Transport and Communications Bulletin for Asia and the Pacific

No. 79

Road Safety

United Nations
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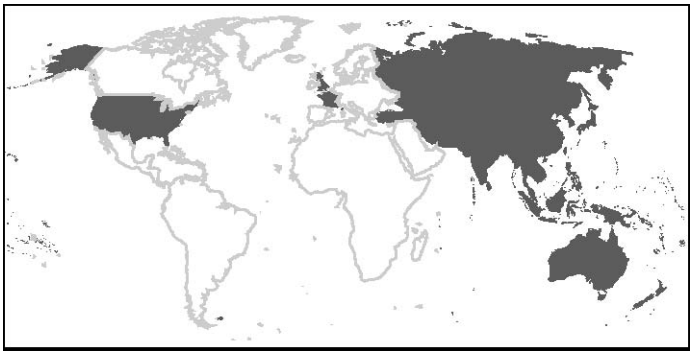

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Editorial statement

The *Transport and Communications Bulletin for Asia and the Pacific* is a peer-reviewed journal published once a year by the Transport Division (TD) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The main objectives of the *Bulletin* are to provide a medium for the sharing of knowledge, experience, ideas, policy options and information on the development of transport infrastructure and services in the Asia-Pacific region; to stimulate policy-oriented research; and to increase awareness of transport policy issues and responses. It is hoped that the *Bulletin* will help to widen and deepen debate on issues of interest and concern in the transport sector.

Road safety in many countries of the ESCAP region is a development issue of concern considering its magnitude and gravity and the consequent negative impacts on the economy, public health and the general welfare of the people, particularly those with low incomes. Although some countries in the region have undertaken commendable initiatives and are implementing various road safety improvement programmes, the overall situation as revealed by recent data is far from satisfactory.

Road traffic accidents kill an estimated 1.3 million people and injure 50 million people per year globally, and global road fatalities are forecast to reach 1.9 million by 2020.[1] It is estimated that the number of deaths from road accidents in Asia is about 700,000 per year, accounting for more than half of the world's road fatalities even though Asia accounted for only 43 per cent of the global vehicle population in 2007. These numbers are very high compared to other parts of the world. The ESCAP secretariat estimates that, by 2020, about two thirds of the world's road traffic fatalities might be in the ESCAP region.[2]

Decision makers of the region have recognized the urgency of the issue. The ESCAP Ministerial Declaration on Improving Road Safety in Asia and the Pacific*,* which was adopted in Busan, Republic of Korea, in 2006, includes the goal of saving 600,000 lives and preventing a commensurate number of serious injuries on the roads of Asia and the Pacific over the period 2007-2015. In order to assess and evaluate the achievement of the road safety goals contained in the Declaration, ESCAP has developed

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[1] Commission for Global Road Safety, *Make Roads Safe: A Decade of Action for Road Safety* (London, Commission for Global Road Safety, 2009).

[2] The calculations use the same assumptions and methodology as the dynamics-as-usual scenario published in the 2004 World Health Organization report on road safety.

regional road safety goals, targets and indicators in consultation with member countries.

Among others, Commission resolution 63/9 on the implementation of the Busan Declaration on Transport Development in Asia and the Pacific and the Regional Action Programme for Transport Development in Asia and the Pacific, phase I (2007-2011), and General Assembly resolution 62/244 on improving global road safety have expressed a high level of political commitment to improving road safety in Asia. Significant efforts and resources will be needed to translate this political commitment into improved road safety.

As a regional organization, ESCAP promotes a multilateral approach in the area of road safety, and has been working in partnership with the Asian Development Bank (ADB), the Global Road Safety Partnership (GRSP), the International Road Federation (IRF), the World Road Association (PIARC), the International Road Transport Union (IRU), the United Nations regional commissions and the World Health Organization (WHO).[3] As part of its activities, ESCAP is encouraging the member countries to consider developing a set of national road safety goals and targets and a set of indicators for monitoring achievements.

In consideration of the importance of and wide interest in the subject, once again *road safety* was chosen as the theme for the current issue of the *Bulletin*. The first article looks at the characteristics of road accidents in India. It reviews the road safety initiatives taken in the country, considers their effectiveness in improving road safety and, finally, presents a road safety action plan and intervention measures.

In developing countries, travel risks and traffic exposure grow at a much faster rate than elsewhere, as the growth of registered vehicles always outnumbers population growth and new roads are constructed. The second article describes how the number of road deaths was estimated in Malaysia incorporating travel risk and traffic exposure factors into statistical models, which helped in setting more realistic national road safety targets. This article provides a framework that may be useful for other developing countries to set and evaluate their own road safety targets.

Speeding happens to be a key contributory factor to road traffic crashes in Thailand. Although speed enforcement has been included as an integral part of the speed management policy, its effectiveness has been limited for a number of reasons. The third article identifies some gaps in

[3] See also General Assembly resolution 62/244 of 2008 on improving global road safety.

knowledge concerning the speeding problem and the current practices of enforcement. Issues related to more effective speed enforcement and potential alternative speed management strategies are discussed.

The fourth article presents the magnitude and trends of the road safety problems and accident characteristics in Bangladesh. It also reviews some major road safety initiatives to control and reduce road traffic accidents and injuries by state and non-state actors and their effectiveness.

Achieving universal helmet use is a critical step in reducing high fatality rates in many developing countries, where motorcycles represent a very high percentage of personal vehicles. In this respect, Viet Nam's experience in increasing motorcycle helmet use offers a model for countries in the region. The fifth article outlines the model which addressed: (1) market failures that made helmets unaffordable and unappealing; (2) weak legislation and enforcement; and (3) public ignorance of the safety benefits of helmets.

The sixth and last article explores the conceptual understanding of road crashes as a social issue among general road users and the behavioural determinants of motorcycle helmet use among young people. One of the conclusions is that the target population was aware of the benefits of wearing helmets, but their behavioural responses were linked to the perceived level of risks and were also influenced by the actions of others.

The articles discuss important policy issues related to improvement of road safety. It is expected that they will generate further debate on the issues that have been discussed and increase awareness of their policy implications and responses. It is also expected that the articles will increase awareness of the benefits of improving road safety in countries of the region and encourage policymakers to take action, as well as motivating them to learn from good practices in other countries.

The *Bulletin* welcomes analytical articles on topics that are currently at the forefront of transport development in the region and on policy analysis and best practices. Articles should be based on original research and should have analytical depth. Empirically-based articles should emphasize policy implications emerging from the analysis. Book reviews are also welcome. See the inside back cover for guidelines on contributing articles.

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CONTENTS

ROAD SAFETY SCENARIO IN INDIA AND PROPOSED ACTION PLAN

P.K. Sikdar* and J.N. Bhavsar

ABSTRACT

Fatalities in road accidents in India constitute 8-10 per cent of global road deaths. This phenomenon is like a silent disaster happening every day and it is worse than any other natural or man-made disaster. India has introduced a major road development programme to make travel faster, but the safety outcomes are not satisfactory due to deficiencies in engineering, education and enforcement (the three E's of traffic engineering and safety management). The characteristics of the accidents and their causal analysis suggest poor discipline in road use coupled with poor enforcement as the main causes of this situation. A more comprehensive road safety programme needs to undertaken to improve the current situation. Considering the magnitude of the problem, a road safety action plan is suggested and the proposed initiatives are discussed. The contribution of the India chapter of the International Road Federation to the cause of road safety is also highlighted.

