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Transportation Research Challenges In Thailand

Sub-Project on

Thailand road safety

November 2008

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THAILAND ROAD SAFETY

RESEARCH CHALLENGE

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Asian Transportation Research Society

November 2008

THE RARITY OF HUMAN LIFE

Samyutta Nikaya XXXV.63
Chiggala Sutta
The Hole

"Monks, suppose that this great earth were totally covered with water, and a man were to toss a yoke with a single hole there. A wind from the east would push it west, a wind from the west would push it east. A wind from the north would push it south, a wind from the south would push it north. And suppose a blind sea-turtle were there. It would come to the surface once every one hundred years. Now what do you think: would that blind sea-turtle, coming to the surface once every one hundred years, stick his neck into the yoke with a single hole?"

"It would be a sheer coincidence, lord, that the blind sea-turtle, coming to the surface once every one hundred years, would stick his neck into the yoke with a single hole."

"It's likewise a sheer coincidence that one obtains the human state. It's likewise a sheer coincidence that a Tathagata, worthy & rightly self-awakened, arises in the world. It's likewise a sheer coincidence that a doctrine & discipline expounded by a Tathagata appears in the world. Now, this human state has been obtained. A Tathagata, worthy & rightly self-awakened, has arisen in the world. A doctrine & discipline expounded by a Tathagata appears in the world."

"Therefore your duty is the contemplation: 'This is stress...This is the origination of stress...This is the cessation of stress...This is the path of practice leading to the cessation of stress.' "

Source : http://www.accesstoinsight.org/canon/samyutta/sn56-48.html

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CHAPTER I INTRODUCTION

1. Introduction

Road accidents have emerged as an important cause of deaths and injuries in the last two decades. With extremely high casualties and property damages, road crashes have tremendous impacts on human life and national economy. The World Health organization has estimated that each year 1.2 million people die from road crashes and the injuries resulting from them are as high as 50 millions (WHO, 2004). The primary goal of transportation is the effective movement of people and goods, this is further enhanced by increasing speeds. The technological innovations in the last decades have focused on increasing speed. Unfortunately, with higher speed, the risk of a road accident and accident severity is also increased.

It has become well accepted that road accident is a major economic, social and health problem in Thailand. Over the last decade (1998-2007), road accidents have killed about 127,296 people, or on an average of 12,729 are killed every year. The 2007 study by the Bureau of Road Safety, the Department of Highways on the costs of traffic accidents to the nation reveals a staggering sum of 232,855 million Baht, equivalent to 2.81 % of the country GDP in 2007 (Department of Highways, 2007). The Thai government, realizing the gravity of this manmade problem, in 2003, set up the Centre for Road Safety Operation headed by the Deputy Prime Minister. Despite the government's efforts, the number of road deaths has remained relatively constant albeit high for the past decade. Thus, there is a need for more effective strategies to bring the number of deaths and injuries in road accidents to a lower level.

Fortunately, these effective strategies can be identified through review of literature of international good practices especially for countries like Japan and European countries like Sweden, United Kingdom and Netherlands (SUN countries) which have excellent records on road safety. Looking into the outcomes of the past efforts also help to come up with measures that are both effective in reducing crashes and injuries and are also cost effective. Experts' opinions need to be sought for this purpose. This is in line with the recent shift in the paradigm in the understanding road safety as outlined by the World Health Organisation (WHO) that "road safety policy must be based on a sound analysis and interpretation of data, rather than on anecdote" (WHO, 2004).

CHAPTER 2 GOAL AND OBJECTIVES

2. Goal and Objectives

The research structure comprises 5 sub-sections: the goal and objective, current situation of Thailand road safety and the challenges, research methodology consisting of the review of best practices in road safety management and interview of local experts, recommendations of strategic research direction and strategic research topics.

2.1 Goal

The goal of this road safety research is to contribute in a major effort of saving some 5000 lives of Thai people in 5 years and at the same time reducing the number of crashes and injuries through the recommendation of strategic research topics.

2.2 Objective

To produce the RED BOOK on road safety situation and strategic research topics.

3. Current Situation of Thailand Road Safety

3.1 Magnitude of the problem

Each year, some 13,000 persons are killed on Thailand's road network. A study commissioned by the Department of Highways (DOH) has estimated that some 1.5 million road crashes occur annually, which in addition to the number of deaths cause other tragic consequences of about 9,000 disabilities, 210,000 serious injuries and 750,000 slight injuries. In 2007, the economic and social cost to the nation was 232,855 million Baht, which was equivalent to 2.81% of the country GDP (DOH, 2007).

3.2 The Trend

The trend in the number of crashes and fatalities are shown in Table 1 and Figure 1. It can be seen that the number of police reported crashes has gone through two distinct peaks in the last two decades, one in 1994, and another in 2004, this is roughly in line with the peak in the economic activities. The number of fatalities has also exhibited a relatively small but steady decline following the two peaks.

Table 1: Number of Road Crashes Injuries and Fatalities (1984-2007)

Year	Number of			Number of population	No. of vehicles	Death rate		Injury rate	
	Accidents	Fatalities	Injuries			per 100,000 population	per 10,000 vehicles	per 100,000 population	Per 10,000 vehicles
1984	18,445	2,908	8,812	50,583,105	N.A.	5.75	N.A.	17.42	N.A.
1994	102,610	15,146	43,541	59,095,419	12,579,903	25.63	12.04	73.68	34.61
1995	94,362	16,727	50,718	59,460,382	14,097,719	28.13	11.87	85.3	35.98
1996	88,556	14,405	50,044	60,116,182	16,093,896	23.96	8.95	83.25	31.1
1997	82,336	13,836	48,761	60,816,227	17,666,240	22.75	7.83	80.18	27.6
1998	73,725	12,234	52,538	61,466,178	18,860,512	19.9	6.49	85.47	27.86
1999	67,800	12,040	47,770	61,661,701	20,096,536	19.53	5.99	77.47	23.77
2000	73,737	11,988	53,111	61,878,746	20,835,684	19.37	5.75	85.83	25.49
2001	77,616	11,652	53,960	62,308,887	22,589,185	18.7	5.16	86.6	23.89
2002	91,623	13,116	69,313	62,799,872	24,517,250	20.89	5.35	110.37	28.27
2003	107,565	14,446	81,070	63,079,765	26,378,862	22.9	5.48	128.52	30.73
2004	124,530	13,766	94,164	61,973,621	20,624,719	22.21	6.68	151.94	45.66
2005	122,122	12,871	94,445	62,418,054	22,571,062	20.62	5.7	151.31	41.84
2006	110,686	12,693	83,290	62,828,706	24,807,297	20.2	5.12	132.57	33.57
2007	101,752	12,492	79,029	63,038,247	25,618,447	20	5	125	31

Source: Royal Thai Police, Department of Provincial Administration and Department of Land Transport, and Office of Transport and Traffic Policy and Planning (2007)

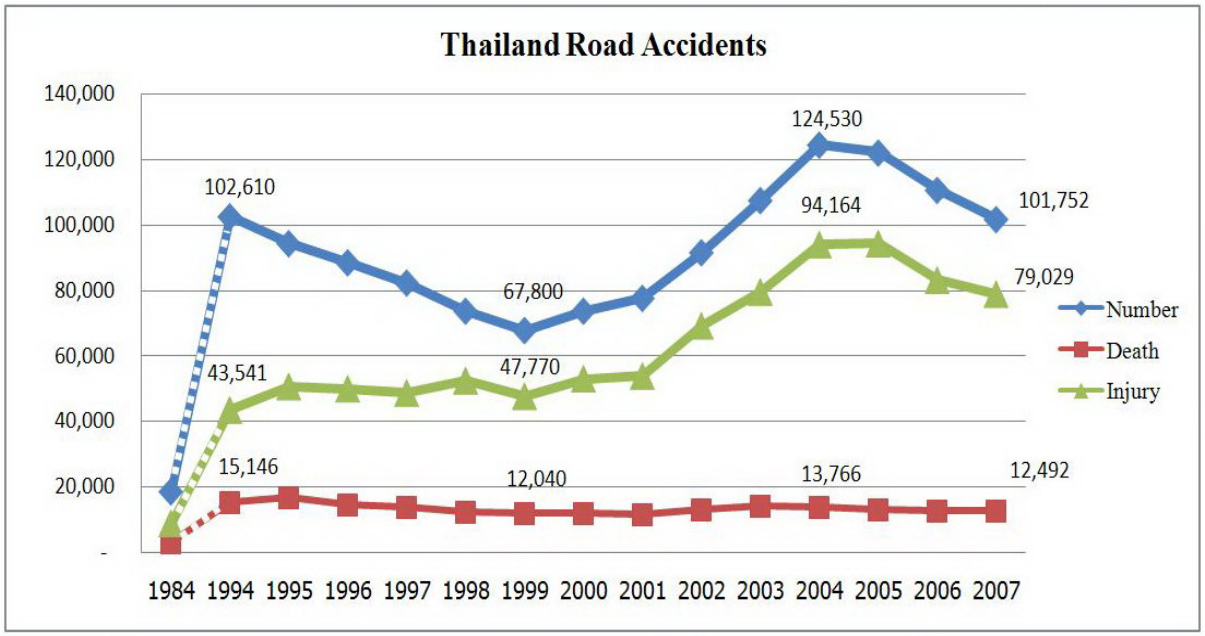

Figure 1: Trend in the Number of Road Crashes Injuries and Fatalities During 1994-2007

Source: Department of Highways (2007)

3.3 The Fatality Rate

Fatality rate for road accidents are commonly expressed as number of human life lost per 100,000 population and in terms of number of deaths per 10,000 vehicles. Fatality rate of road accidents in Thailand for the years 1994-2007 are shown in Figure 2.

