

243712

HE 01146

247

BUS SAFETY IN THAILAND



กรมการขนส่งทางบก

245

HI-01146

BUS SAFETY IN THAILAND
(Road Safety)

100 *ป๋าย*
710 *ป๋าย* *๕๘๖๖๖๖๖๖*
Pichai Taneerananon BE(Hons)MEngScPhD
Prince of Songkla University Hat Yai 90110 Thailand
Tel/fax +66 74 446519 email: pichait@hotmail.com

400
Weeradej Cheewapattananuwong BEngMEngSc
Department of Highways Sri Ayutthaya road
Payathai Bangkok 10400 Thailand
Tel +66 2 2456904 Fax +66 2 2467766
email: weeradejch@hotmail.com



ผลงานอาจารย์

Pichai Taneerananon
Associate Professor of Civil Engineering

Pichai Taneerananon gained his BE(Hons) in Civil Engineering from the University of Western Australia in 1974. He completed his MEngSc in Transportation Engineering and PhD in Civil Engineering at the University of New South Wales in 1976 and 1981 respectively. He has specialised in the areas of Transportation Engineering and Planning and Road Safety Engineering. On the latter subject, he has published a number of papers over the past 10 years. He is presently an Associate Professor and Director of the Centre for Traffic and Transport Management in Southern Regional Cities, Prince of Songkla University, Thailand.

Weeradej Cheewapattananuwong
Senior Traffic Engineering, Traffic Engineering Division

Weeradej Cheewapattananuwong received his BEng in Civil Engineering from the Prince of Songkla University Thailand in 1987. He completed his MEngSc in Transportation Engineering at the University of New South Wales in 1996. He has worked at the Department of Highways for over 10 years. He is also a visiting lecturer at the Department of Transportation Engineering, Suranaree University of Technology, Nakhonratsima, His present position is a senior traffic engineer in the Traffic Engineering Division where he is responsible for traffic and safety engineering aspects of the Department's roads.

260 *Pr* *Songkla* *Pr* Prince of Songkla University Hat Yai *Pr* [19-11]
300 p.1-11

1. INTRODUCTION

Road accidents or road crashes are problems of societies with motorized forms of transport. The World Health report indicates that in 1998, there were 1,171,000 deaths resulting from road crashes worldwide or 2.2% of the total number of deaths from various diseases in all countries which amounts to 53,929,000. In addition, the number of injuries were estimated at around 10 millions (World Health Report, 1999). In many countries, road accidents are now commonly the second largest cause of deaths for the core age group (5–44 years) and the problem has been considered by the World Health Organization to be of epidemic proportions. (Road accidents cost countries between one to three percent of annual Gross Domestic Product (GDP) and annual losses due to road crashes have been a serious economic drain and problem for many developing countries (Ross, 1998). Ross estimated that these costs were at least US\$20bn per year.

The severity of the problem is still increasing in the developing countries while the developed countries have largely kept the problem under control. However, in its World Disaster Report, the International Federation of Red Cross and Red Crescent has predicted that road traffic accidents would emerge as the 3rd leading cause of disease or injury burden in 2020 from its 9th ranking in 1990. (World Disaster Report, 1998).

This paper describes the results of a Thai bus safety study (Taneerananon, 1999). Bus accidents, their causes and suggested remedial measures are discussed.

2. ROAD CRASH SITUATION IN THAILAND

2.1 Magnitude of the Problem

Records of the Office of National Police and The Department of Highways (Department of Highways, 1998) indicate that, the number of crashes increased dramatically from 24,132 cases in 1987 to 102,610 cases in 1994 (See Table 1 and Figure 1) when it peaked. During the same period the number of fatalities has gone from 2,104 to 15,176, it reached the peak number of 16,727 and declined to 12,234 in 1998.