Keywords: road accidents in India, road safety action

INTRODUCTION

Road fatality rates in India are probably among the highest and out of 1.25 million deaths worldwide every year, 8-10 per cent (about 115,000) of all road deaths are in India. With the rising purchasing power of average Indians, motorized vehicle ownership is growing at a fast pace and, in some cities, vehicle ownership has reached a level comparable to that of the developed countries. The poor and inadequate public transport services in cities, particularly the non-metropolitan cities, have compelled many residents to use private modes more often than should have been necessary. As a result, the use of private modes for work trips is very high. The World Health Organization (WHO, 2004) has estimated that fatalities per 100,000 population in the developing world will grow from 13.3 in 2000 to 19.0 in 2020, while in the developed world during the same period, they will decline from 11.8 to 7.8. It may be mentioned that India had 10.1 fatalities per 100,000 population in 2007.

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Safety is supposed to be built into the road traffic system by traffic engineering practices, but traffic engineering has yet to find its due importance in road system development and operation in India. The giant road development programme being undertaken in India is grossly deficient in traffic engineering. The aim of engineering is to provide the most scientific design to make the roadway safe for all users and to provide a forgiving road. The other critical dimension of the road safety problem in India is the poor public education regarding road safety. Education is a long-term matter which needs to be inculcated in all road users from childhood in order for them to possess good road senses and to remain responsible to others while using the road. Similarly, enforcement is another dimension where a legal system is required to be introduced to penalize the violators of traffic rules so as to act as a deterrent. Of course, in these efforts, economic rationality has to be considered while ensuring appropriate safeguards for preserving the safety environment.

The road system and the traffic operations in India are deficient in safety management. One of the reasons for this situation is that there is very little opportunity to learn from the past mistakes. The accident records are supposed to provide the best clue about what has been deficient in the road, vehicle and user systems to explain the causes of accidents and to develop remedial measures. This aspect of the road safety management system is poor in India, with untrained police officers collecting only incomplete records of fatal accidents and always stating the road user's fault as the cause of the accident. In a road environment where the road design (engineering), knowledge of traffic rules (education) and traffic control and policing (enforcement) are not satisfactory, the cause of the accident can also be the driver's fault. In a deficient road and traffic environment, causes are mainly linked to poor road geometry and poor traffic control aggravated by poor traffic sense.

This paper describes the huge road development programme being undertaken in India and its safety implications. While the magnitude of the problem is discussed, the nature of the road safety problem and basic issues are also analysed. Road safety initiatives introduced in the past and those that are ongoing and being contemplated by the government are also discussed, along with the mission of the India chapter of the International Road Federation (IRF) to achieve targeted reductions in road fatalities. A road safety action plan has been proposed using engineering, education and enforcement (the three E's of traffic engineering and safety management), including enforcement.

STATUS OF ROAD DEVELOPMENT

India has a road network of an estimated 3.3 million km, which carries nearly 65 per cent of freight and 85 per cent of passenger traffic. The road traffic is estimated to be growing at an annual rate of 7-10 per cent, while the vehicle population is growing at a rate of 12 per cent per year. Road length by category of roads is shown in table 1. The national highways in the country account for only 2 per cent of the total road network, but they carry over 40 per cent of the total road traffic.

Table 1. Road network in India

Category of road	Length in km
National highways/expressways	66 754
State highways	128 000
Major and other district roads	470 000
Rural roads	2 650 000
Total road network	3 314 754

Source: India, Department of Road Transport & Highways, *Annual Report 2007-2008*.

The Government is implementing a massive National Highways Development Project (NHDP) in the country in seven phases to increase the capacity by 54,450 km of national highways (NH) by widening them to 4-6 lanes. The National Highways Authority of India (NHAI) is entrusted with the implementation of NHDP. Phase I and II of NHDP, comprising 14,000 km, are almost complete, while the other phases are in various stages of implementation. These improved high-speed roads are spread out over the whole country and include 1,000 km of expressways and 700 km of bypasses in congested areas.

II. SAFETY HAZARDS ON INDIAN ROADS

Road traffic accidents constitute 32 per cent of all accidental deaths in India. An account of accidental deaths in the country with special reference to traffic accidents is given in table 2.

Table 2. Accidental deaths in India

Year	Deaths due to natural disasters	Deaths due to unnatural accidents*		
		Total	Traffic accidents (road, rail, air, etc.)	Road accidents
1998	22 762	235 647	93 996	79 919
1999	27 506	244 412	99 541	81 996
2000	17 366	238 517	98 038	78 911
2001	36 651	234 368	99 516	80 888
2002	16 723	243 394	101 958	84 674
2003	14 954	244 671	102 951	85 998
2004	18 937	258 326	111 794	92 618
2005	22 415	271 760	118 265	94 968
2006	21 502	293 302	131 652	105 749
2007	25 153	315 641	140 560	114 444

Source: Central Bureau of Health Intelligence and Ministry of Road Transport and Highways, India.

* Major causes of unnatural accidents other than traffic accidents include the collapse of structures, drowning, explosions, fire, firearms, stampede, suffocation, being killed by animals and other similar causes.

The dominance of road transport will continue in India as it has in the rest of the world. The share of the movement of both passengers and goods is expected to increase further in the coming years with the full implementation of the current road development programme being undertaken in the country. Most of this high-speed road development programme is expected to be completed by 2015. Without complementary developments in other transport subsectors, the road safety problem could become worse. Table 3 shows the number of fatalities and injuries due to road accidents and the corresponding vehicle population from 1970 to 2007.

Table 3. Road accident statistics of India

Year	Total no. of road accidents	Total no. of persons killed	Total no. of persons injured	Total no. of registered motor vehicles (1 000)	No. of accidents per 10 000 vehicles	No. of persons killed per 10 000 vehicles	No. of accidents per 100 000 popula-tion	No. of persons killed per 100 000 popula-tion
1970	114 100	14 500	70 100	1 401	814.42	103.50	21.20	2.70
1980	153 200	24 000	109 100	4 521	338.86	53.09	22.80	3.60
1990	282 600	54 100	244 100	19 152	147.56	28.25	33.80	6.50
2000	391 449	78 911	399 300	48 857	80.12	16.15	38.60	7.80
2001	405 637	80 888	405 200	54 991	73.76	14.71	39.30	7.80
2002	407 497	84 674	408 700	58 924	69.16	14.37	38.80	8.10
2003	406 726	85 998	435 100	67 007	60.70	12.83	38.10	8.10
2004	429 910	92 618	464 600	72 718	59.12	12.74	39.80	8.60
2005	439 255	94 968	465 282	81 502	53.90	11.65	39.90	8.60
2006	460 920	105 749	496 481	89 618	51.40	11.79	41.40	9.50
2007	479 216	114 444	513 340	98 000*	48.90*	11.67*	42.40	10.10

Source: http://morth.nic.in; Transport Research Wing, Ministry of Road Transport and Highways, *Road Accidents in India 2007*.

* Estimated.

A. Scale of the problem

Table 3 shows that currently about 115,000 people are killed and another 0.5 million are injured in road traffic accidents per year. These numbers are conservative estimates, however, as some motor vehicle accidents are not reported to avoid lengthy and coercive adjudication problems. It is estimated that the country loses around 750 billion rupees (Rs) ($17 billion) per year due to road traffic accidents, which is 2-3 per cent of the gross domestic product (GDP). Casualties due to traffic accidents (which occur only one or two at a time) attract less attention than other less frequent types of natural or unnatural disasters. Table 4 compares road fatalities with many contemporary natural and man-made disasters, which are literally dwarfed by the road accident-related deaths and injuries every year. Road accidents can easily be called a silent disaster and a national mission is needed to mitigate the menace of this sociotechnical problem, just as any other epidemic requires. They are a menace with complex causes

and, therefore, a very professional comprehensive approach is needed to combat them (Sikdar, 2005).