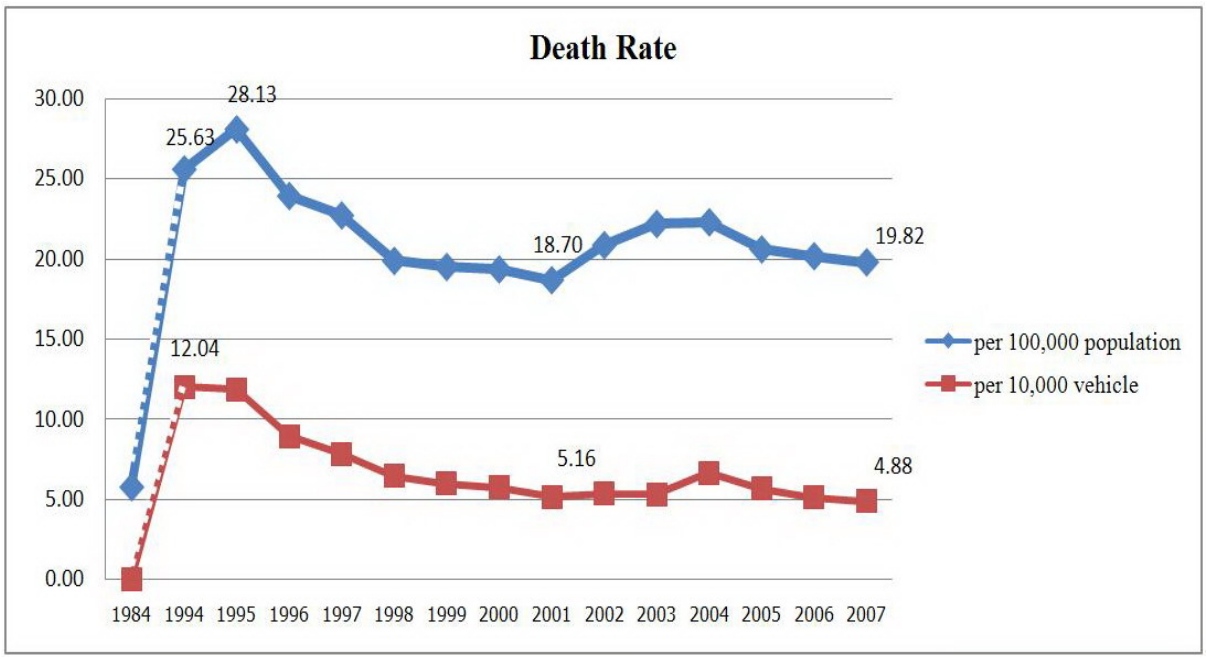

Figure 2: The Fatality Rate of Road Accidents in Thailand

Source: Department of Highways (2008)

3.4 The Challenge

Benchmarking with the other developed countries indicates the magnitude of the challenge Thailand is facing. For example, in terms of number of road users killed per 100,000 population, the figure for Japan, Sweden, UK, Netherlands and Thailand for 2006 are shown in Table 2. This shows that the rate for Thailand is 3-4 times higher than those countries. In terms of deaths per 10,000 vehicles, the respective figures for these countries indicate the danger of getting killed on the roads in Thailand is about 6 times higher than Japan and the SUN countries.

Table 2: Fatality Rate for SUN Countries, Japan and Thailand

Country	Deaths/10,000 vehicles	Deaths/ 100,000 inhabitants
Sweden	0.80	4.9
Great Britain	0.88	5.4
Netherlands	0.72	4.5
Japan	0.95	5.7
Thailand	5.12	20.2

Source: OECD-IRTAD database (2008), Department of Highways (2008)

Road traffic fatality rate (deaths per 100,000 population) in 2006 of some selected countries are shown in Figure 3.

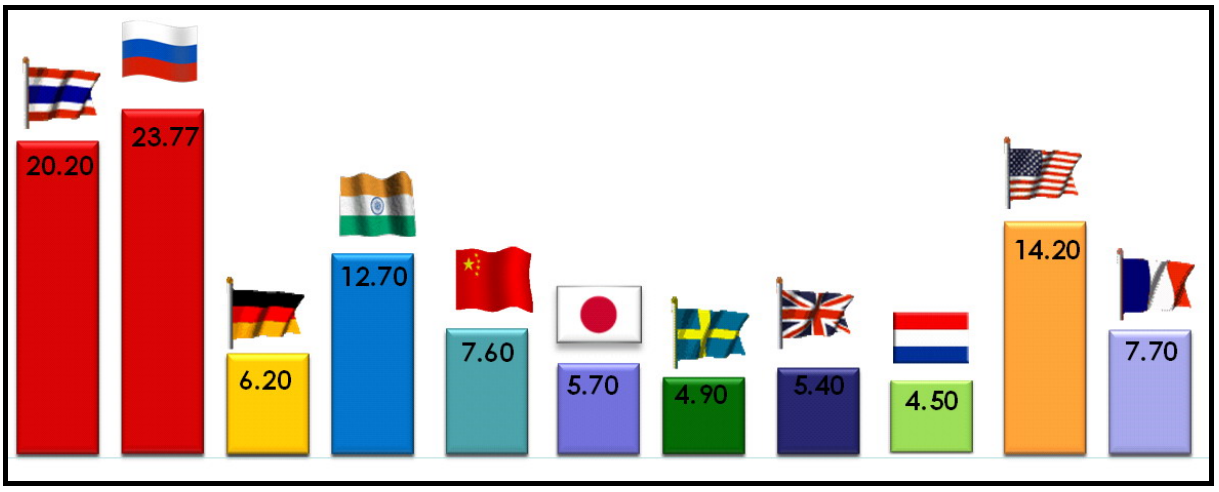

Figure 3: Road Traffic Fatality Rate in 2006 of Thailand, Russia, German, Hungary, China, Japan, Sweden, UK, Netherlands, USA, France

Source: IRTAD(2008) and Royal Thai Police (2008)

CHAPTER 3 CURRENT SITUATION OF THAILAND ROAD SAFETY

In ASEAN countries too, road accidents have caused huge losses of human lives. For example, Table 3 gives police reported and estimated fatalities as compiled by Asian Development Bank (ADB) for ASEAN and other Asian countries. Figure 4 shows the ASEAN Road Fatality Rate per 100,000 populations.

Table 3: Police-Reported and Estimated Fatalities for 10 ASEAN Countries in 2003 and 4 other Asian Countries

Country	Year	Deaths (police-reported)
Brunei Darussalam	2005	38
Cambodia	2005	904
China	2005	98,738
Indonesia (estimated)	2003	30,484
Japan	2007	5,744
Lao People's Democratic Republic	2003	426
Malaysia	2005	6,200
Myanmar	2003	1,308
Philippines (estimated)	2003	9,000
Republic of Korea	2004	6,563
Singapore	2005	173
Taiwan	2005	2,894
Thailand	2007	12,492
Viet Nam	2005	11,000
Total		185,964

Source: ADB (2005), and Authors' compilation

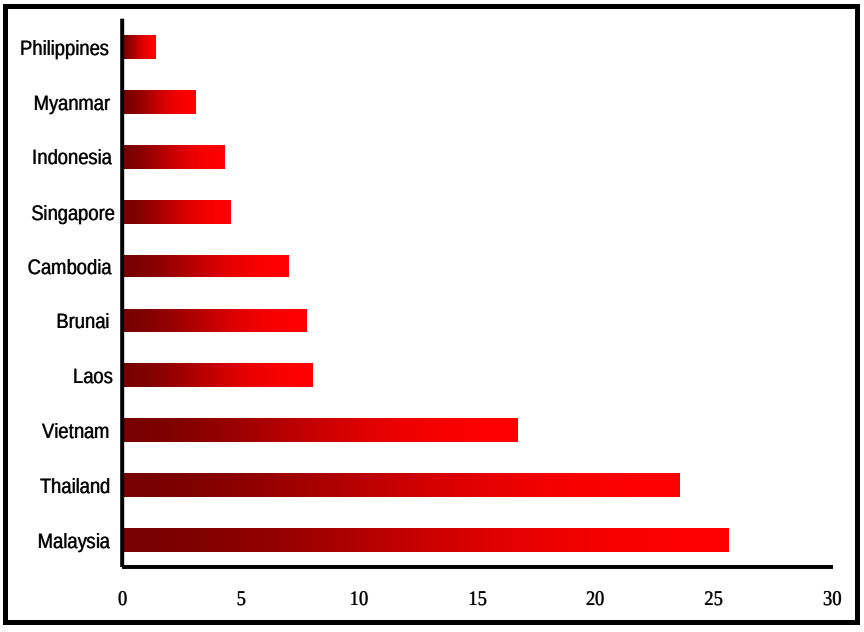

Figure 4: ASEAN Road Fatality Rate (Fatality per 100,000 population)
Source: ADB (2005)

ASEAN Road Safety Situation reports that there are over 75,000 human deaths and over 4.7 million people are crippled or injured annually in road crashes and it costs the ASEAN economy about $15 billion each year. The cost of fatalities in road accidents is very high and is as shown in Table 4.