Table 1 : Thailand Traffic Accident Statistics, 1987 - 1998

Year	Bangkok Metropolis			Other Provinces			Whole - Kingdom		
	Accidents	Killed	Injured	Accidents	Killed	Injured	Accidents	Killed	Injured
1987	19,745	752	8,333	4,387	1,352	2,256	24,132	2,104	8,589
1988	31,175	817	9,565	4,114	1,198	3,939	35,289	2,015	13,504
1989	31,709	917	10,005	6,388	4,451	3,076	38,097	5,368	13,081
1990	33,064	949	10,701	7,417	4,816	7,551	40,481	5,765	18,252
1991	38,355	1,057	10,778	7,946	5,276	8,777	46,301	6,333	19,555
1992	46,743	983	11,025	14,586	7,201	9,677	61,329	8,184	20,702
1993	64,006	1,011	11,031	20,886	8,485	14,299	84,892	9,496	25,330
1994	72,359	1,290	18,849	30,251	13,856	24,692	102,610	15,146	43,541
1995	64,469	1,284	21,697	24,898	15,443	29,021	94,362	16,727	50,718
1996	60,308	1,069	23,314	28,248	13,336	26,730	88,556	14,405	50,044
1997	54,324	903	20,933	28,012	12,933	27,828	82,336	13,836	48,761
1998	46,800	732	18,920	26,925	11,502	33,618	73,725	12,234	52,538

Source : Office of the National Police, Office of the Prime Minister and Traffic Engineering Division, Department of Highways (1998).

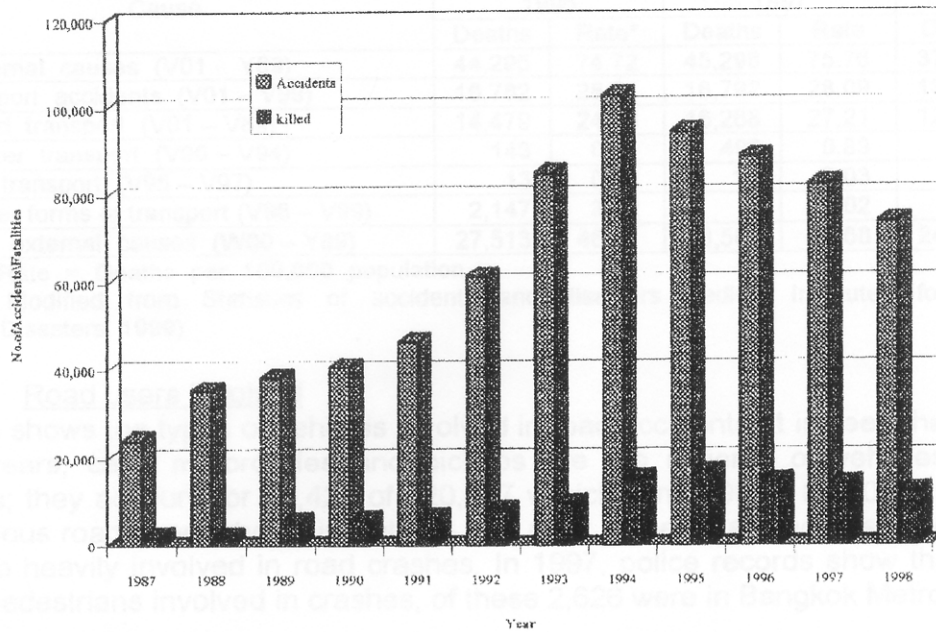


Figure 1: Trend in Number of Crashes and Fatalities

Table 2 shows the ten major causes of death in Thailand in 1998. It is seen that the external causes (See Table 3) which include various forms of accidents, poisoning homicide etc., are the second major cause of death. Transport accidents are a significant part of the external causes causing 13,073 out of 37,662 deaths. Of these, road traffic accidents accounted for 12,942 deaths or 99% of the transport related deaths in 1998.

