road safety by setting up the In-depth crash investigation

project on Inter City Motorway Route No. 7 (Bangkok – Chonburi) and No.9 (Outer Bangkok Ring Road from Bang Pa In to Bang Plee).

The road accident is rarely the result of a single variable such as a vehicle, a man and road. In addition, an accident is caused by a mixture of unrelated events coming together. In transportation modes, the human element in this chain of events can be significant. There is normally the result of one or more defects in the safety system, when an accident occurs. People hardly make mistakes consciously but will often do things that have grave significances. [2]

According to the Office of the Commission for the Management of Land Traffic (OCMLT) report, The causes of the accident in Thailand come from three factors and can be simply represented in Venn diagram as shown in Fig. 1. [3].

Accident investigation focuses on improving the safety of the system and aim to answer five questions:

- What happened?
- How did it happen?
- Why did it happen?
- What can be done to prevent a reoccurrence?
- What can be done to minimize accident consequences?

[2]

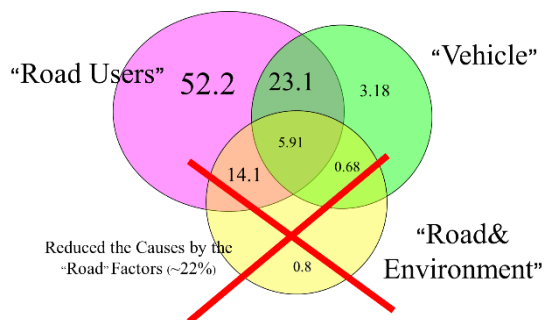


Figure 1. Cause of accidents in Thailand [3]

Solah et al. investigates and analyzes the causes and severity of accidents on public buses in Malaysia. There are several issues supporting the cause of death and severe injuries caused by accidents involving public buses, such as vehicle structural imperfections, roadside hazards, operators' lack of safety and environmental health in the workplace and poor vehicle maintenance. [4]

Abdel-Aty and Radwan studies influencing accident factor on the SR 50 in Florida. This study was based on the negative binomial regression model, and they found that the increased average daily traffic volume per lane, the high curvature of the curves and the number of traffic lanes lead to increased accidents. In the other hand, wider width of shoulder, travelled way and median as a result, the accident has decreased. [5]

Thailand Accident Research Center has investigated the accident related to roadside hazards such as an inappropriate guardrail installation and location which it is a cause of the overturning of vehicle. [6]

This study is another adaptation of in-depth of accident investigation on both motorway routes in Thailand in order to examine and dissipate the problems on road factor for ensuring safer road for motorway users.

II. GENERAL INFORMATION OF STUDY AREA

A. General Data

In General, Motorway was built on a high standard with full control access that the road users can travel up to speed limit of 120 kilometers per hour. The total traffic passing the tolled plaza on Inter City Motorways Route No. 7 and No.9 are 106,460,923 and 97,716,133 vehicles in 2016 [7].

Accident investigation is conducted on 13 cases on two routes as follow:

1. Motorway Route No. 7 (Bangkok-Chonburi) with eight travelled ways and shoulder of both directions. There are starting from Srinakharin interchange (Sta. 0+000) to Bang Pra interchange (Sta. 78+850) and a porting of connecting spur from Bang Kwai Interchange to Bang Bo interchange for a distance of 4 km, which is total 165.750 km for both directions.

2. Motorway Route No. 9 (Bang Pa In – Bang Plee) with eight travelled ways and shoulder of both directions. There are starting from Bang Pa In interchange (Sta. 0+000) to Wat Salut Interchange (Sta. 65+325) with total distance on both directions of 130.650 km.