Table 4: Cost of Fatality in Road Accident in ASEAN

Country	National Costs ($ million)	National Costs (B million)	Fatal Costs ($ million)	Fatal Costs (B million)	Approach
Brunei	99	4,146	1,419,639	**59,454,481**	HC.
Cambodia	116	4,792	18,864	779,272	HC.
Indonesia	6,032	**249,182**	47,698	1,970,404	HC.
Loa	47	1,984	7,203	301,662	HC.
Malaysia	2,400	100,512	323,021	13,528,119	WTP.
Myanmar	200	8,376	43,614	1,826,561	HC.
Philippines	1,900	79,572	41,330	1,730,900	HC.
Singapore	457	20,894	921,271	42,120,510	HC.
Thailand	3,000	123,930	69,061	2,852,924	HC.
Viet Nam	885	36,559	11,463	473,526	HC.

From: Asean Regional Road Safety Strategy and Action Plan (2005-2010)

Source: ASEAN Regional Road Safety Strategy and Action Plan (2005)

3.5 Thailand Road Safety Manifesto

3.5.1 The Human Tragedy

In 2004, the number of road accidents in Thailand was 1,549,369. There were 14,245 human lives losses, 217,039 serious injuries, 775,245 minor but painful injuries, 9,078 disabilities and 920,394 road accidents causing property damage only. The total cost to the nation in road accidents was, in terms of 2007 value, 232,855 million Baht which was equivalent to 2.81% of the GDP.

3.5.2 The Challenge

The challenge of this road safety research is to contribute towards a major effort of saving some 5000 lives of Thai people in 5 years (2007-2011) as proposed by the Thai Society for Transportation and Traffic Studies in the Thailand Road Safety Manifesto (www.thaitransport.org). This is achieved by reducing the number of fatalities from 13,000 to 8,000 as well as reducing the number of crashes and injuries. The challenge of road safety research is shown in Figure 5

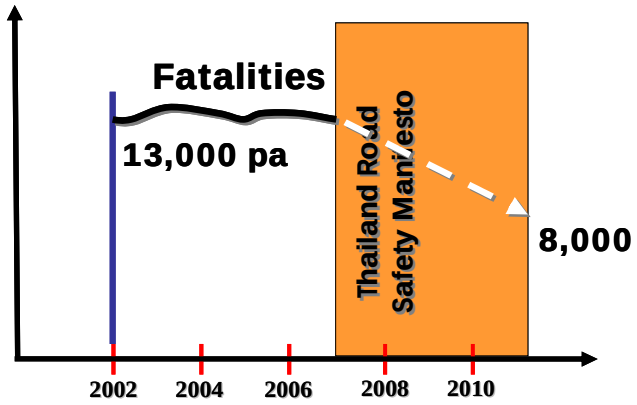

Figure 5: The Challenge of Road Safety Research

CHAPTER 4 METHODOLOGY

4. Methodology

Drawing from the words of the Lord Buddha

"The chances of being born a human being are as likely as a blind turtle surfacing on the ocean once every one hundred years and poking its head through a hole in a floating yoke!" Such is the rarity of a human life. An image of the Lord Buddha is shown in Figure 6.

It is immensely clear that life is the most valuable thing for human being and thus one should do one's utmost to protect life. The framework for the research methodology is based on the 2551 year-old system approach to eradicating the human suffering as exhorted by the Lord Buddha in the profound teaching: The Four Noble Truths.

Dukkha: suffering,

Samudaya: cause of suffering,

Nirodha: an end of suffering, and

Marga: a path that leads out of suffering.

Figure 6: Image of Lord Buddha

Problem is a form of suffering, in any strategic pursuit, the main goal is to get rid of the problem that is to strive for the stage when the problem has ceased. In road crash research, the strategy is to reduce the number of crashes and casualties as well as prevent these crashes from happening by implementing the right countermeasures. With the cessation of crashes and casualties, the goal of road safety is attained. Applying the teaching as the framework for the research, the following steps can be defined:

- **The Problem:** **Road crashes/casualties**
- **The Cause:** **What are the causes of crashes and injuries**
- **The Goal:** **Road safety: Cessation of crashes and casualties**

- **The Strategy:** The path to road safety via the right countermeasures obtained through knowledge gained from research

4.1 Review of Literature

The method used in this research is to review of research works that have been done in Thailand and good practices in road safety management in vogue, in different parts of world. In this case the focus would be on countries like Japan which has the best road safety record in Asia, and three European countries with the best road safety records namely: Sweden, United Kingdom and Netherlands (SUN Countries). In addition, interviews with local road safety experts are also conducted.

The authors conduct a brief review of previous research works carried out in Thailand, and also of best practices of countries performing well in road safety. This review can broadly be classified in 4 types. The first type concerns the human behavior factor;

preliminary review has identified speeding, drink driving, helmet and safety belt use as the main issues. The second type is on vehicle factor, there have been works carried out on motorcycle and motorcycle helmet, bus and truck. The third type is about the road environment, research works on roadside hazards, in-depth crash study, intersection control and pedestrian facilities have been identified. The fourth deals with topics relating to road crashes, these include management of road traffic injuries, effectiveness of law enforcement, cost of road traffic accidents.

4.2 Review of Best Overseas Road Safety Practice

4.2.1 Japan White Paper on Road Safety

Road safety in Japan is on high priority list, the Government in Japan, acts in accordance with an Act of 1970, which requires the government to submit annually, a report known as White Paper on Traffic Safety in the Japanese Parliament known as "Diet". The report deals with the status of traffic accidents in the previous years, the measures being implemented to promote traffic safety and plans for traffic safety measures in the current year. Road traffic accident fatalities show a dramatic declining trend from the peak in 1970. Thereafter, Traffic Safety Policy Laws were enacted and were implemented as Fundamental Traffic Safety Program. The road accident trend in Japan is as shown in the Figure 7.

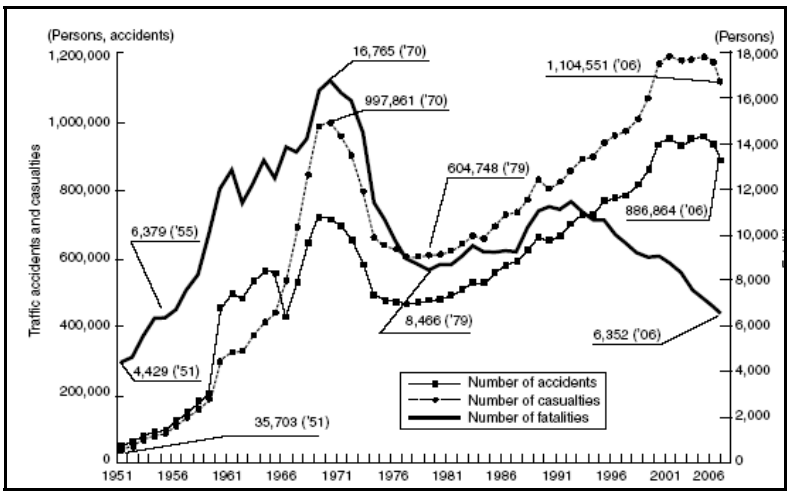

Figure 7: Changes in Road Accident, Fatalities and Casualties. *Source: ITASS(2007)*

The White Paper of 2007 (ITASS) reports that there is a decline of more than five percent in the number of accidents, causalities and injuries. The fatalities have declined by more than 7.5 percent. This is attributed largely due to measures based on Fundamental Traffic Safety Programs which are aimed at improving road environment, disseminating and reinforcing messages on traffic safety, preserving order on roads and enhancing rescue and emergency medical system, and enforcement which includes seat-belt use, lower pre-accident speeds, drunk driving penalties and other measures against dangerous driving. The paper reports that the population above sixty five years of age has the largest number of road fatalities and the age-group 30-39 has the highest incidences of injuries. Further, it also reports that that automobile riders account for 63.0 percent injuries and 37.1 percent of all fatalities. The bicycle riders are involved in 20 percent of all the traffic accidents. There is a trend of increase in pedestrian accidents even though fatalities and injuries are on a decline.

The white paper cites the benefits of use of seatbelts and child safety seats. It was reported that seat belt users had just one tenth of the fatalities of the non-users. Fatalities and serious injuries on children restrained by child safety seats were found to be twenty times lesser that the non-users. A new approach to regulate on-street parking has been focused. This puts greater burden on the road user rather than driver. This involves association of private operators and parking patrols prepared with the help of police. This has led to decrease in illegal parking by sixty percent, reduction in congestion by 12.2 percent and lower incidence of collision with a 24 percent decline. Efforts and measures were also taken up to eradicate drunk driving. In spite of introduction of Partial Amendment of Road Traffic Law in 2002 which advocated heavier penalties for driving while intoxicated (DWI) and supported the efforts for anti-drunk driving, it was found to be inadequate. In 2006, Task Force of the Central Committee on Traffic Safety Measures adopted a

resolution adopting 'Eradicating Drunk Driving' by changing public attitudes. It called for cooperation between all parties involved including government agencies, alcohol manufacturers, transport operators, safety experts and voluntary organizations. Some of the subsequent efforts taken up were intensification of efforts for the eradication of drunk driving, reinforcement of efforts and enforcement against drunk driving, vehicle technology based solution viz. alcohol interlock device and strengthening of coordinated efforts against habitual offenders (ITASS, 2007).