Table 2 : Major Causes of Death in Thailand in 1998

Cause	No. of Deaths	Death/100000 Population
1 Diseases related to blood circulation (I00 - I99)	59,601	98.57
2 External causes: Accidents etc. (V01 - Y89)	37,662	62.29
3 Cancer (C00 - D48)	26,478	43.79
4 Respiratory Diseases (J00 - J98)	20,415	33.76
5 Infectious & some parasitic Diseases (A00 - B99)	16,894	27.94
6 Diseases of blood & blood production organs etc. (D50-D89)	8,806	14.56
7 Digestive system (K00 - K92)	8,647	14.30
8 Diseases of Nervous System (G00 - G98)	8,400	13.89
9 Diseases of Reproductive & Urinary System (N00 - N98)	5,242	8.67
10 Diseases of endocrine glands etc. (E00 - E88)	4,941	8.17

Source : Division of Health Statistics, Ministry of Health. Compiled by Medical Institute for Accidents & Diasters (1999)

In summary, it can be said that for the past decade (1990-1999) road traffic accidents have caused around more than 1,000,000 million baht and 10,000 lives.

Table 3 : Deaths Resulting From External Causes Including Road Accidents

Cause	1996		1997		1998	
	Deaths	Rate*	Deaths	Rate	Death	Rate
All external causes (V01 - Y89)	44,295	74.72	45,298	75.76	37,662	62.29
1 Transport accidents (V01 - V99)	16,782	28.31	16,792	28.09	13,073	21.62
- Land transport (V01 - V89)	14,479	24.43	16,268	27.21	12,942	21.40
- Water transport (V90 - V94)	143	0.24	499	0.83	112	0.19
- Air transport (V95 - V97)	13	0.02	16	0.03	17	0.03
- Other forms of transport (V98 - V99)	2,147	3.62	9	0.02	2	0.00
2 Other external causes (W00 - Y89)	27,513	46.41	28,506	47.68	24,589	40.67

Note : * Rate = Deaths per 100,000 population

Source : Modified from Statistics of accidents and disasters (Medical Institute for Accidents & Disasters 1999)

2.1.1 Road users involved

Table 4 shows the types of vehicles involved in road accidents. It is seen that for the past three years, cars, motorcycles and pickups are the majority of vehicles involved in crashes; they account for 96,424 of 120,077 vehicles in 1998 or 80.30%. In addition to the various road users shown in Table 4, the most vulnerable road user, the pedestrians are also heavily involved in road crashes. In 1997, police records show that there were 4,155 pedestrians involved in crashes, of these 2,626 were in Bangkok Metropolitan.

Table 4: Types of Vehicles Involved in Road Crashes 1996-1998

Rank	Type of vehicle	Unit: vehicle		
		1996	1997	1998
1	Car	44,179	42,103	36,536
2	Motorcycle	43,964	41,939	37,414
3	Pick up	28,151	25,484	22,472
4	Van	2,139	3,524	2,975
5	Big truck	7,276	5,708	4,102
6	Big bus	4,999	4,414	3,717
7	Taxi	3,953	4,210	4,476
8	Truck (6 wheel)	4,576	3,794	3,157
9	3-wheel Paratransit/tuk tuk)	2,684	2,187	1,717
10	Farm vehicle (E-tan)	268	309	282
11	Bicycle	1,339	1,311	1,319
12	Tri shaw	735	522	500
13	Others	1,294	1,157	1,408
	Total	145,557	136,662	120,077

Source: Accident analysis and prevention unit, Office of Engineering and Safety, Department of Land Transport, and Information Center, Office of the National Police (1999)

2.2 Costs of Road Accidents

The economic losses due to road accidents are immense, as mentioned in section 1, that the costs to the economy of a country is between 1-3% of GDP. In 1997, a road safety master plan carried out for the Ministry of Transport and Communications (MOTC) showed the economic loss to the country at 106,368 million baht per year, this is equivalent to 3.41% of the GNP for 1993 (Kingdom of Thailand, 1997).

In summary, it can be said that for the past decade (1990-1999) road traffic accidents have costed Thailand more than 1,000,000 million baht and 102,126 lives.

3. BUS CRASHES

3.1 The Number of Bus Crashes

Despite the high number of road crashes involving private vehicles, crashes involving public transport is a major source of concern to the travelling public particularly on inter-city journeys. The Department of Land Transport which oversees the operation of bus transport is also very much concerned about bus safety, despite its rather passive approach to the problem.

The number of bus accidents has been declining since 1994, significant reductions occur from 1995 onwards. Table 5 gives the trend in bus crashes during 1992-1998 period. Official records do not give account of fatalities or injuries from the bus accidents.