B. Severity of Accident on Motorways

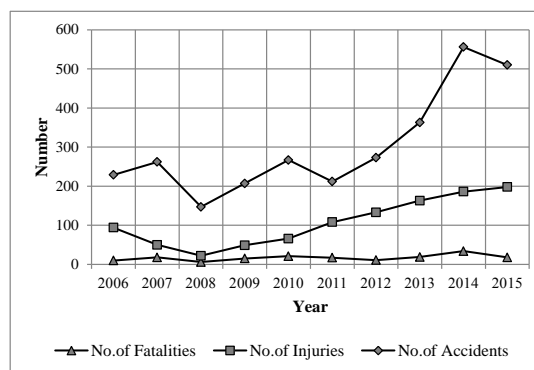
According to the report of Bureau of Highway Safety, Department of Highways (DOH), Thailand, the number of the road accident, injuries and fatalities on motorways are tended to increase during 2006 to 2015 with the average number of fatalities are 16.9 persons per year. Table I and Fig. 1 show details of the accident report by DOH [8].

In addition, accident rates of DOH motorways have very high rate of accident and severity compared to the other roads in Thailand. Table II shows the rate of accident, injuries and fatalities per 100 kilometer and per 100 Million vehicle-kilometers on motorways in 2015.

TABLE I. TRAFFIC ACCIDENTS ON MOTORWAYS IN 2006 - 2015

Year	No.of Accidents	No.of Injuries	No.of Fatalities
2015	510	198	18
2014	556	186	34
2013	363	163	19
2012	273	133	11
2011	212	108	17
2010	267	66	21
2009	207	49	15
2008	147	22	6
2007	262	50	18
2006	229	94	10
Average	302.6	106.9	16.9

Source: Adapt from Bureau of Highway Safety, 2015 [8]



Source: Adapt from Bureau of Highway Safety, 2015 [8]

Figure 2. Trend of accidents on motorways, Thailand

TABLE II. RATE OF ACCIDENTS ON MOTORWAYS IN 2015

Issue	Accidents	Injuries	Fatalities
Number	510	198	18
Rate per 100 kilometer	245.76	95.41	8.67
Rate per 100 M.Vehicle-km.	6.84	2.65	0.24

Source: Adapt from Bureau of Highway Safety, 2015 [8]

III. METHODOLOGY

A. Field Data Collection

The survey team consists of: A person who specializes in accident which consists of the road safety expert, the highway engineers, the vehicle expert, and the

psychologist. Priority should be given to cases of accidents such as: in the case of a public bus; in the case of a serious accident; deaths in the public interest such as: school bus, large trucks, dangerous goods transport and van personal. Data collection was separated in 4 parts as shown following;

1) Accident overview of driver behaviors, passenger behaviors, injury characteristics and deaths.

- a. Review accident data and number of casualties and deaths in the event.
- b. Study the accident data report.
- c. Injury and fatalities were recorded in hospital and police records.
- d. Interview from doctor, nurses, polices and relevant officers.

2) Investigation team collects defected of the vehicle such as *the* body structure, the engine, the license plate, brand, the gear box, standard equipments, tyres, wheels dimension and property, type and number of seats and number of passengers.

3) Investigation team collects physical elements of motorways such as crash *location*, road alignment, environmental factors and evident of crash.

### B. Data Analysis

Accidents were analyzed by Haddon matrix to reconstruction the crash at before crash stage, during crash stage and after crash stage. All stages were considered in 3 main factors of road accident: human, vehicle, and road and environment in a form of relations matrix as shown in the research finding part of this paper.

### C. Investigation Tools

Investigation tools consist of the in-place investigation form of road and environment, driver's behaviors, passengers' behaviors, vehicles' defects, and the crash simulation model.

## IV. RESEARCH FINDING

Results from Accident investigation of 13 cases along motorway route No.7 and No.9 were examined and reported together with the recommendations. Table III shows relevant vehicles in this study. Almost relevant vehicles are trucks which it parked on shoulder and emergency parking of travelled way, and it hit by others vehicles.