An overview of current policies on road safety in Japan is given in the White Paper (ITASS, 2007). The Japanese Government in its effort to improve the road traffic environment has strived for "people-first" walking spaces offering safety and peace of mind. The local and national governments pursued road safety projects to enhance side-walks for school routes, residential roads, urban thoroughfares and other areas. Local community members were involved in its implementation. Projects were taken up to ensure safety and comfort of pedestrians and bicycle users. Principle of Universal Design was followed to design sidewalks for the elderly and disabled especially in the areas like train station, public facilities, welfare centers and hospitals. Other facilities like barrier-free traffic signals, elevator equipped pedestrian overpasses etc. was also focused. Japan has continued to pursue the implementation of intelligent transport systems (ITS), which incorporate advanced information technology to coordinate people, roads, and vehicles under one integrated system. ITS are designed to enhance road safety and transportation efficiency and comfort, as well as to protect the environment by reducing traffic congestion and otherwise streamlining the flow of traffic. Guided by the principles established in 1996 under the Comprehensive ITS Initiative, the government spearheaded research and development projects, field tests, infrastructure development, and other efforts that involved collaboration with industry and academia. A key component of ongoing work on ITS has been the Universal Traffic Management Systems (UTMS), it aims to ensure traffic safety and comfort through a network of advanced traffic control centers. Two way communication and electronic toll collection (ETC) are some of the other measures implemented.

Recently governmental agencies and the private sector have worked together towards the development of practical forms of infrastructure cooperative driving safety support system which is based on new information technology (IT) reform strategy. It has an on-board system that helps drivers to respond to traffic situation outside their field of vision by wirelessly receiving the data. The National Police Agency (NPA) is working on Driving Safety Support Systems (DSSS). This will enhance safety, avoid rear-end collision of vehicles and provide information about pedestrians. The Ministry of Land, Infrastructure and Transport is constructing the

Advanced Cruise-assist Highway System (AHS) as an effective strategy for reducing traffic accidents. The system is designed to keep drivers alert by providing information as needed, and thus can help to realize safe, comfortable travel. A collaborative project between the government, industry, and academia to promote the development and propagation of Advanced Safety Vehicles (ASV) had been taken up, which incorporate information technology to enhance safety. The project members are working toward practical ASV deployment in Japan (ITASS, 2007).

The dissemination and reinforcement of traffic safety messages had been taken up in Japan. The effort includes traffic safety education for the elderly. In pursuance of the effort, the government supported the establishment of Traffic Safety Clubs within Senior's Club and retirement homes and promoted training of "Silver Leaders," seniors who provide education on traffic safety to other seniors. Hiyari Maps (maps of near-miss spots) with the help of related agencies is to be taken up.

Japanese Government undertook an investigative study to assess the economic losses caused by road traffic accidents. It quantifies the costs of road traffic accidents and analyzes it in terms of not only financial losses, but also non-financial losses, such as pain, suffering, and inability to enjoy the pleasures of life. By clearly highlighting the costs associated with traffic accidents, the government seeks to raise public awareness concerning the magnitude of these losses, and to encourage the implementation of effective, efficient traffic safety measures. The total road accident cost was found to be 1.4 percent of the GDP. Vehicle safety measures and safe driving practices have also been prioritized. Programs for rescue and emergency medical service like "Doctor-Helicopter Program" have been enforced.

4.2.2 Vision Zero in Sweden "the loss of human life in traffic is unacceptable "

Swedish National Road Administration (SNRA, 2007) elaborates that "Vision Zero" is the image of future in which no one will be killed or serious injured in road crashes. It is the basis for the work conducted on road safety in Sweden. This was ratified by Parliament, which resulted in changes in road safety policy and the work approach taken. It is both an attitude to life and a strategy for designing a safe road transport system. It establishes that the loss of human life in traffic is unacceptable. Road safety in the spirit of Vision Zero means that roads, streets and vehicles must be adapted to human capacity and tolerance. The responsibility for safety is shared between those who design and those who use the road transport system. The idea is, it is impossible to prevent accidents altogether, however it is possible to alleviate the consequences of accidents through safer roads, vehicles and greater insights into the importance of safe behavior in traffic (SNRA, 2007). Road Traffic Safety Bill

founded on the basis of Vision Zero was passed by Swedish Parliament in 1997, and was based on principles of ethics, responsibility, safety and mechanism for change SNRA (2007). Since Vision Zero was established in Sweden there have been fewer people killed on roads. The ideas behind Vision Zero have also made an international breakthrough.

SNRA (2007) mentions some of the strategies adopted under Vision Zero. One of the important strategies of vision zero is to separate different categories of road users and to change speed limits according to changes in the traffic environment. Roundabouts having traffic calming characteristics are replacing intersections to limit seriousness of any accident. "Forgiving roadside elements" like cable guard rails especially at steep rock cliffs are being introduced. Sweden is also a party to the collision tests conducted by EuroNCAP, which demonstrates car safety standards. Promotion of safety measures like use of seat belts, cycle helmets are some other strategies. Professional drivers are being given training in first aid as they are identified to be first on the site of occurrence of accidents. Help of local residents and municipalities are taken to identify accident prone locations and improvement of safety at those locations. Speed surveillances by permanent camera locations are helpful not only identifying the violators but also act as traffic calming measure.

Shared responsibility is the key element of Vision Zero. According to it, the responsibility of any traffic accident is shared by all those who have an effect on, or participate in road traffic (SNRA, 2007). This includes politicians, planners and road managers like the SNRA and the municipal authorities that construct and maintain roads. The police, vehicle manufacturers, organizations helping to improve safety, purchasers of transport services, transport operators and all those who use the road are also sharer of this responsibility.

The Ministry of Industry, Employment and Communications (1999) have introduced 11 Point Programme for improving road traffic safety in Sweden. This included special safety measures for the most dangerous roads, better road safety in urban areas, emphasis on road user responsibility, safer conditions for the cyclists, quality assurance for transport services. The program also have focus on compulsory use of winter tires, better utilization of Swedish technology, greater responsibility on road traffic system designers. Fair handling of traffic offences, more roles to voluntary organizations and alternative financing of new roads were also parts of the program.

4.2.2 Tomorrow's roads - safer for everyone in United Kingdom

In UK, the number of deaths and serious injuries in road accidents has gone down and it has one of the best road safety records in Europe. Still everyday 10 persons are killed and 110 are seriously injured in UK. Every year around 3,500 people are killed and about 40,000 are seriously injured in United Kingdom. The direct cost of road accidents involving deaths or injuries amounts to £ 3 billion/year (Department for Transport (DfT), 2007). The UK Government, the Scottish Executive and the National Assembly for Wales announced a new national road safety strategy and casualty reduction targets for 2010. These targets were introduced to focus on achieving substantial improvement in road safety over the next ten years, with particular emphasis on child casualties. The targets, which are given in the document *"Tomorrow's roads - safer for everyone",* were based on the annual average casualty levels over the period 1994 to 1998. It is expected to achieve following targets by 2010.

- **a 40% reduction in the number of people killed or seriously injured in road accidents.**
- **a 50% reduction in the number of children killed or seriously injured.**
- **a 10% reduction in the slight casualty rate, expressed as the number of people slightly injured per 100 million vehicle kilometers.**

The second three-year review of the strategy (DfT, 2007) based on 2005 data considers the overall progress of the strategy against the given target to be good. It was reported that there is a reduction of 33 percent below the 1994-98 baseline against the target of 40 percent reduction in killed or seriously injured (KSI) casualties in 2010. It was reported that there was a reduction of 49 percent in child KSI against a target of 50 percent in 2010. Greater progresses have been achieved in deprived areas and the targets for 2005 were met in 2002. The biggest concern was the slow progress the strategy was making towards number of death reduction.

It was pointed out that there was an overall reduction of 11 per cent, however certain areas like Scotland had made better progress in this area. There has been some concern about increase in accidents involving single vehicle, increase in drink-drive death with a small drop lately in 2005 and also high risk groups viz. motorcyclists, young drivers and those who drive for work.

Broughton (2007) has estimated that since the year 2000 the improvements in road casualties are mainly result of improvements in road infrastructure, car technology and management of speed, which were the elements of road strategies adopted in

UK. The strategy also involves increasing enforcement and enhancing publicity campaigns against drink-drive and seatbelt wearing. The aim is to increase 20 mph limit areas in residential areas and to implement consistency in local speed limits across UK. New driver training and testing system based on new syllabus, competency and knowledge and systematic assessment criteria is being adopted. A new Motorcycling Strategy of government sets out framework for action for high risk motorcycle riders, this is being implemented by involving motorcycle manufacturers and its users. Work has been underway to change in culture in the way the employers deal with driving for work by employees. There is also significant progress in reduction of pedestrian and pedal cyclists. The budget of Cycling England has been doubled to improve cycling infrastructure and training provision for the children. Schemes like Kerbcraft, a child and pedestrian training scheme is being popularized. A national Road Safety Delivery Board is being set up to bring together representatives of all parties. Road safety is now being considered as part of central and local government strategy.

4.2.3 Sustainable Safety in Netherlands

The Netherlands tops the world in having the lowest number of fatalities per inhabitant in road accidents. SWOV Institute of Road Safety Research (2006) estimates the cost of crashes to be around nine billion Euros. In spite of their high safety record the Dutch consider the size of their road safety problem as unacceptable. In Netherlands, the road safety approach has shifted from a reactive approach to a general proactive and integral approach. Sustainable Safety Vision was launched in early 1990s with an idea to make the traffic system safe albeit large speed, mass difference and fallible users. It has received lots of supports from all quarters. The inception of the vision started as Start-up Programme having most important element of extension of 30 km/h zones in urban areas and 60 km/h zones outside urban areas. SWOV Institute published the first Dutch National Road Safety Outlook in 1992 which introduced Sustainable Safety as the basis for thoughts and actions to promote road safety. The second outlook (2005- 2020) deals with safety assessment, background analysis of problem of road safety and evaluation. The principle of sustainable safety is to prevent road crashes happening and where it is not feasible to reduce the injury level to a minimum. Guiding principles to achieve sustainable safe road traffic is shown in the Table 5.