Table 5: Total Number of Buses Involved in Crashes

Year	Number of buses
1992	5,640
1993	6,895
1994	5,569
1995	5,510
1996	4,999
1997	4,414
1998	3,717

Source: Safety Division, Department of Land Transport

3.2 The Transport Company Bus Accidents

Table 6 shows road accidents involving buses of the Transport Company, a semi government enterprise which holds all the long distance route licenses, and its affiliates' buses. It can be seen that although the number of accidents have declined substantially in the last three years, fatality and injury figures have not followed. This trend suggests the increase in severity of bus accidents.

Table 6 : Accident Statistics of the Transport Company and its Affiliates Buses/during Financial years 1990-1998

Financial Year	The Transport company buses			Affiliated buses			Total		
	No. crashes	Injuries	Fatalities	No. crashes	Injuries	Fatalities	No. crashes	Injuries	Fatalities
1990	603	145	36	185	553	240	788	698	276
1991	601	196	56	193	798	199	794	994	255
1992	582	138	47	273	1033	324	855	1171	371
1993	635	215	79	163	760	202	798	975	281
1994	630	254	57	199	849	273	829	1103	330
1995	500	179	50	123	533	112	623	712	162
1996	495	152	52	104	683	142	599	835	194
1997	432	187	51	98	710	136	530	897	187
1998	298	258	57	79	546	118	377	804	175

Source: The Transport Company Limited

3.3 Major Bus Crashes as Reported in Newspapers

In 1998, there were 32 major bus crashes in Thailand, resulting in 65 fatalities and 692 injuries. Inter-city Category 2 buses were involved in 9 crashes, urban buses in Bangkok 10 with the remainders comprising 8 cases of Inter-city Category 3 bus, 4 of tourist buses and 1 of private bus. Table 7 gives details of the casualties and types of crashes.

Table 7: Major Bus Crashes in 1998.

Type of service	Number of Casualties		Number of Crashes	
	Fatalities	Injuries	Hit other vehicle	Single vehicle
Category 2 bus	36	309	7	2
BMTA bus	5	133	5	5
Category 3 bus	18	127	3	5
Tourist bus	4	103	1	3
Private bus	2	20	1	-

Note: BMTA = Bangkok Mass Transit Authority; Category2 bus: run between Bangkok and the provinces; Category3 bus: run between the provinces.

From the table it can be seen that single bus accidents constitute about 50% of the total. It should be noted that in the case of Inter-city buses when the vehicle ran off the road and rolled over or ran into a road side object, its roll over strength becomes a critical factor; in many incidents the bus body was crushed by the force of impact.

The most serious accident in which there were 14 fatalities and 20 injuries was a collision between a category 2 bus and a 10 wheel truck, the accident occurred at 0330 hr; speeding and bald tyres were cited as the causes of accident.

3.4 Causes of Road Accidents

3.4.1 Police records of the causes of accidents

The causes of road accidents are collected by police when investigating a crash. Table 8 gives details of the causes of road accidents in 1997. The 3 major causes for the whole kingdom are : Speeding (29%), Abrupt Cutting-in (14%) and Improper Overtaking (11%). For accidents on the inter-city and inter-district highways, the three major causes are similar i.e. Speeding (39%), Abrupt Cutting-in (15%) and Failure to Indicate Intention (8%). For 1998, the figures for the 3 major causes for the whole country are 32.3%, 19.0% and 13.9% respectively.

Table 8: Causes of Road Accidents in 1997

Cause	Whole	Bangkok	Regions	Highway
	Kingdom	Metropolis		
Exceeding speed limits	23,408	11,889	10,568	951
Abrupt cut-in	11,627	7,131	4,002	494
Improper overtaking	9,222	6,996	2,160	66
Failure to indicate intentions	4,865	3,821	676	168
Disregarding traffic signal/sign/Marking	4,317	3,823	478	16
Disregarding stop sign at intersection	3,445	2,852	580	13
Not keeping to the left	2,909	2,646	262	1
Total	80,854	51,453	27,419	1,982

Source: Safety Division Department of Land Transport and Police Information Centre , Office of the National Police Force

3.4.2 Other information on the causes of bus accidents

Nearly all data related to road accidents are collected by the police. However, the Safety Division of the Department of Land Transport and the Traffic Engineering Division of the Department of Highways produce information on the causes of accidents from police records. In addition, the Safety Division of DLT compiles data on serious bus or truck accidents but does not publish them. The Transport Company produces information on the causes of their bus accidents in which they were the guilty party. These could be regarded as representatives of the causes of bus accidents.