Table IV shows in-depth investigation of 13 cases by characteristics and locations. Since 5 December 2016 to 18 September 2017, there are serious accidents which needed to investigate by the investigation team. We found that there are daytime 8 cases (06.00 – 18.00) and nighttime 5 cases (18.00-06.00). The interesting point, almost accident cause is doze off of passenger drivers and pickup drivers (6 cases).

TABLE III. RELEVANT VEHICLES

Vehicle types	No.	Percentage
Truck	11	45.83
Pickup	7	29.17
Passenger car	5	20.83
Bus	1	4.17
Total	24	100

TABLE IV. IN-DEPTH INVESTIGATION OF 13 CASES BY CHARACTERISTICS AND LOCATIONS





Case	Date	Time	Cause of accident	Accident characteristics and locations	No. of injuries	No. of deaths	In-place Evidence
1	5 Dec 16	18.30	Exploding tire	A pickup truck is lost controlled and rollover on Motorway No.7 KM.89+300 inbound to Bangkok.	6	2	
2	26 Dec 16	14.25	Defective braking system	A truck hit a passenger car's rear end on Motorway No.7 KM.67+600 inbound to Bangkok.	2	0	
3	29 Jan 17	06.20	Doze off	A pickup truck hit a truck's rear end on Motorway No.7 KM.108+600 outbound to Pattaya.	2	1	
4	3 Feb 17	04.55	Doze off	A passenger car hit the handrails and guardrail of bridge on Motorway No.7 KM.59+700 outbound to Chonburi province.	0	2	

TABLE IV. IN-DEPTH INVESTIGATION OF 13 CASES BY CHARACTERISTICS AND LOCATIONS (CONT'D)

Case	Date	Time	Cause of accident	Accident characteristics and locations	No. of injuries	No. of deaths	In-place Evidence
5	11 Feb 17	06.50	Suddenly brake and lane changing	A bus hit a truck's rear-end on Motorway No.7 KM.95+700 outbound to Chonburi province.	11	0	
6	17 Feb 17	02.40	Doze off	A passenger car hit a truck's rear-end at left shoulder on Motorway No.7 KM.80+300 inbound to Bangkok.	1	1	
7	18 Mar 17	03.00	Doze off	A pickup truck hit a semi-trailer's rear-end at left shoulder on Motorway No.7 KM.33+300 outbound to Bang Pa In.	1	1	
8	1 May 17	04.25	Exploding tire	Exploding tire of a pickup truck hit a trailer on the emergency parking on Motorway No.7 KM.42+100 outbound to Chonburi province.	1	1	
9	4 May 17	11.05	Doze off	A pickup truck is lost controlled and hit a tree on Motorway No.9 KM.61+600 outbound to Bang Na.	1	2	
10	6 May 17	05.35	Lack of driving experience	A pickup truck is lost controlled hit a parked trailer's rear end on the left shoulder on Motorway No.9 KM.27+700 outbound to Bang Pa In.	0	1	
11	14 May 17	07.40	Doze off	A passenger car hit a trailer on the emergency parking on Motorway No.7 KM.27+900 inbound to Bangkok.	0	3	
12	9 Sep 17	09.55	Speeding	A truck hit the parapet of bridge on Motorway No.7 inbound to Bangkok.	1	1	
13	18 Sep 17	06.12	Speeding	A truck is lost controlled and rollover on Motorway No.9 KM.0+100 outbound to Bang Pa In	0	1	
Total					26	16	
Percentage					69.90	38.10	

Table V shows matrix of accident investigation by cause of accident and severity, and recommendation for 3 main factors; human, vehicle defect, and road and environment which related to the cause of accident and severity. As shown in Fig. 1 and Table V, it is clear that main accident factor is human. Almost the cause of the accidents which was in-depth investigated such as doze off, lack of driving experience, speeding and suddenly brake and lane changing. In addition, we found that 10 deaths are caused by human factor or 62.5 percent of total. Severity level of the accident should be reduced by law enforcement such as control of speeding, fasten seatbelt and illegal parking on shoulder. In case of

vehicle defect, we found problems come from the wheel system such as the exploding tire and defective braking system. Severity level of accident is related with the protection devices of a truck: under-run and lateral protection device. Road and environment do not related crashes in this study, because of the high standard design of motorway geometry. We found that an accident may be occurred at the same location, and there is often repaired by DOH because of lack of maintenance budget; so severity level will be increased at these locations. In addition, severity level will be increased by the improper installation of guardrail and lack of crash cushion.