Table 4. Comparison of casualties caused by road accidents and other disasters

Disaster (natural and man-made)	Deaths	Injuries
Bhopal gas tragedy, India, 2-3 December 1984	20 000	530 000
Latur (Killari) earthquake, India, 30 September 1993	9 000	20 000
Orissa super-cyclone, India, 29-30 October 1999	20 000	NA
World Trade Centre (9/11), USA, 11 September 2001	3 000+	NA
Bhuj (Kuchch) earthquake, India, 26 January 2001	13 800	166 800
Asian tsunami, many countries, 26 December 2004	245 000	1 000 000
Sichuan earthquake, China, 12 May, 2008	90 000	375 000
Road accidents (India), 2007	**115 000 per year**	**> 0.5 million per year**

Source: Compiled by the authors.

An estimated 0.8 billion motor vehicles are in use worldwide and India has only 100 million of those vehicles, according to the number of motor vehicles registered in 2007. About 70 per cent of the vehicle population of India is the most vulnerable (in terms of safety of operation)—two-wheelers. In comparison to the developed world, India has a low vehicle ownership rate. However, the demand for road travel is growing faster than the average income of the population or the rate of growth of GDP. Inadequate road safety provisions and poor travelling conditions (operational control and road use behaviour) have created a high level of risk in road travel. Consequently, the fatality rate per 10,000 vehicles in India is 15-20 times higher than that of developed countries. A World Bank study (2002) identified poor safety outcomes as one of the significant transport sector deficiencies in India.

The mixed traffic conditions on Indian roads is often said to be responsible for the high accident rate. The mix of the vehicle fleet in India has been changing over the last 50 years. While the share of the two-wheeler population grew considerably during the 1980s and 1990s, it has been on the decline since 2000; the population of cars, however, is increasing very quickly. The changing mix of vehicles over the decades is shown in table 5**.**

Table 5. Trends of motor vehicle growth in India (Thousands; (Percentage))

Vehicle type	1951	1981	1991	2001	2011*	2021*
Two-wheelers	27 (8.8)	2 618 (48.6)	14 200 (66.4)	38 556 (70.1)	84 480 (64.0)	160 524 (54.6)
Car, jeep and taxi	159 (52.0)	1 160 (21.5)	2 954 (13.8)	7 058 (12.8)	26 400 (20.0)	95 256 (32.4)
Buses	34 (11.1)	162 (3)	331 (1.6)	634 (1.2)	1 320 (1)	2 940 (1)
Goods vehicles	82 (26.8)	554 (10.3)	1 356 (6.3)	2 948 (5.4)	8 052 (6.1)	19 698 (6.7)
Others	4 (1.3)	897 (16.6)	2 533 (11.9)	5 795 (10.5)	10 560 (8)	14 994 (5.1)
Total	**306** (100)	**5 391** (100)	**21 374** (100)	**54 991** (100)	**132 000** (100)	**294 000** (100)

Source: http://morth.nic.in.

Note: Figures in parentheses show percentages of the total for that year.

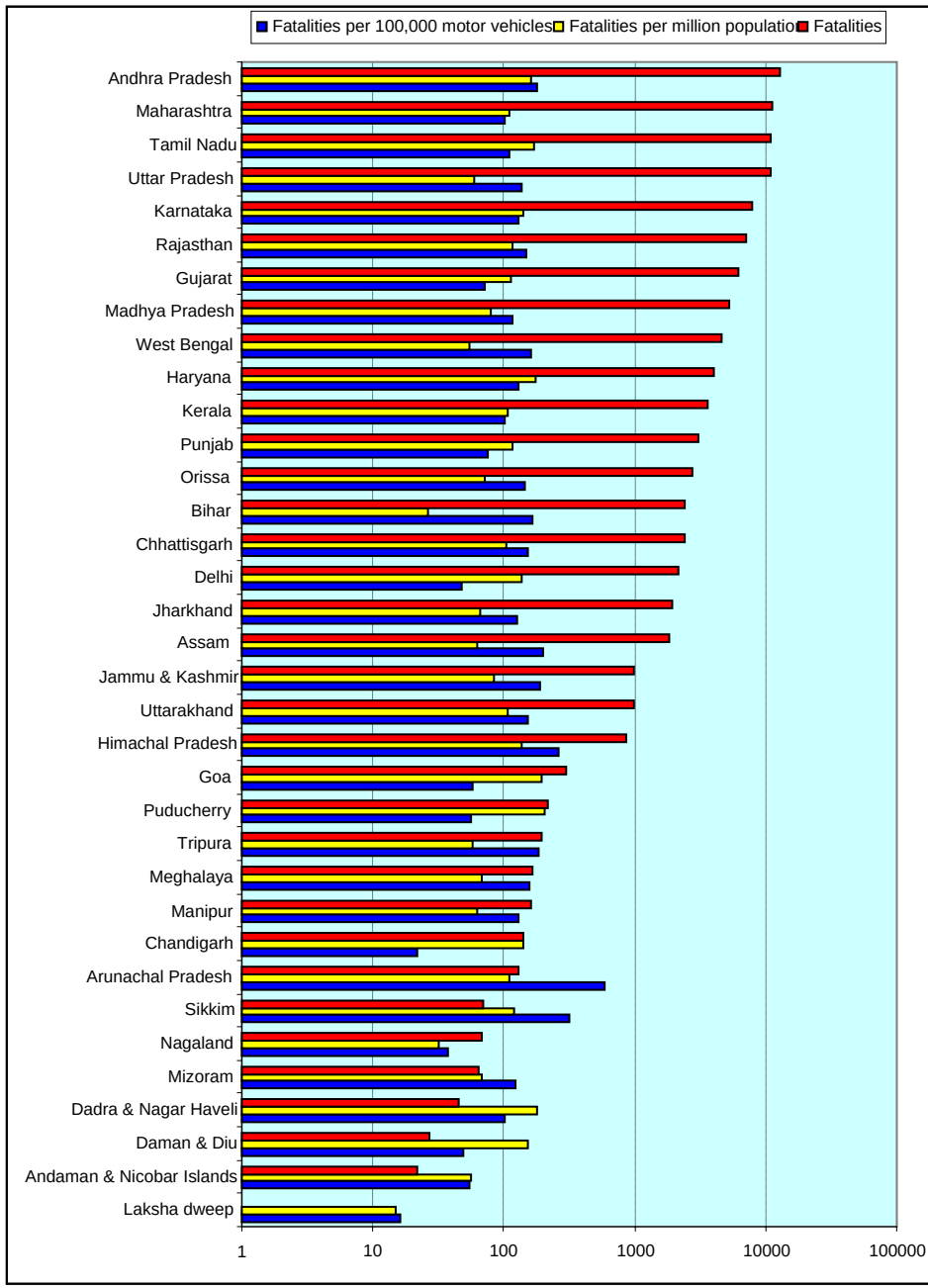
* Projection based on transport demand.

The number of accidents is generally related to traffic flow levels (i.e. exposure). This relationship is hard to establish in the Indian context, however, as the density of traffic is still very low except in major metropolitan cities. Rather, the deficiencies in engineering design and poor management of roads and traffic are mostly to blame for this problem. These deficiencies are the primary causes of this man-made disaster that wipes out a large number of people every year, equivalent to the population of a medium-sized city.