Table 5: Sustainable Safety Principles in Netherlands

Sustainable Safety principle	Description
Functionality of roads	Monofunctionality of roads as either through roads, distributor roads, or access roads, in a hierarchically structured road network
Homogeneity of mass and/or speed and direction	Equality in speed, direction, and mass at medium and high speeds
Predictability of road course and road user behaviour by a recognizable road design	Road environment and road user behaviour that support road user expectations through consistency and continuity in road design
Forgivingness of the environment and of road users	Injury limitation through a forgiving road environment and anticipation of road user behaviour
State awareness by the road user	Ability to assess one's task capability to handle the driving task

Source: SWOV Institute (2006)

The Netherlands road safety policy centers on the concept of sustainable road safety. In the 1980's, the Netherland's Ministry of Transport, Public Works and Water Management, set the following road safety targets: 50% fewer fatalities and 40% fewer hospital admissions resulting from road crashes by the year 2010 compared to 1986. In 1991, it became apparent that these targets would not be met if traditional policies were continued, even if the related activities would be intensified, and new, scientifically based and data-driven policy was developed with the aim to develop a sustainable and safe traffic system. This comprises an infrastructure that is adapted to road user capacities and limitations, safer road vehicles, and road users that are adequately trained, informed.

The other strategies include improvement in vehicle safety through European New Car Assessment Programme (EuroNCAP), in-car and out-of-car provisions to simplify and assist drivers task by the use of intelligent transportation system (ITS), advances in driver/rider training, traffic education and police enforcement. The strategy integrates human, vehicle and road elements. Road Safety Audits were recommended and carried out for various road categories. Three and four branched intersections were converted into roundabouts and vehicles coming from right at any intersection were given priority. Lengths of zones, more than the set targets were converted for 30 km/h and 60 km/h zones. Moped riding on carriageway rather than cycle path were advocated. A design guide on rural roads has been supplemented with sustainable safety principle (SWOV, 2006). Education, Campaign and enforcement were some other guiding principles.

In The Netherlands the growth of mobility, development of faster vehicles and fallibility of road users has caused number of road fatalities to increase as shown in Figure 8.

Figure 8: Number of Registered Fatalities in the Netherlands 1950-2004

Source: AVV Transport Research Center (2004)

There have been large differences between modalities. The risk of being killed in a traffic crash is highest for mopeds followed by motorcycles as shown in the Figure 9.

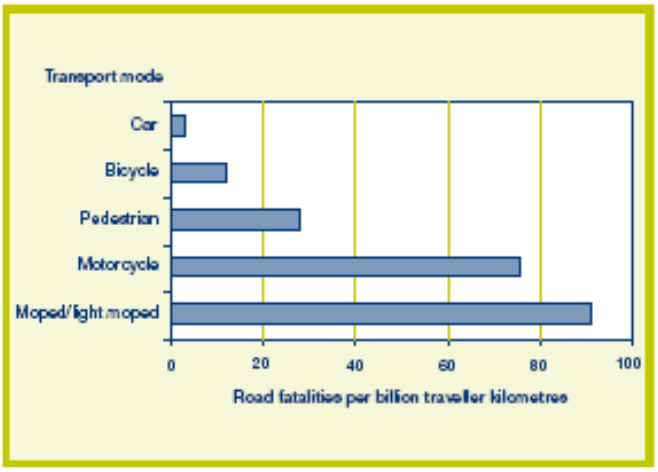

Figure 9: Number of Fatalities in the Netherlands for Different Transport Modes

Source: AVV Transport Research Center (2004)

Car/Moped impact with fixed obstacle accounted for greatest proportion of severely injured victims, for two party crashes pedestrians conflict with cars was the most vulnerable conflict. The fatality risk varies with road type and most road deaths and severe injuries occur on rural roads with 80 km/h speed limit and on urban roads with 50 km/h speed limit. Single vehicle conflict predominates in serious crashes

outside built-up areas whereas on urban roads conflict at intersections predominates.

An intermediate fatality reduction rate was set at 25% for the year 2000 (compared to 1.527 fatalities in 1986). The number of killed persons on Netherlands roads in 2000 was 1.082 (actual reduction of 29%). In 2001, the number of road fatalities dropped below 1.000 (993 killed persons). The following national road safety plan was the Start-up Programme for 1998-2001, and regional road safety plans are being developed from the national plan. The next step will be to integrate a Long-term Road Safety Programme (MPV) into the Netherlands National Traffic and Transport Plan (NVVP).

4.3 Review of Thailand Road Safety Research

There are many organizations doing research and developing road safety knowledge in Thailand. Some research works were supported by funding from various foundations. Key research centers include Thailand Accident Research Center (TARC) and Technical Center for Road Safety which produce and disseminate many research findings for Thailand road safety. A brief review of some of the works follows.

Motorcycle Accident Causation and Identification of Countermeasures in Thailand

This work was carried out by Vira Kasantikul (Kasantikul, 2001). The author identified the causes of motorcycle accidents and countermeasures to address these causes. A summary of the findings are: Motorcycle crashes cause most significant losses among all road crashes in Thailand. Every year, almost 10,000 motorcyclists lose their life in road accidents. Even though the related organizations have been trying to overcome this problem; the toll has remained almost constant in recent years. Since the characteristics of motorcycle design and traveling pattern are different from other vehicle types, the lack of understanding in its crash pattern can create the difficulties in proposing the effective countermeasures. This study attempts to present the characteristics of motorcycle crash in Thailand by using the statistical and the in-depth analyses. Injury Surveillance data, obtained from 28 center hospital database was collected and highlighted on all relevant issues for motorcycle crashes. Crash investigations or accident in-depth analysis, was performed by the Thailand Accident Research Center to acquire mechanism of crash and victims injuries. Finally, the issues of crash type, young rider, helmet use and its effectiveness, and injury characteristics were presented. The recommended countermeasures were also proposed in order to satisfy the reduction of both

number of crash and level of injuries among the countries with high motorcycle population. Among the key findings are:

- Rider error was the most frequent and primary contributing factor in the majority of both single and multiple vehicle accidents
- Alcohol related accidents constituted 30% of all accidents reported here.
- About 40% of the accidents involved improper traffic strategy such as unsafe speed, unsafe position, or following another vehicle too closely.
- About half of the accident-involved riders were unlicensed and none had any formal training in motorcycle riding techniques and collision avoidance strategies
- Most were self-taught or learned from friends and family. This lack of training, licensing and knowledge frequently appeared as rider errors in many accidents.
- The fatal accident often caused by motorcycle hitting a large truck which has poor visibility, parked on the shoulder lane which is doubled as the motorcycle way, at night time.

Among the key recommendations are:

- Training of riders in upcountry is imperative, so far, only Honda Safety Training Center provides training but mainly to police officers
- Law enforcement should focus on alcohol detection and licensing of riders
- Discontinue the requirement for motorcyclists to ride on the curb lane
- Current helmet standard to be dramatically upgraded to meet quality standard

Factors Affecting Bus Safety in Thailand

Among all types of vehicles involved, bus accident is considered a major public concern as when a crash happens, it often results in many casualties with characteristic high death tolls. The gravity of the situation is creating great concern among the traveling public as some 3,500 to 4,000 bus accidents occur annually in Thailand. Among the key findings are: some 1,470-1,680 people die annually from bus crashes, some 3,600 sustain serious injuries, the cost to the nation is between 8,000 – 9,000 million Baht (25,000 – 28,125 million JPY), over 50 % of the drivers

interviewed have only primary education, 46.2 % have experienced some accidents, 78 % of these drivers learn how to drive the bus by themselves, 17% have some form of illness including heart disease and diabetes, the crashworthiness of the bus is well below bus safety standards of as specified in UNECE regulation, particularly those involving rollover strength, and seat and anchorage strength (Taneerananon et.al, 2008)

Safe Driving Speed

As road accidents are often a result of a chain of events comprising driver' errors, and/or road infrastructure defects and/or vehicle defects ,with driver's errors form the majority of the cause; a research study is currently being carried to identify the effects of speeding , a common error made by Thai drivers (see Figure 10) on road crashes (TARC, 2008) .