TABLE V. MATRIX OF ACCIDENT INVESTIGATION

Factor	Cause of accident	Cause of severity	Recommendation
Human	<ul style="list-style-type: none"> <li>- Doze off</li> <li>- Lack of driving experience</li> <li>- Speeding</li> <li>- Suddenly brake and lane changing</li> </ul>	<ul style="list-style-type: none"> <li>- Do not fasten seatbelt</li> <li>- Speeding</li> <li>- Parking on shoulder</li> </ul>	<ul style="list-style-type: none"> <li>- Installation of safety equipment at risk area such shoulder rubble strip</li> <li>- Installation of guide sign and anti-skid surface</li> <li>- Installation of speed warning sign</li> <li>- Installation of speed camera</li> <li>- Implement of law enforcement</li> <li>- Provide rest area and facility</li> <li>- Law enforcement of speeding</li> </ul>
Vehicle defect	<ul style="list-style-type: none"> <li>- Exploding tire</li> <li>- Defective braking system</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of under-run protection and lateral protection device of the truck</li> </ul>	<ul style="list-style-type: none"> <li>- Promote of vehicle and accessory device maintenance</li> <li>- Provide standard and law enforcement of under-run protection and lateral protection device of the truck</li> </ul>
Road and environment		<ul style="list-style-type: none"> <li>- Lack of maintenance budget to repair highway furniture after the accident</li> <li>- Improper installation between guardrail and handrails of bridge</li> <li>- Lack of crash cushion at ticket tolls</li> </ul>	<ul style="list-style-type: none"> <li>- Reallocate highway maintenance to repair furniture after the accident</li> <li>- Reinstall and design the connection between guardrail and handrail between bridge to absorb the impact of the vehicle</li> <li>- Install the crash cushion at ticket tolls</li> <li>- Install speed cameras</li> </ul>

### V. CONCLUSION

Accident investigation aim to answer what happened, how did it happen, why did it happen, what can be done to prevent a reoccurrence and what can be done to minimize accident consequences. We study 13 serious accident cases on Motorway No. 7 and 9 of Department of Highways Thailand. We confirm that the human is a main factor of road accident. In this study, 62.5 percent of deaths are caused by human factor such as doze off, lack of driving experience, speeding and suddenly brake and lane changing of passenger drivers and pickup drivers. Accidents almost occurred in daytime and related with parked trucks on shoulder and emergency parking of travelled way. Severity of accidents are related with

drivers and passengers do not fasten seatbelt, speeding, illegal parking on shoulder, lack of under-run and lateral protection device of the truck, lack of maintenance budget to repair highway furniture after the accident, improper installation between guardrail and handrails of bridge and lack of crash cushion at ticket tolls

Finally, accident is a chain of events: human errors, vehicle defects, and road and environment. Number of accidents will be reduced by measurements of engineering, education and enforcement. For engineering measurement, we propose to reinstall and redesign guardrail at bridge neck, traffic calming such as shoulder rubble strip, rest areas, anti-skid surface. For enforcement, we propose to implement speed camera and law enforcement. Lastly, we propose to implement new standard of vehicle protection devices.

### CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this paper.

### AUTHOR CONTRIBUTIONS

Tassana Boonyoo conducted this research; Usanee Raha, and Kraisri Tippayawong analyzed the data; Atitep Srikongsri, and Chalut Tipakornkiat wrote this paper; all authors had approved the final version.

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