Depending on the vehicle population, road density, terrain, etc., the road accident deaths in various states of India are different. Interestingly, the number of fatalities per million population and per 100,000 motor vehicles for the majority of states in India hover around a value of 100 (as shown in figure 1). Based on total fatalities, three distinct groups of states emerge: (i) states with fatalities of over 5,000 (8 states); (ii) states with fatalities between 500 and 5,000 (13 states); and (iii) states with fatalities below 500 (14 states and Union Territories). The first group of eight states contributes 68 per cent of all road fatalities.

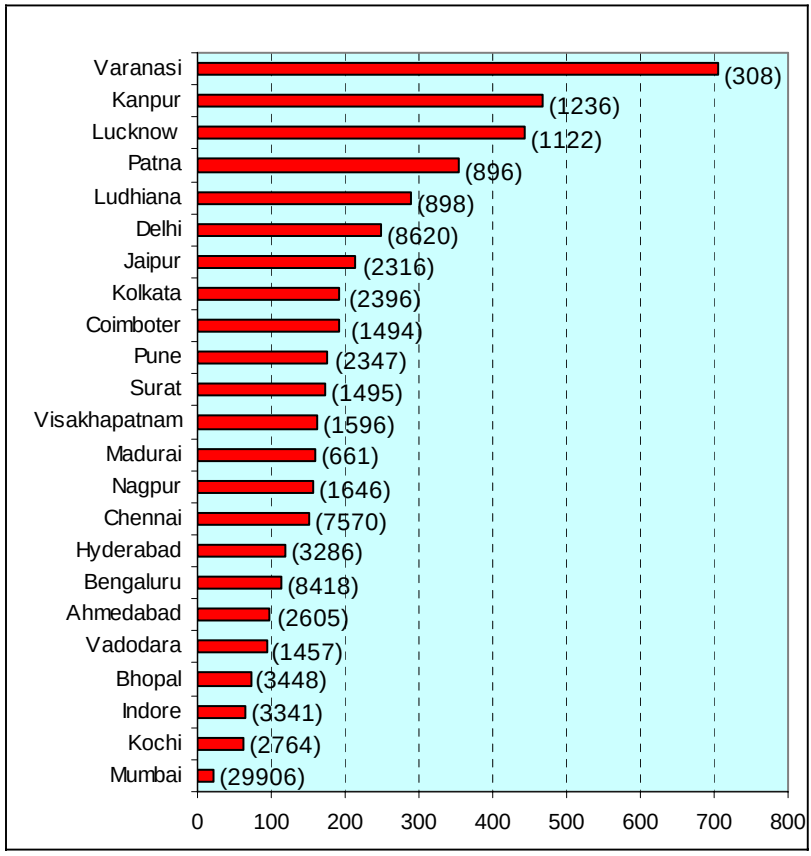
The accident data for selected cities in India reveal that four metropolitan cities (Delhi, Chennai, Mumbai and Bengaluru) except Kolkata contribute 61 per cent of road accidents in the selected cities, which is about 11 per cent of total accidents in the country. As shown in figure 2, Mumbai, with the highest number of accidents, has the lowest accident severity, while Varanasi, which has the lowest number of accidents, has the highest accident severity.

Figure 1. Road traffic fatalities per population and motor vehicles for states of India, 2006



Source: Transport Research Wing, Ministry of Road Transport & Highways, *Road Accidents in India 2007*.

Figure 2. Road traffic accident severity for select cities in India, 2007



Source: Transport Research Wing, Ministry of Road Transport & Highways, *Road Accidents in India 2007*.

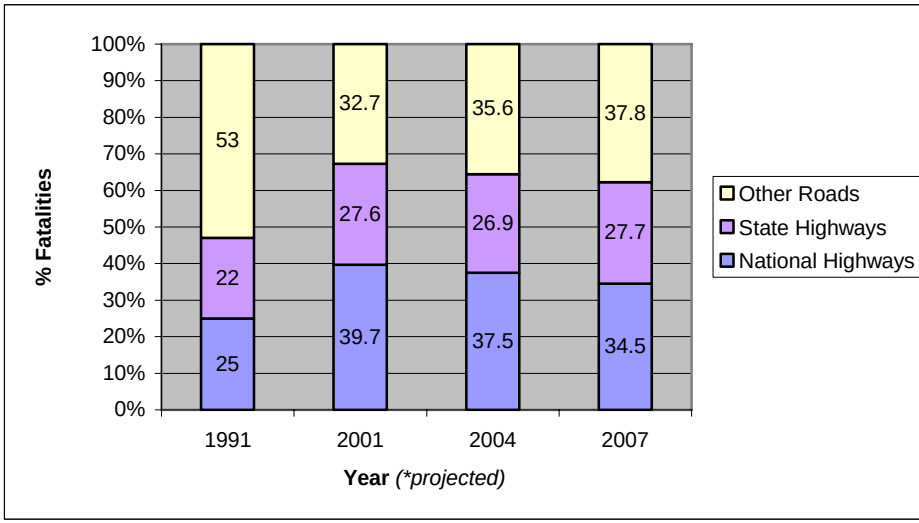
Note: Accident severity is the number of fatalities per 1,000 accidents; values in parentheses are the number of road accidents.

B. Causes and characteristics of road accidents

The main constraint in making the road network safe is that the high-speed roads are also not free from mixed traffic and they are not fully access-controlled. The slow traffic is not segregated to service roads or provided with separate lanes. Expressways are being built with full access control, but there are only a few hundred kilometres of them so far. About two thirds of the total fatalities in India occur on highways, while in such states as Haryana and Bihar, the share is as high as 82 per cent and 98 per cent, respectively. Over the last decade, the national highways and state highways (SH) have

seen dramatic improvements (although not the entire network of NH and SH) in terms of capacity (by widening to four lanes) and riding quality. Thus, the shares of fatalities on NH, SH and other roads show a changing pattern over the years, as can be seen in figure 3. The actual number of fatalities, however, is growing unabated for all types of roads.

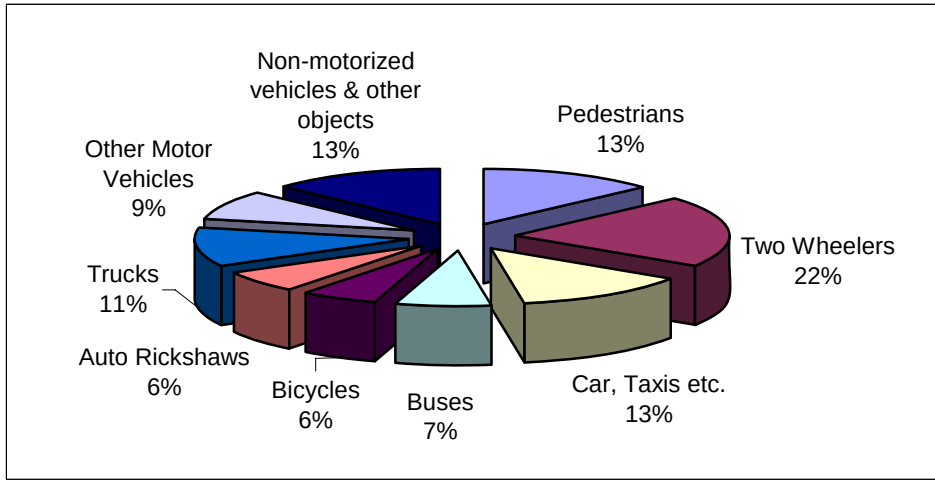
Figure 3. Share of fatalities on different types of roads



Source: Transport Research Wing, Ministry of Road Transport & Highways, *Road Accidents in India 2007*.