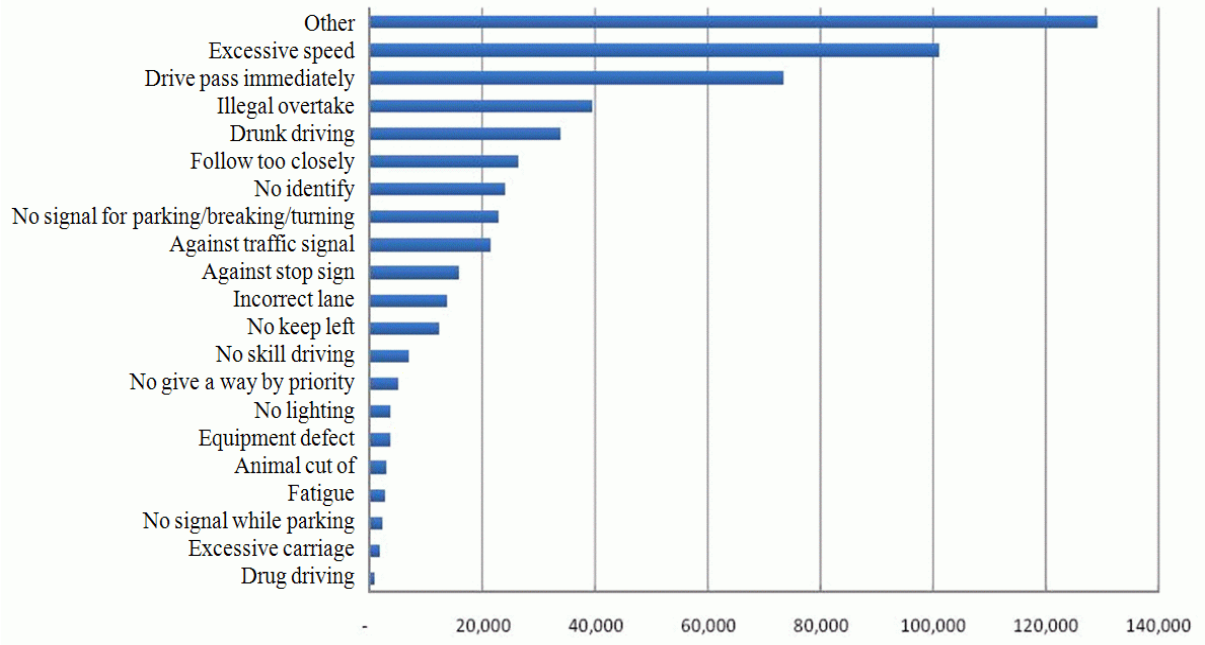

Figure 10: Road Accident Causes

Source: Royal Thai Police (2006)

Some preliminary review of literature on the study on the effect of speed on stopping distance which affects crash occurrence, and its severity follow:

"Speed" Increase the Chance of Occurrence of Road Accidents

According to a research, driving at high speed requires more braking distance to come to a stop, for example an increase speed from 32 km/hr to 112 km/hr increases the braking distance 8 times (Directgov, 2008) as shown in Figure 11.

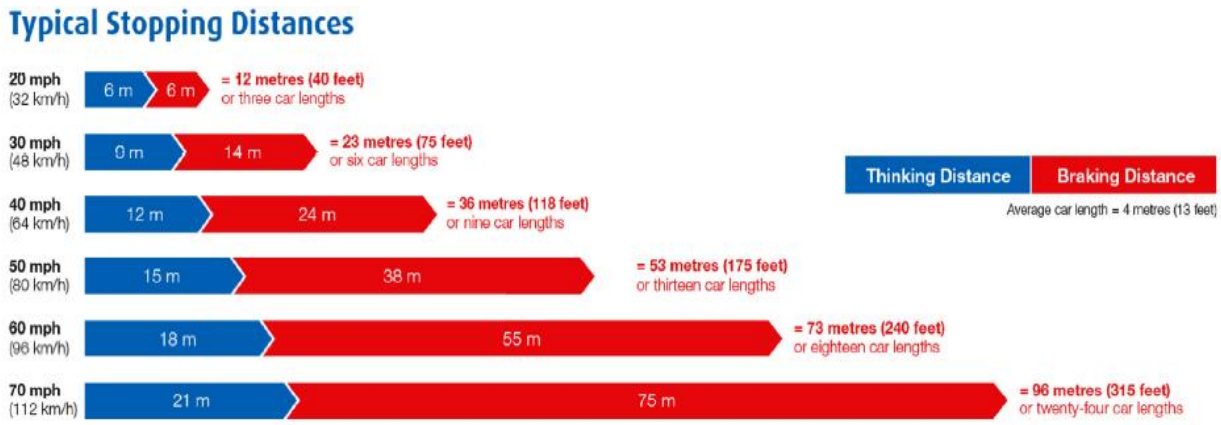

Figure 11: Typical Stopping Distance

Source: Directgov (2008)

"Speed" Increases Severity of Road Accidents

In a research carried out in UK, if car crashes into pedestrian at 48 km/hr, the chances that the pedestrian may die is 20% but if it crashes at 64 km/hr, the chances of death of pedestrian is 90% (Directgov, 2008).

Sweden research reports that increasing speed by 10% will result in increase in force attack by 21% and increase in the severity of road accidents causing death by 46% (Vagverket, 2008).

In-Depth Crash Investigation

To fully understand the cause of a crash, a complete and thorough investigation of a crash is required. Works in this area has been initiated by Thailand Road Accident Center and are ongoing and since then a number of Thai universities are conducting similar in-depth study of crashes. A brief summary of the in-depth crash investigation is given: The socio-economic development, level of motorization and alarming rate of road crashes have strong interrelationship in Thailand. The uprising trend of motorization level has the same serious impact on road safety issue in Thailand as among other ASEAN countries. Economic losses from the road traffic crashes also demonstrate quite a high figure in terms of GNP which is 2.81 % annually (DOH, 2007). Statistics indicate that road traffic accidents in Thailand are one of the major causes of premature death and disabilities among the working adults age group over the last two decades. . There is a need to conduct road crash investigation and reconstruction in a systematic manner to establish and confirm the real cause of many crashes in Thailand. This ongoing study investigates the factors which contribute to the crashes. Specifically, it aims to describe how and why vehicular crashes occur in Thailand. Application of "Event Tree" to focus on the events prior to a crash can demonstrate complex human interaction with vehicle,

and road and environment which can lead to the identification of contributory factors of the crash.

Traffic Accident Cost

A recent World Bank supported study has managed to quantify the economic costs of road accidents on Thai roads by estimating the price tag of the deaths and injuries caused by such accidents. The result shows why road safety should be a government priority.

Based on research during 2005-2007, *The Study of Traffic Accident Cost in Thailand* (DOH, 2007) estimates that road accidents cost a cumulative 232.8 billion baht (about $7.2 billion) in financial terms in 2007 or 2.81 percent of the country's GDP. That is 60 percent more than what the Thai Government spent last year on health service delivery.

The Study of Traffic Accident Cost in Thailand estimates the cost of a fatal crash around the nation to be, at 2007 prices, 5.3 million baht in financial terms (about $166,111). The cost of a crash causing disability is 6.2 million baht (about $192,720) on an average. In Bangkok, both of these costs are considerably higher. A crash that causes death in Bangkok costs 11 million baht ($343,750) on average, while the one that causes disability costs 12.4 million baht ($387,500).

The study was based on a collection of data from a number of Thai government agencies, private business owners, courts, and the police. The research team combined the data with interviews with politicians and a wide range of concerned citizens, including doctors and nurses; rescue workers; law enforcement officers and legal experts; insurance agents; and the accident victims as well as their families.

Other Research and Studies on Road Safety

Some of the titles from Thai road safety research communities are (TARC, 2008):

- Injuries and Fatalities from Road Accidents
- Study of Laws and Measures on Motorcycle Safety in Thailand
- Public Transportation Safety between Cities
- Review of Motorcycle Accidents
- Impact of Road Side Trees on Road Accidents
- Bus Accident at Sungklaburi District, Karnjanaburi Province
- Nakornchai Company Investment for Bus Safety
- Review Bus Accidents Statistics

- Barriers to Accident Claim
- Road Safety Policies for Motorcycle Accidents
- Compilation of Rights of Public Transport Passengers
- Development of Bus Standards
- Development of Road Accident Reporting Computerized System in Thailand
- Impact of Seatbelt Use to Road Accidents in Thailand
- Applying Public Participation Process to Black Spot Identification Process - A Case Study in Thailand
- An Integration of Hand-held Computers, GPS Devices, and GIS to Improve the Efficiency of EMS Data System
- Study on the Impact of Short-Term Work Zone Along an Un-interrupted Flow Highway: A Case Study in Thailand
- Decision Support System for Work Zone Safety Management: A Case Study in Thailand
- Development of Road Accident Reporting Computerized System in Thailand
- Determination of Economic Losses due to Road Crashes in Thailand
- Road Accidents in Thailand: Changes Over the Past Decade
- Analysis of Motorcycle Accidents in Developing Countries: A Case Study of Khon Kaen, Thailand
- A Study on Pedestrian Accidents and Investigation of Pedestrian Unsafe Conditions in Khon Kaen Municipality, Thailand
- Implementing Road Safety Audit in Thailand
- Development of Emergency Medical Service Support System Through GIS and Trauma Registry Record: A Case Study of Khon Kaen, Thailand
- Development of GIS Based Traffic Accident Database Through Trauma Management System: The Developing Countries Experiences, A Case Study of Khon Kaen, Thailand
- Developing Road Safety Audit Expertise in Thailand
- Pedestrian Characteristics Study on Walkways in Bangkok
- Injury Mechanism Analysis of Occupants in Road Crashes
- Injury Mechanism Analysis of Occupants in Road Crashes
- Mechanisms of Road Crashes through Accident In-Depth Study Carried out by the Thailand Accident Research Center
- Application of Event Analysis in In-depth Study of Road Accidents
- Is it a timely Approach for Bus Accident Investigation in Thailand
- An in-depth analysis of road crashes in Thailand
- Motorcycle Crash Characteristics in Thailand
- In-depth Study on Road Accidents: Thailand Perspective