Causes of Accidents of the Transport Company Buses

The Transport Company operates some 850 buses, some of which were involved in 298 crashes in 1998. Of these, 48 were single vehicle accidents (See Table 9) and 142 involved other vehicle (See Table 10). For single bus accidents, the three major causes are: speeding, poor visibility and slippery road with burst tyre ranks fourth. For accidents involving collisions with other vehicle, the three major causes are: failure to apply brake, speeding and poor visibility with the fourth being slippery roads. It can be seen that drivers' errors feature prominently and when combining with road environment factors of poor visibility and slippery road contribute to many accidents.

Table 9 : Single bus accidents involving the Transport Company and its affiliates' buses in 1998

Causes	No. of Crashes by Region						Total
	The Transport Company buses					Affiliated Buses	
	N	NE	C	S	E		
1. Speeding	2	5	1	2	1	-	11
2. Can not see	2	-	-	-	-	-	2
3. Slippery Surface	4	1	-	5	1	-	10
4. Burst tyre	2	-	1	-	-	4	7
5. Lost control + Avoiding other vehicle	-	2	-	-	1	17	20
6. Others + Driver Sleepiness	1	5	2	7	-	5	20
7. Failure to apply brake	-	1	2	-	-	-	3
8. Vehicle cuts in front at close range	-	-	1	-	-	-	1
Total	11	14	7	14	3	26	74

Source: The Transport Company Ltd.

Table 10 : Causes of Accidents of the Transport Company Buses involving Other Vehicles

Causes	No. of Crashes by Region					Total
	N	NE	C	S	E	
1. Fail to brake	10	11	14	10	1	46
2. Speeding	15	10	7	6	1	39
3. Can not see	4	5	4	1	-	14
4. Slippery road	5	1	-	5	1	12
5. Abrupt cutting	5	-	5	1	-	11
6. Change lane suddenly	-	3	-	-	-	3
7. Avoid other vehicle	-	2	-	-	-	2
8. Others+drowsiness+drive in wrong lane	2	5	3	3	2	15
Total	41	37	33	26	5	142

Source: The Transport Company Ltd.

3.4.3 Unsafe and unforgiving roads and road environment

Studies in the UK and USA show that the contribution of human factor alone to road crashes amounts to 65% and 57% respectively, the combined factors of human error and road defects contribute to 24% and 27% of the total crashes (Ogden 1996). For Thailand, drivers' fault accounts for 82.5% of the total road crashes in 1998 (See Table 11).

Table 11 : Factors involved in road crashes in Thailand in 1998

Factor	%
Driver's faults	82.5
Vehicle defects	0.6
Road & road environment	1.5
Others	15.4

Source: Information Centre, Office of the National Police 1999

4 STRATEGIES FOR COMBATING THE ROAD CRASHES

4.1 Road Safety Master Plan

The grave situation of road crashes which continues with unacceptably high number of fatalities has finally led to the development of a Road Safety Master Plan (RSMP) (Kingdom of Thailand, 1997). The RSMP consists of extensive list of issues which address road safety as a whole. Bus safety aspects are covered under many programmes including drivers training and vehicle safety. MOTC in 1997 proposed 9 programs of activities to be implemented over a five year period, with a total budget of 9,850 million Baht. These programmes to be implemented over a 5 year period are as follows (Ministry of Transport, 1997):

- Road Safety Economy, Policy and Organization Programme A
- Legislation and Law Enforcement Programme B
- Accident Analysis and Research Programme C
- Driver Training and Licensing Programme D
- Traffic Training in Schools Programme E
- Public Information Programme F
- Vehicle Safety Programme G
- Infrastructure Programme H
- Emergency Treatment of Accident Victims Programme I

4.2 Proposed Remedial Measures for Bus Accident Problem

From the bus safety in Thailand study (Taneerananon, 1999) the following measures are proposed to address the bus accident problem in Thailand. They cover areas of driver behaviour and fitness, road environment improvements, vehicle safety and traffic law enforcement.