A conservative estimate of the ratio between deaths, major injuries and minor injuries is 1:15:70, from the pattern observed in most countries (World Report on Road Traffic Injury Prevention, 2004). Thus, even for the present lower proportion of high-speed roads, for 115,000 fatalities in road accidents, the estimates for serious and minor injuries would be 1,500,000 and 7,500,000, respectively. There is no uniform system for accident data collection and analysis followed by state and city authorities, which makes all of the available data largely unusable. Accident data are collected by the police for the adjudication of claims and for crime records, not for accident investigations. Thus, the real causes related to the accidents never get revealed for any correction or improvement focusing on road safety. The data available from the metropolitan cities indicate that 60-80 per cent of all reported fatalities are to the vulnerable road users (VRU) and in some cases, this percentage is as high as 75-90 per cent, while on non-urban roads the share of VRU in fatalities is about 50 per cent. Figure 4 shows the share of fatalities to road users in India.

Figure 4. Share of fatalities in road accidents by type of motor vehicle user/occupant (2007) in India



Source: Transport Research Wing, Ministry of Road Transport & Highways, *Road Accidents in India 2007*.

Some of the major causes of road accidents in India are:

- Absence of an inspection and maintenance regime to ensure the roadworthiness of vehicles
- Poor discipline of road users linked to level of education
- Lack of safety provisions in roads as well as poor operation and maintenance
- Primitive traffic management and poor levels of enforcement
- Mixed traffic (slow traffic sharing the same right-of-way as fast traffic).

A study sponsored by the Ministry of Road Transport and Highways revealed that about 19 per cent of fatal accidents on four-lane divided highways were head-on collisions, while pedestrians and bicycles were involved in 35 per cent of fatal accidents (Mohan et al., 2009). These findings indicate the need for stricter enforcement of traffic regulations on highways and an awareness drive for VRUs to change their behaviour.

III. ROAD SAFETY INITIATIVES IN INDIA

A. Past initiatives

Every road project has an allocation of 2 per cent of the project cost for safety. In reality, however, this budget has been used as a contingency for different purposes. Other unstructured initiatives implemented in an unplanned way and resources distributed thinly out of a small budget have not produced the desired results. The Commission for Global Road Safety (CGRS) has made a candid recommendation for an allocation of 10 per cent of the project fund for road safety features (CGRS, 2009), which deserves careful consideration.

The major initiatives of the government for safety improvement have been in the following areas:

- Road engineering through NHAI and state public work departments (PWD)
- Enforcement of traffic laws through state police
- Education and training: sporadic campaigns in print and television media, and driver training programmes through NGOs
- Accident relief: NH accident relief service and trauma care centres have been established in some areas
- Road safety audit: selected sections of NH and expressway sections have been subjected to audits, but not in all stages of development and very few of audit recommendations have been implemented
- Funding: there has been low level of funding, with Rs 520 million ($11 million) in one year (2007-2008)
- A national road safety policy was formulated at the beginning of the decade, but it has not yet been adopted

B. Ongoing initiatives

In spite of all the initiatives taken so far, the road safety situation in the country has not changed. The reason for this has been identified as the absence of an institutional set-up with implementation and enforcement teeth. The Apex Committee formed by the Government of India to address road safety has recommended wide-ranging actions, including the enactment of a national road safety and traffic management act to ameliorate the safety problems. The Committee has also recommended the creation of a national road safety board with sweeping powers on various aspects of road safety

which can be implemented through state-level boards. The recommendations include:

(a) Road-related measures—designing, setting standards and conducting audits

(b) Vehicle-related measures—prescribing safety features

(c) Road safety research—institutional linkages and training

(d) Traffic laws related to operations and management

(e) Capacity-building

(f) Road user behavioural changes through public awareness and education

(g) Medical care and rehabilitation

(h) Other functions of liaison with national and international agencies on road safety

The enactment of the law has yet to take place. The concern of the government for road safety is now visible, however. The National Highways Authority of India is aiming to take up a road safety improvement programme with multilateral funding at the national level (for the NHDP) in order to chart a new course for road safety in the country.

C. Initiatives of the India chapter of IRF

The India chapter of IRF has taken up road safety as its mission. After three successive regional conferences on the objective of enhancing road safety through better planning, design, construction and operation of highways, the 2009 conference will address accident prevention through road safety measures. Its call for a drastic reduction in road fatalities by 50 per cent in three years is being objectively targeted through planned efforts of all of the government and private agencies involved in the development and management of roads and highways. The India chapter of IRF is also working with some of the build-operate-transfer entrepreneurs to create examples of best practices in the provision of built-in safety of the highest standards, which will meet the requirements of all road users. While advocating a mandatory road safety audit (RSA) for all new roads or their upgrades, the India chapter of IRF has also recommended various ways and means to make VRUs visible in traffic streams. It has also addressed the government and automobile manufacturers concerning the mandatory provision of in-vehicle safety devices similar to those available in the developed world, and the deployment of appropriate intelligent transport system (ITS) devices to assist in enforcement.

IV. ROAD SAFETY ACTION PLAN

On the basis of the current status of road safety in India, it is clear that a national mission is required to improve road safety. It would not be possible to reverse the growing trend of road accident casualties by any short-cut or piecemeal approach. This mission must have highly ambitious and time-bound targets, championed by the highest political echelon.

It has been observed through the audit carried out along sections of NH that some unsafe road user behaviours are the fallout of unsafe or inconvenient provisions by design and operations. At the same time, it was observed that road users with higher awareness levels also showed poor road use behaviour in the absence of enforcement measures. The objectives of the high-speed multi-lane highway for faster travel will be defeated if the dangers of using such roads in an incorrect way are not understood.

A. Safety audit

Safety is to be achieved by enhancing the safety capability of each of the elements of the road-vehicle-road user system. While vehicle and roadway safety can be enhanced by engineering improvements, road user behaviour appears to be a very vast and diffused problem, which can be addressed through public education. The vehicle safety (in new vehicles) has improved significantly in recent years. The engineering safety of the road is to be pursued uniformly through road safety audits. Audits of road user behaviour are never carried out, yet they are the weakest link in the process. A behavioural audit can reveal many issues which may vary by types of road user. Usually, RSAs do not cover behavioural audits that need to be addressed.

Road safety audit

A considerable amount of resources can be deployed with the aim of reducing accidents by improving the geometries and operational conditions of the roads. This can be achieved by a road safety specialist performing an independent check on the safety elements. The specialist, after systematic examination, can comment on the safety aspects of the road. RSA appears to be an ideal technology for improving road safety in India. As basic and accurate data on accidents have yet to be collected, preventive measures through prescriptions of RSA can help in a significant way by reducing accident occurrences due to faulty road geometrics and design.

Behavioural audit

The behaviour of road users is a very important dimension of the road safety problem, especially in India. With a low level of literacy and an

even poorer knowledge of road safety, the public at large is extremely vulnerable to traffic exposure. High-speed traffic, which is otherwise legitimate for the more rapid movement of people and goods across the country, has posed a serious problem for the population and activities located close to the national highways and other high-speed roads which do not have access control. A proper road use behaviour audit can identify all the incorrect behaviours of the road users that are incompatible with modern roads, and they need to be targeted through a road safety campaign. The high-speed roads being built under NHDP pass through many villages and towns, and they create ribbon developments, which obviously cause the frequent and unsafe exposure of the inhabitants of these villages and towns to the dangers of high-speed traffic.