- **A Study on Pedestrian Accidents Based on the Injury Surveillance (IS) Data: Thailand's Case**
- **A Framework of Injury Surveillance (IS) Database for the Developing Countries: A Thai Experience from the Road Safety Perspective**
- **Probability of Survival (PS): An Alternative Severity Assessment Approach in Road Safety**
- **Efficacy of Safety Helmets for the Thai Motorcyclists**
- **Analysis of Traffic Accidents During New Year Festival in Thailand**
- **Utilization of Road Accident Data during New Year Festival for the Management of Police**
- **In-depth Study on Road Accidents: Thailand Perspective**
- **Crash Investigation and Reconstruction? The New Experience in Developing Countries: Thailand Case Study**
- **Thailand Accident Research Center: Its Role in Thai Society**
- **An Alternative Approach to Road Safety Problem in Developing Countries: A Public Participation Approach to Identify Black Spots Location**
- **Road Safety Audit Project of the Chalerm Maha Nakhon Expressway**
- **The Cost of Traffic Accidents in Thailand**
- **The Status of Road Safety in Thailand**
- **An Investigation of Pedestrian Facilities on GIS in Bangkok**
- **Road Safety Audit: A New Alternative Approach to Solve Road Accident Problems in Developing Countries? The Thai Experiences**
- **Road Safety Audit: Another Approach for Solving Traffic Accidents in Thailand**
- **Development of Emergency Medical Service Support System Through GIS: A Case Study of Khon Kaen, Thailand**
- **Road Safety Audit in Thailand: Present and Future**
- **GIS Application on Road Accident Management System as a Part of Trauma Management System for Community Health Promotion: A Case Study of Khon Kaen, Thailand**
- **Traffic Accident Study: Thailand and Japan Experiences**
- **Traffic Safety in the Developing Countries: Problems and Issues in Thailand Bangkok Experience**
- **Ideas to Countermeasure the Traffic Accident Problems in Bangkok**
- **Development of road accident management system on GIS through the Trauma Management System : a case study in Khon Kaen, Thailand**
- **The Impact of Fatigue and Sleep Deprivation on Driving Performance**
- **Development of Accident Database Management System for The Highway Police**

- **Application of Satellite Imagery Map for Black Spot Identification along**
- **A Study of Seat Belt Usage and its Impact in Thailand**
- **Identification of Factors in Road Crashes Through Accident Investigation and Reconstruction in Thailand**
- **An application of a traveler information system for incident occurrences on the Bangkok expressways**

4.4 Results of Expert Interviews

A number of experts were interviewed to get their views and opinions on the key issues that need a rethink and to obtain supporting evidence in order to deal with them effectively. The experts interviewed include:

1. **Medical experts**
2. **Police experts**
3. **Road safety experts**
4. **Engineering experts**

The research got full cooperation and help from these experts from the field of road safety. They shared their ideas and wide experience on this important problem and solutions. Their ideas are important inputs in the formulation of strategic topics. Some of the ideas and suggestions are discussed below.

4.4.1. Motorcycle Lane

Motorcycles form the majority of vehicle fleet in Thailand. According to the Department of Transport's statistics at the end of 2007, of the total 24.74 vehicles registered under the motor vehicle act, 15.96 millions or 64.2 % are motorcycles. From the road safety point of view, some 10,000 motorcyclists and pillion passengers lose their lives annually (Kasantikul, 2001), or about 70-80 % of the total annual road fatalities of some 13,000. Apart from the helmet law which requires riders and their passengers to wear the helmet while riding, the introduction of daytime running head light, and the campaign to get these road users to use the helmet, there is almost no other measure to help motorcyclists survive on the road. The provision of motorcycle lane, will be an important active safety measure to help reduce motorcycle casualties. Few attempt have been made on this subject, but there is no real study on the subject.

Study of design, construction and operation of motorcycle lane in Malaysia is a good starting point for the research. A motorcycle lane in Malaysia is shown in Figure 12.

In providing the motorcycle lanes, safety consideration in the design must be carefully researched. For example, how the motorcycle rider is going to make a right turn at intersection and u-turning at mid block sections? Existing inclusive motorcycle lane on highway in rural areas does not function safely, particularly when it goes through the community area because of it is often occupied by parking vehicles. Example of a motorcycle lane on Kumpang Petch – Lumpang road is shown in Figure 13.

Figure 12: Motorcycle Lane in Malaysia

Source: State Planning Unit Sarawak (2008)

Figure 13: Motorcycle Lane on Kumpang Petch –Lumpang Rd., Thailand

Source: Asia Museum Company (2008)

Research and development of motorcycle lanes are thus required for the safety of motorcycle rider and passenger, before it can be safely and effectively applied throughout the country.

Underpass for Connecting Two Sides of a Highway

Many communities in Thailand are separated by highways but people in the communities need to travel between both sides, and they often do this by means of motorcycle and walking. Under existing road layout, people have to ride their motorcycles to cross the highway at u-turn or intersections. For those who walk, they often have to run across high speed traffic. This creates unnecessary danger for the people, who through no fault of their own find themselves at risk on a daily basis because on the design of highways has not taken their need into account.

Figure 14: Underpass in Thailand
Source: DOH, Thailand(2007)

The one solution is suggested by the experts to provide underpass like the one shown in Figure 14. Although this solution requires material budget for the infrastructure but its benefits include the saving of people's lives and preventing serious injuries. The underpass provides the divided community to physically connect in a safe and convenient environment. There are many types of underpass such as two ways two lanes in case of low travel demand and four lanes with median in case of higher demand. A practical research into their infant stage of development with the aim of duplicating their application nationwide would help Thailand in reducing the number of crashes and casualties.

4.4.2. Development of a New Licensing System

Significant number of Thai drivers and riders drive and ride without driving license, Studies conducted for the Office of Transport and Traffic Policy and Planning in regional cities show some 30-50 % of riders are without license. Some are under the permitted age while some have insufficient skill to drive or ride. Similar findings were echoed by Vira (Kasantikul, 2001). These unskilled, lack of traffic knowledge road users not only create potential risk of a crash for themselves, they also endanger other road users.

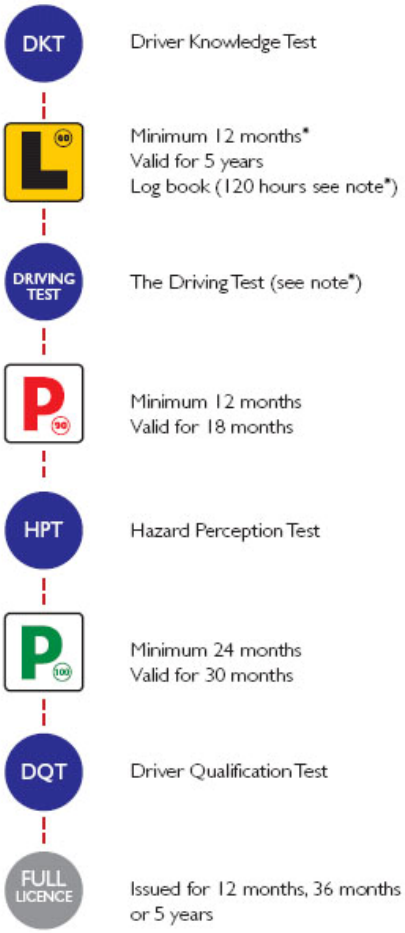

Figure 15: License System in NSW, Australia

Source: Roads and Traffic Authority (NSW)(2008)

On the other hand, those who have driving license are often found to have unsafe behavior as evidenced in the police report which cite speeding and abrupt cutting in as the two main causes of accident. The current licensing system in Thailand is compared to many countries well below par. It is not vigorous enough to produce drivers or riders with sufficient knowledge and skill required to use the road safely. It is obvious that to first enter the road, which is a dangerous arena even for people with driving experience, the new drivers/riders must be well trained.

Research and development of a new license system is thus imperative. The new system should not only focus on skill to control vehicle, but should also cover safe driving skills and this requires knowledge on many fronts including effect of speed on vehicle braking . The new system will enable Thailand to leapfrog into a new era of road safety by turning out SAFE drivers and riders.

New South Wales, Australia provides a good example of a rigorous licensing system. The process to get a full license requires many tests and take at least 3 years as shown in Figure 15.

4.4.3 Motorcycle Safety Standard

As too many casualties from motorcycle accidents occur every year. All efforts must be brought to bear on the gravity of the situation. Apart from the motor cycle lane, the new licensing system, there is a need to identify areas where safety can be improved on the vehicle itself.

Figure 16: Heavy goods in front basket can destabilize turning manoeuvre

Figure 17: Front basket can block headlight and discourage helmet wearing

As an example, motorcycle should have no basket in the front of handlebar because the weight of the goods kept in the basket will interfere with the proper control of the vehicle, particularly this could be one of the reason that some 30 % of motorcycle crashes are single vehicle crash. An example is shown in Figure 16. In addition the stuff in the basket can block the headlight at night time and discourage helmet wearing as shows in Figure 17. Furthermore, leg injury is one of the most frequent occurrences, provision of leg protecting frame would help reduce leg injury in case of an accident. Figure 18 shows a motorcycle with leg protection.

Figure 18: Motorcycle in USA
Source: FHWA(2008)

4.4.4 Roadside Safety

Studies worldwide and Thailand indicate that fatalities resulting from vehicles running off the road and hitting fixed objects constitute a significant percentage of road deaths. In the US and some other countries, the figure is around one third. For Thailand, the death tolls from vehicles hitting fixed objects on roadside on the highways belonging to the Department of Highways account for some 30% of the total deaths on the highways. This magnitude of casualties alone warrants detailed research into how the situation can be improved. Trees planted well within the standard clear zone have contributed to hundreds of deaths and serious injuries in the past few years. In addition, roadside should not be safe for only 4 wheel or more

vehicles, but for motorcycles also. For instance, un-tapered vertical shoulder drop-offs are more dangerous for motorcycles than for other vehicles. The research will need to look at all aspects of roadside safety.