4.2.1 The Driver Factor

Competency and Behavioral Controls

A stricter driving test and monitoring is suggested. Under the Land Transport Act, applicants are required to pass 38 of the 50 questions or 75%. It is noted that applicants for a public vehicle licence need not have prior experience in driving, they only need to be 22 years of age which was recently reduced from 25 and if they do not possess junior

high school certificate (9 years at school) they are required to sit for a one day training organized by the Department of Land Transport and pass the written and simple practical tests on the second day. For those with 9 or more years of education, only about half a day is required for training, this is then followed by written and practical tests in the afternoon of the same day. The simple driving tests are conducted off roads usually in a small compound. Thus theoretically, new drivers who pass the test can go on the road the next day with little or no experience on the actual driving on the road. There is therefore a clearly needed improvement in the issue of driving licence for public transport vehicles. Driving experience should be made a requirement in addition to competency in driving.

It is understandable that not many drivers surveyed liked the idea of stricter driving tests scenario (6%) but the Department of Land Transport has an obligation to provide the travelling public with the maximum safety possible.

Fitness Checks

Medical check ups for driving licence application should be performed by recognized medical institutions, and not just by any doctor as in the present situation. This is to ensure that check ups are strictly and properly carried out. This may incur some extra inconvenience to the applicants but then the importance of a licence can not be overestimated.

For drivers on the road, the interview results reveal that 55% of the drivers never had any medical check up, and a disturbing 9% failed the 20 m eyesight test. These figures point to the need to monitor the health of drivers. Annual check up should be made a requirement for drivers on certain age group. The Transport Company's policy on medical check up on each driver's birthday month is to be commended.

Provision of Rest Area for Drivers

Drivers fatigue has been shown to be a significant cause of bus crashes. The Department of Labour Control specifies that within a 24 hour period, a driver is allowed to drive for a maximum of 4 hours, after a break of not less than 0.5 hour the driver can drive for another maximum of 4 hours. The provision of well designed rest areas at appropriate locations will enhance the compliance of the law.

4.2.2 Improving the Road Environment

Good Roadside Hazard Management

Many of the single bus accident could have been avoided or at least reduced in severity if the road are well designed and managed. For instance in November 1998, a tour bus with 90 people on board ran off the road and fell about 10 meters, 85 were injured 4 seriously. In this case the crash barrier gave in and the driver was suspected of driving under the influence of alcohol. Another accident in which 10 people were killed and 30 injured occurred in April 1999 when a tour bus skidded off the road and hit a power pole. A 'forgiving roadside' could have averted the tragedy. Thus a good roadside hazard management programme should be designed and implemented by the concerned authorities.

In addition, black spots on highways should be dealt with especially where bus crashes have occurred.

4.2.3 The Vehicle Factor

Vehicle Inspection

Vehicle roadworthiness is an important element in bus safety. Despite the encouraging results from the survey which indicate that the bus fleet in Thailand is in relatively good shape, some defects e.g. tyre burst was still a significant event leading to bus crashes. Present annual bus inspection should be enhanced. While most provincial DLT offices are well equipped with inspection instruments and facilities, problems are that at present many are out of order or are not properly calibrated. These expensive equipments should be made to function as intended. The DLT could set up an efficient maintenance task force to help look after the 75 provincial offices nationwide.

Vehicle Design

In crash situation the integrity of the whole bus body including its interior becomes critical. Regulations on critical aspects of bus safety to render it crashworthy should be looked into by the Thai government. These aspects include installation of safety belts, seat strength, roof strength, anti-locked brakes and emergency exits. The UN ECE regulations can be used as guidelines to develop these regulations. For example, UN ECE regulation 66 which deals with roof strength should be looked into by the Thai government as many bus crashes had manifested that the roofs caved in on passengers. Installation of seat belts in new buses or retrofitting existing buses would improve safety of passengers in a cost-effective manner during crashes or prevent injuries in case of sudden braking and should be made a requirement as car seat belt wearing is already.