The incorrect behaviours might be due either to a lack of knowledge of traffic and general safety rules or to defiant behaviour regarding the rules. For example, not responding to a warning sign by a driver might be due to not understanding the meaning of the sign or to overconfidence. A survey on national highways in India (NHAI, 2008) resulted in the following important findings on non-compliance with safety requirements:

- Vehicles travel in the wrong direction (in the opposite carriageway) for a short stretch to avoid travelling the extra distance to take a U-turn at the next median opening
- Due to long hours of continuous driving without adequate rest, truck drivers feel drowsy while driving
- Women in veils and burkas are vulnerable on the road due to their limited vision
- Small children unaccompanied by adults are vulnerable, as they may exercise poor judgment
- Groups of cyclists or pedestrians walking along the road are highly vulnerable to high-speed traffic
- Road users do not use safety devices such as helmets and seat belts
- Overloading is common in vehicles carrying both passengers and goods

B. Public education-cum-publicity campaign

All unsafe behaviours should be addressed through public education campaigns. The campaign may use different mediums and be sustained over a long period of time. The frequency and intensity of the campaign seems to have a significant effect on the correction or modification of behaviours, as seen in the NHDP corridors (NHAI, 2008). As the younger population has

more reception and absorption capacity and is more likely to be moulded to safer behaviours, school curricula need to be extended to include wider coverage of social behaviour relevant to road safety. Where such contents have already been included, their effectiveness may be evaluated. Unstructured publicity for social issues carried out in a sporadic manner has no impact; only the institutionalization of the road safety education campaign can make a difference. The extensive network of schools and colleges can provide an excellent basis for establishing a road safety cell (RSC) in each of these institutions to spread the road safety messages through campaigns and various other related activities. A coordinating mechanism, such as a road safety monitor (RSM), will be required to lead the activities; it can be developed at the grass roots level to champion the cause through a bottom-up approach, as the National Service Scheme (NSS) and the National Cadet Corps (NCC) were.

C. Enforcement campaign

An enforcement campaign is an important part of any road safety action plan. It should be initiated by setting up a mechanism in liaison with the road agencies (PWD, NHAI and municipal corporations), police officials and local village administrations to enforce safe road use practices. The enforcement campaign can be designed to target the following:

- Encroachments, if any, which can be dangerous for safe traffic movements should be removed
- Parked or stopped vehicles on the highway or urban roads (at unsafe locations) are to be promptly approached for immediate removal
- Speed limits can be set based on the adjoining land use, especially in populated areas, and enforced by the police
- Blood alcohol concentration (BAC) limit enforcement is very important in the reduction of alcohol-related road accidents
- Helmet and seat belt enforcements have a salutary effect in the reduction of injuries; enforcement should be stricter
- Stricter enforcement is called for to prevent talking on mobile phones while driving and even while crossing the road as pedestrian

The concept of citizen policing to supplement the efforts of traffic police force will significantly enhance the enforcement of capacity. While traffic police cannot be deployed everywhere, alternative policing arrangements can be made available at any location. A large network of

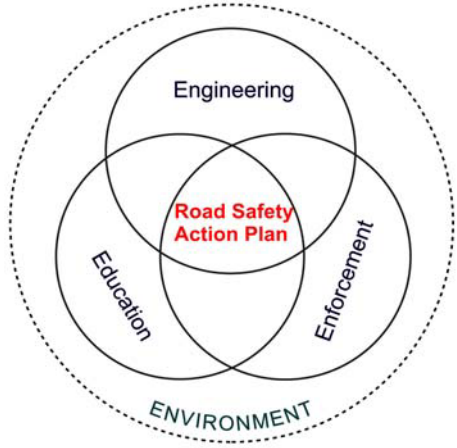
competent people (voluntarily enrolled citizens) with knowledge and training in traffic laws and enforcement systems can provide a wonderful service.

All road safety enforcement campaigns are to be taken up in coordination with a public education campaign, as the probability of behavioural change is high when the road users perceive that there is a higher chance of being detected. This campaign is to be aimed at increasing public knowledge about the traffic rules and raising awareness of increased enforcement.

D. Institutionalized effort

A well-designed road safety programme involving all of the 3 E's can bring about the desired change in the safety situation. A framework for such a programme for a typical highway corridor must be comprehensive, as shown in figure 5.

Figure 5. A conceptual framework for a road safety action plan



A realistic change in terms of a reduction in deaths and injuries is possible through a series of multi-pronged actions taken by a safety board or authority through the development and implementation of a comprehensive national road safety programme (NRSP) with the following components:

(i) Road safety monitoring and evaluation programme;
(ii) Institutional and capacity-building programme;
(iii) Road safety demonstration and awareness programme, which may include the following:

- Black-spot treatment programme

- Vehicle inspection and testing programme
- Driver training and testing programme
- Road safety audit and safety inspection
- Safety enforcement programme
- Road user education and awareness programme
- School road safety education programme
- Road accident emergency medical services programme

F. Mobilization of resources

Due to the poor safety records of the roads, the Government may create a dedicated fund to support the financing of road safety. The proposed national level road safety board is likely to have a separate budget exclusively targeted to safety outcomes. The problem has assumed such a dimension that resources from the Government alone may not be sufficient.

Additional resources may be tapped from insurance companies, automobile companies and oil giants, which can easily change the scale and speed of road safety-related activities in the country. For example, a small percentage from the compulsory third-party insurance premium for all motor vehicles can be collected in a central road safety fund for the provision of required safety features on every road. However, it is not only the shortage of the fund which has created the crisis. It is also the limited human resources and research facilities for dealing with road safety problems, which need to be addressed.

CONCLUSION

The massive road development programme of NHDP being undertaken in India is bringing huge benefits to the nation in terms of faster road travel. However, the road accident record in India is among the worst in the world, with an estimated 125,000 fatalities every year. With less than 1 per cent of the world's vehicle population, India accounts for 6 per cent of the world's road accidents and 10 per cent of the world's road fatalities. The rapid growth in vehicle ownership is closely following the highly ambitious road development plans. With plans for developing more than 50,000 km of high-speed roads without access control and adequate safety provisions and with poor road use behaviour, the consequent safety hazard is likely to be a potential threat to the entire country on the scale of an epidemic. The traffic engineering and basic enforcement and operation measures on non-urban roads in India are found to be grossly deficient and are considered to be the primary causes of accidents.

In order to mitigate the high level of risk to which the population with poor or little knowledge of road safety and safe behaviours are exposed, a

systematic action programme is required and should be undertaken as a national mission. A structured and targeted public education campaign to modify road user behaviour has to be an important component of the programme. It has also been observed that the frequency and intensity of the campaign has long-term impacts on knowledge and behaviour.

The safety initiatives in India in the past lacked objectivity and, therefore, could not make a great difference in safety outcomes. An action plan has been suggested with various ingredients from the three E's to remove the engineering deficiencies and modify road use behaviour. The Apex Committee recommendation that there should be a dedicated fund and an executive agency, such as a board, to implement time-bound targeted road safety projects is sound, as these measures can provide the necessary institutional set-up at the national and state levels. The proposed comprehensive action plan, along with the initiatives of the IRF India chapter, is likely to make a difference.