4.4.5 Electric Motorcycle

Figure 19:Electric Vehicle GPRS
Source: Electric MOTORSPORT(2008)

With the advent of high oil price, the use of two – wheel vehicles have increased significantly in many countries, Thailand is no exception. The old moped is making a come back and is making in-road to the Thai market. Apart from their small sized engine, these electric engine vehicles are popular as they emit little or no pollution. These vehicles also have advantage in road safety because of their low speed. In order to promote their wide spread use, a research into their operation safety needs to be conducted. Example of a GPR-S electric motorcycle is shown in Figure 19.

4.4.6 Law Enforcement

Enforcement is one important measure for making any road safe. The law can not be enforced on drivers without police. The road safety efforts assign important responsibility of enforcement to police. However, it has not been very successful. The problem of lack of success in enforcement is complicated and difficult to answer. Some experts think barriers to effective law enforcement come from the dated laws, low police performance and lack of enforcement equipments. As an example, Thailand has Land Traffic Act which has been applied since 1979 and many items need to be updated, despite the regular issuances of new clauses. As technology in both road construction and vehicle manufacturing has greatly improved, this induces changes to driving behavior. Drivers can now drive at much higher speed than in 1980s. However, the present high speed driving is still safer because of the technology. So, the law about speed limit should be updated in order to be relevant and hence respected.

There are many reasons for failures of police to efficiently deal with road safety problems. Police have many duties to perform, they usually give low priority to road accidents than criminal activities. However, authority and power to enforce the law is in police hands, and if they do not give road safety the priority it deserves then there is a need to identify strategies that can overcome the barriers to effective

police performance in road safety. Preliminary study has identified the shortage of equipment as one of the barriers. For example, police usually capture drivers who don't stop at red light, do not put on safety belt, or use mobile phone without any photographic evidence. There are few speed measurement equipments in police works. Some experts shared their ideas that Thailand should produce and develop these equipments instead of buying them as it will be cheaper and because there are enough technology and technical experts available in the country. To help the police in their work, automatic enforcement equipments are required. The essential equipments are red light cameras and speed camera. Example of red light camera installation is shown in Figure 20. These equipments will help reduce road fatalities because speeding and red light disobedience usually result in very serious accidents. Figure 21 shows an automatic ticket machine that issues fine slip, which will further reduce police workload.

Figure 20: Red Light Camera

Source: Wikimedia Foundation, Inc(2008)

Figure 21: Red Light Camera Ticket

Source: Mike McGuff(2008)

Some experts suggest that police should increase budget and promotion for the police force working in the area of road safety in order to boost effective enforcement. Traffic police are supposed to be a specialist and have their own system of promotion different from others. Present traffic police work more than 12 hours per day without over time wage. Some have to use their own motorcycle for official duty. It is therefore evident that they will not have good health because of pollution and lack of resting time. Thus there is a need for better facilities and welfare measures for the traffic police.

The research and develop of a standard manual for enforcement operation will further the goal of effective enforcement of traffic laws.

4.4.7 Mass Transit for Road Safety

Mass transit does not only reduce personal travels by private vehicles but reduce fatalities also. A good example is Shinkansen in Japan which has no fatality since it started operation more than 40 years ago. If most of private vehicle trips change mode to public transport, the number of accidents should be greatly reduced.

Figure 22: Shinkansen in Japan
Source: Wikimedia Foundation, Inc(2008)

During the Shinkansen's 44-year, nearly 7 billion passenger history, there have been no passenger fatalities due to derailments or collisions (including earthquakes and typhoons). Figure 22 shows Shinkansen photo in Japan. Injuries and a single fatality have been caused by doors closing on passengers or their belongings; attendants are employed at platforms to prevent this. (http://en.wikipedia.org/wiki/Shinkansen)

In Thailand, although there are mass transit such as BTS and MRT in central Bangkok, but they are still insufficient to meet travel demand. In big provinces such as Chiang Mai and Nakorn Rachasrima, implementing mass transit systems will likely help reduce road casualties on a large scale. A research study with focus on the benefits of the system in reducing crashes will help speed up its implementation.

Key Performance Index in Road Safety

Thailand loses about 3% of GDP from road accidents in 2007 (DOH, 2007) but the amount of budget spent on road safety was far too small to impact the effort to save lives and prevent injuries. Despite the low budget being allocated for road safety, it is important to measure the impact it has on promoting road safety, no matter how small this impact may be. To be able to measure this impact, it is necessary to develop some kind of index, the Key Performance Index (KPI). Appropriate KPI will enable the effective management of limited resources in each stockholder's organization, and also serves as a marker of advancement towards road safety goal.

5. Recommendation of Strategic Research Direction

In light of the socio-economic and technological advancement, road safety has become a top priority for most of the developed countries while most developing countries are still struggling to cope with the problem which comes with increasing motorization, including Thailand. In economic terms, the lack of road safety leads to huge losses incurred from the loss of lives, injuries and property damages in road crashes. Special measures related to road infrastructure, driver and vehicle have been taken up to enhance road safety situation. Some of these measures have already been implemented and have been found to be effective, especially in Japan and the SUN countries as previously mentioned.

The strategic research direction in Thailand should be based on the principle that the loss of human life in traffic is unacceptable and the country needs to leapfrog into saving the life of its citizens from road crashes. Like the four countries mentioned above, the involvement of Thai parliament through the enactment of a Road Safety Bill or Road Safety Act will enhance the country in setting the right direction to safer road, safer vehicle and safer road users. The SUN countries' guiding principle: adaptation of road infrastructure, and vehicle to human capacity and tolerance should be adopted in the design and construction of the same for Thailand. Based on the principles mentioned, the strategic research should address the safety challenges confronting the country.

In other words, some of the problems related to road safety are specific to Thailand and special care is to be taken to deal with such problem. As an example, motorcycle use is rampant in Thailand. Motorcycle crashes and the ensuing casualties are the most significant component of all the road crashes and casualties in Thailand. The strategic research in future should be focused to ameliorate the safety of the motorcycle users. In addition to the crucial need to upgrade the skill and knowledge of riders, crash investigations and analysis can be taken as a lead in the future researches relating to the design of motorcycles, its safety features, exclusive motorcycle lanes and its roadside elements, use of low speed electric motorcycles etc.

Researches of practical significance like improvement of vehicle safety features based on the some standard practices like EuroNCAP may be introduced. Use of ITS techniques to enhance safety of vehicles by simplifying and assisting drivers and also providing information for all road users is considered an important area for future

researches in road safety. Researches towards improvement of safety for pedestrians and cyclists and the facilities related to them are other strategic research areas. Enforcement measures and its efficacy including modernization of surveillance, revision of licensing system are some other areas for the future researches. The economic issues related to road safety including the economic losses of road accidents, design and provision of safer road infrastructures and the cost benefit analysis are some of the strategic topic for future researches. The identification of barriers to and opportunity for introduction of a road safety bill to mandate the setting and implementation of road safety strategies for dealing with the short and long term challenges must be a key research area.

The researches in the above areas should be based on a scientific data collection and correct reporting. This can only be possible by a proper coordination between all parties related to road safety and road use. This can also be taken as a strategic research area.

CHAPTER 6 STRATEGIC RESEARCH TOPICS

6. Strategic Research Topics

The review of best practices, results of interviews with experts have culminated in many proposals for strategic research topics. These topics can be grouped into five categories as safer human development, safer road infrastructure, vehicle safety, law and enforcement and safer transportation system development. The emphasis is being given to improving the safety of users of motorcycles. New rider training and testing system based on new syllabus, competency and knowledge and systematic assessment criteria is essential for ensuring the rider's own safety. The new system is also being adopted in the UK which has also introduced a new Motorcycling Strategy. Provision of motorcycle lane is in line with a safety principle of the Netherlands' sustainable safety, that is providing homogeneity of mass and/or speed and direction. As improving road safety requires a system approach, it is clear that all the five categories are important elements of the system. However, given the limited budget available for research, the research groups and the topics within each group have been arranged in order of priority as follows.

6.1 Safer Human Development

- **Research and development of a new licensing system**
- **Improving knowledge and skill of motorcyclists**
- **Improving knowledge and skill of drivers of public transport**
- **Development and implementation of road safety education for children**
- **Human resource capacity in road safety and its potential contribution to creating a research institute of road safety technology**

6.2 Safer Road Infrastructure

- **Research and development of motorcycle lane**
- **Research and development of underpass on highway to improve safety of communities on two sides of the highway**
- **Effectiveness of road hierarchy in speed control**

- Review speed limit on each road type
- Research and development of traffic calming devices including roundabouts for communities
- Research in city planning for road safety

6.3 Vehicle Safety

- Improving safety of motorcycle and related safety equipment
- Improving bus safety standard
- Research and development of electric motorcycle standards

6.4 Law and Effective Enforcement

- Barriers to and opportunity for introduction of road safety bill
- Research and development of a new licensing system
- Upgrading the 1979 Land Traffic Act
- Barriers to the setting up of traffic court
- Research and development of a traffic police operation manual
- Barriers to effective enforcement
- New technology in road safety enforcement equipment
- Research and development of red light camera
- Research and development of speed measurement equipment
- Effectiveness of social sanction in improving poor road user behavior

6.5 Safer Transportation System Development

- Development of key performance index in road safety
- Design of safer traffic signal control at intersection
- ITS application in road safety
- In - depth investigation of road accidents
- Further development of the national accident database system.
- Research on effectiveness of traffic management by engineer vs. police
- Development of road safety plan in local governments (province, district and sub-district)
- Road safety benefits of mass transit
- Barriers to Implementing mass transit in large provinces

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