Use of Technology

The Tachograph. It is clear from the survey, the Transport Company and police records that speeding is the major cause contributing to bus crashes, it thus seems appropriate that serious measure should be taken to address the problem of speeding. Tachograph, a device used to record speed and duration of a journey should be made a requirement for buses, particularly inter-city buses. The tachograph in essence is a 'silent cop' who the bus driver reluctantly takes with him on his trip.

Flashing Light. A system of mechanical-electrical mandatory installation on the bus to send out flashing signals on its roof top when speed limits are being exceeded can help control drivers' behaviour. The practice is used in many places including Singapore and Japan. There is however still a need to have police present to book the speeding driver.

4.2.4 Traffic Law Enforcement

Traffic and Transport law enforcement forms an essential part of accident prevention. Without strict law enforcement, it would be hard to keep speeding and drunk driving under control. Australian experience indicates that for education or publicity campaigns to work, it must be accompanied by enforcement. However, effective law enforcement requires manpower and resources. The study team's investigation reveals that the highway police who are responsible for enforcement on the highways are ill-equipped to do their job, lacking in both manpower, vehicles and equipment. Interviews with officers at the Highway Police Station 3 in Hatyai confirmed that of the total police force of 35 and 14 vehicles and 2 radar speed guns, only 20 men and 9 vehicles are deployed to patrol about 900 km of road, they work day and night shifts without holidays. The remainder of the force are used to perform other duties including secretarial works, radio communication and security works. There is a need to quantify what resources are needed for effective enforcement and would they be cost-effective in bus accident prevention.

4.3 Setting up an Accident Investigation Unit

Serious accidents including bus accidents are required to be reported to the Department of Transport by the DLT provincial chiefs where the accident takes place. However, there is no systematic investigation into the cause of these accidents. Thus there have been little knowledge gained on how to deal with the problem and prevent similar problem from occurring. The set up of an accident investigation unit will help Thailand gain valuable experience and information required to better deal with one of its most critical problems.

5. CONCLUSION

The paper describes the road crash situation in Thailand. It gives account of bus accident problem, its causes and suggests a number of measures to deal with the problem. These measures address the issues of drivers' competency and fitness, road improvements, vehicle safety and traffic law enforcement.

6. ACKNOWLEDGMENTS

The authors would like to express their sincere thanks to the Transport Research Laboratory of the UK for its funding of this research. We are grateful to the generous advice of Dr. D.A.C Maunder and Mr. T. Pearce. We gratefully acknowledge the kind cooperation and assistance of the many operators, drivers, individuals, government departments and organizations especially, the Transport Company Limited, the Department of Land Transport and the Highway Police region 7. The surveys conducted by Mr. Wiwat Suthiwipakorn and postgraduate students are fully acknowledged.

REFERENCES

- Department of Highways. 1999. Traffic Accident Statistics. Annual Report.
- Office of the National Police . 1999 . Road Accident Report for 1998.
- Kingdom of Thailand, Ministry of Transport and communications . .1997. Developing a Road Safety Master plan and a Road traffic Accident Information System.
- Ministry of Transport and Communications. 1997. Summary of Action Plan for Road Safety.
- Ogden, K.W. 1996. Safer Road : A Guide to Road Safety Engineering Averbury.
- Ross, A . 1998 . Road Safety in Developing Countries, J. of Int. of Highway & Transportation, pp. 26 – 28.
- Taneerananon, P. 1999. Bus Safety in Thailand. A Research Report, Department of Civil Engineering, Faculty of Engineering, Prince of Songkla University.
- Thailand Development Research Institute . 1994 . White Paper on Economic Losses from Traffic Accidents.
- World Disasters Report . 1998 . International Federation of Red Cross and Red Crescent.
- World Health Report . 1999 . Making a difference. Geneva, World Health Organization.