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DEVELOPMENT OF NATIONAL ROAD SAFETY TARGETS AND INTERVENTION INITIATIVES IN MALAYSIA

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ABSTRACT

Road safety is a public health problem around the world. With over 1 million people killed on roads every year, the need to address the issue cannot be neglected. In developing countries, travel risks and traffic exposures grow at a much faster rate, as the growth of registered vehicles always outnumbers population growth and new roads are constructed. By incorporating travel risk and traffic exposure factors into statistical models, the number of road deaths can be estimated, which can help in setting more realistic road safety targets. This paper provides a framework for developing countries such as Malaysia to set and evaluate their road safety targets.

Keywords: traffic exposures, statistical model, road safety target, interventions

INTRODUCTION

Road safety remains a public health problem around the globe. In a recent global status report (WHO, 2009), it has been shown that over 1.2 million people die on the road every year, and between 20 and 50 million suffer non-fatal injuries. One of the distressing findings is the fact that over 90 per cent of the world's fatalities on the roads occur in low- and middle-income countries, which have only 48 per cent of the world's vehicles. Most of the countries in the Asia-Pacific region are developing countries, including Malaysia. In Malaysia in 2007 alone, at least 6,282 fatalities were recorded; another 9,273 experienced serious injury and more than 18,000 were slightly injured (PDRM, 2007).

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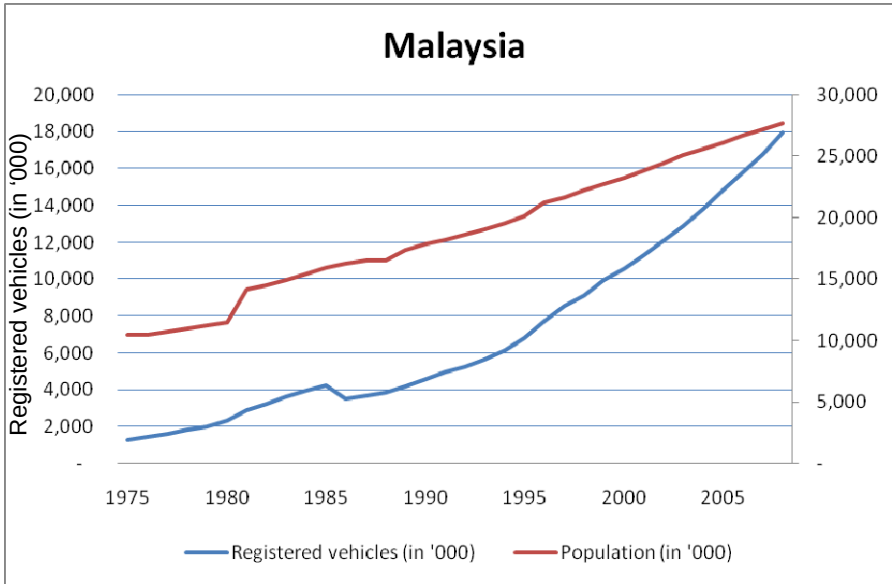
Since its independence in 1957, Malaysia has experienced a remarkable period of economic expansion and growth in population, economy, industrialization and motorization. Within a 10-year period between 1996 and 2005, Malaysian population has increased from 21.2 million to 26.4 million with an average of 2.5 per cent growth a year. It continued to increase and reached 27.2 million in 2007.

Together with the population growth, the number of registered vehicles has also grown to fulfil the need of mobility. The ability to move is a key to keep people connected and to conduct their activities. Over a period of 38 years (1970-2008), the number of registered vehicles has increased from 669,294 vehicles in 1970 to over 17.9 million in 2008. Between 1996 and 2005, an average annual growth of 8 per cent of registered vehicles was recorded. Rapid economic growth and population expansion over the past two decades have led to a tremendous increase in the level of motorization in Malaysia. Figure 1 illustrates the trend in population and motorization growth for the study period.

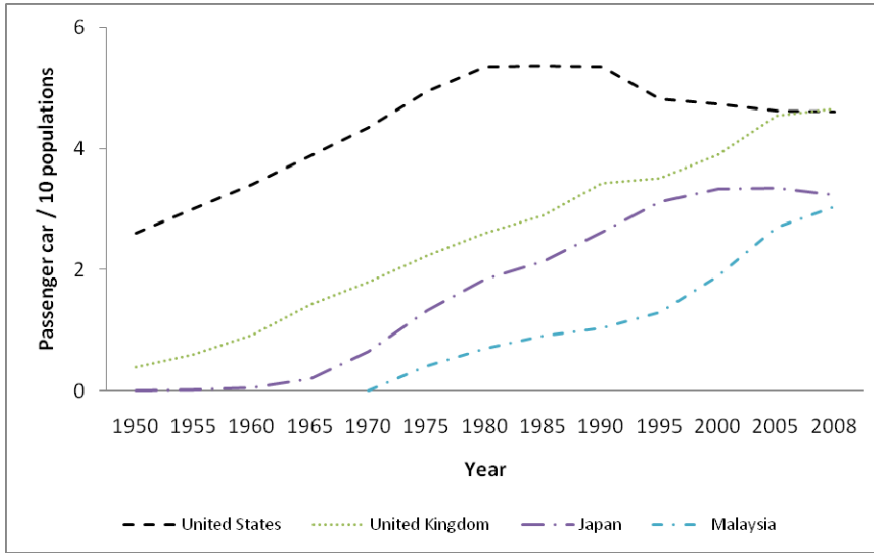
Figure 1. Population and number of registered vehicles in Malaysia



Generally, the motorization growth follows an “S” curve where at an earlier stage it grows exponentially and saturated when it reaches to the level of about one vehicle for every two persons. Koonstra (1993) developed an

exponential model for Malaysia's vehicle ownership for 2020. He estimated that in 2000 almost 10 million vehicles would be registered. The estimate was not very far off, as Malaysia had 10.5 million registered vehicles in 2000. Koonstra also estimated that Malaysia would experience the saturation level in 2018 with an estimate of one vehicle for two persons.

Figure 2. Passenger vehicles ownership rate



Sources: United States of America: http://www.fhwa.dot.gov/pubstats.html U.S Department of Transportation, Federal Highway Administration, accessed on 20 August 2009; United Kingdom of Great Britain and Northern Ireland: http://www.dft.gov.uk/pgr/statistics/datatablespublications/vehicles/licensing, accessed on 20 August 2009; Japan: Motor Vehicle Statistics of Japan 2009, Ministry of Land, Infrastructure and Transport (Annual/English), accessed from http://www.jama-english.jp/publications/MVS2009.pdf on 20 August 2009; Population figure: www.census.gov/, accessed on 20 August 2009; Malaysia: Highway Planning Unit (2007). Road Traffic Volume Malaysia 2007. Kuala Lumpur, Malaysia.

Figure 2 shows the comparative vehicle ownership growth curves for Japan, Malaysia, the United Kingdom of Great Britain and Northern Ireland and the United States of America. Compared with other countries, Malaysia appears to be still in the growth trend part of the curve. For being in the explosion zone it simply means that the Malaysian drivers have higher risk due to high exposures. In fact, more vehicles created more demand for new roads and highways. The combined effort of the increase in population, motorization and infrastructure has led to a rapid increase in the number of road traffic accidents.

As Malaysia is in the explosion zone, where registered vehicles and population growths are high, a linear model seems to be inappropriate to capture road accident fatality. Linear models may be considered for the developed countries which have reached the saturation level. Malaysia needs to consider an exponential model. Modelling road accident fatality is important to forecast the future situation which helps in setting the road safety targets.

I. SETTING THE NATIONAL ROAD SAFETY TARGET

Road safety targets need to be established to help offset the increasing trend of accidents and fatalities. Setting road safety targets is important, as they establish the foundation for considering road safety plans and interventions. In addition, road safety targets provide the framework for federal, state, district and local governments and others to undertake road safety initiatives. An improvement in road safety is achievable if appropriate road safety targets and a time frame for their achievement are set.

In setting the targets, a linear model is normally used to predict road accident fatalities and accidents in the developed countries. This method may also be appropriate for developing countries in which the growth in motorization is at the initial stage of the S-shaped curve. However, for high-growth developing countries, the motorization level is in the explosion zone where vehicle growth is rapid. A linear model is not suitable to capture the rapid growth of motorization and is not suitable for use as a foundation to set road safety targets.

The rapid expansion of the road network and the growth in population and motorization in Malaysia have made the setting of road safety targets a rather challenging task. Time series models have been used to forecast the number of fatalities and accidents on the road. Despite their ability to capture trends, time series models usually need a longer series in order to make reliable forecasts. In developing countries, where road safety is relatively new and data are scarce, employing time series models is rather challenging. Data are available only for short series, even data on traffic exposure, such as annual vehicle kilometres travelled (VKT) by road users may not exist, which makes the modelling exercise difficult. Considering such data limitations, appropriate proxy exposure data and dummy variables are used to develop such models.

In setting realistic road safety targets based on these models, a number of methods are available. The first method is setting the targets by using base-year figures. Comparison and analysis is made by using a particular year as a base period. Australia, for example, has set targets to

achieve a reduction in the number of fatalities from 9.3 per 100,000 population in 1999 to no more than 5.6 per 100,000 population in 2010 (Law et al., 2005). The second method is by establishing index figures. Three indices are being benchmarked internationally. They are: (i) fatality per 10,000 vehicles; (ii) fatality per 100,000 population; and (iii) fatality per 1 billion VKT. The third method involves setting an absolute number, where number of fatalities or accidents reduction is clearly defined.

In the Malaysian context, road safety targets are set by benchmarking road safety performance by comparing the results between: (i) the projected value of accidents and fatalities without any intervention; and (ii) the projected value of accidents and fatalities with road safety interventions.

The projected value without any intervention is defined as business as usual (BAU), while the projected value with intervention being introduced is known as the intervention model. This method seemed to be more feasible as fatality reduction could be projected through the use of the earlier fatality model, and the life savings could be estimated through the known reduction of each road safety intervention introduced (Radin Umar, 1998). By estimating potential life savings by each road safety intervention, more realistic values for the road safety targets can be set. For example, it was forecasted that by year 2000 there would be a total of 9,127 deaths due to road accidents. However, with the introduction of road safety intervention planned by the government in 1997, it was estimated that deaths would reduce by 30 per cent to 6,389 in 2000.

II. EVOLUTION OF SAFETY TARGETS IN MALAYSIA

Early works of modelling road deaths in Malaysia started with the development of a simple linear model by Aminuddin and Radin (1990). In the mid nineties, Rehan (1995) proposed an improved model, similar model to Smeed's as the following:

$$Death = 0.08193\ (population \times number\ of\ vehicle)^{0.333}$$

From the above model, Rehan projected 5,067 deaths in 2000, with estimated exposures of 23 million people and 10 million vehicles by that year. However, the increase in road length, especially after the opening of a new expressway[1] in 1994, and the phenomenal increase of vehicles required a

[1] The North-South Expressway starts at Bukit Kayu Hitam in the north and ends in Johor Bahru in the south, linking all major cities on the west coast of peninsular Malaysia between Thailand and Singapore. In addition, two other adjoining expressways make a total of 847.7 km

revision of the model. Based on the actual figures of population and number of vehicles, Rehan's model forecasted a much lower figure in comparison with the actual deaths.

Radin and Hamid (1998) found that the rate of infrastructure growth in both roads and highways were highly correlated (with r = 0.95). To improve the model, another two explanatory variables (road length and the effect of standardized accident data) were added (see table 1). Additional data coverage for Sabah and Sarawak in 1981 required new data interpretation.

Table 1. Definition of traffic exposure variables in Radin's model

Variable	Details	Unit
Death	All deaths within 30 days due to road accident as reported to Royal Malaysian Police	Number of people killed
Population (P)	Population figure as reported by Statistics Department, Malaysia	Millions
Vehicle (V)	Number of registered vehicles from Vehicles Registration Department	Millions
Road (R)	Road length from Public Works Department	Thousands of kilometres
System	Changes in accident recording system	0: Peninsular Malaysia only 1: Peninsula, Sabah and Sarawak

With these additional explanatory variables, Radin developed an exponential model to explain fatalities in Malaysia as follows:

$$Death = 2289\,(e^{0.0000\,vehicle.population.road})\,(e^{0.207\,system})$$

Multivariate time series modelling was also applied to estimate fatalities in Malaysia. Many previous studies have used log linear modelling following Poisson distribution considering the nature of accident data, which fall under count data. This was necessary after considering the exponential growth in exposure variables. Some of the earlier studies (Radin et al., 1996;

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of inter-urban toll highways referred to as the North-South Expressway. Constructed in phases over a period of seven years, the North-South Expressway was officially opened on 8 September 1994 by the then Prime Minister of Malaysia, YAB Dato' Seri Dr. Mahathir Mohamad, signalling the beginning of the age of Malaysia's road transport system. (http://www.plus.com.my/)

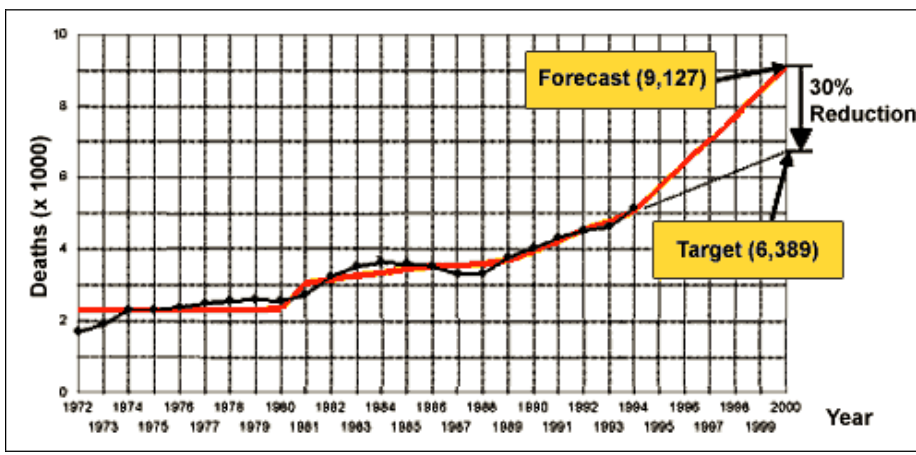
Homel, 1994; Maycock and Summersgill, 1994) also found that the shape of this model was suitable in explaining accident count although it required some corrections caused by over dispersion. To overcome the problem of over-dispersion, Radin used the "quasi-likelihood" method proposed by McCullagh and Nedler (1983). Table 2 shows the uncorrected and corrected models for road fatalities in Malaysia.

Table 2. Uncorrected and corrected models for road fatalities in Malaysia

Final model	Explanatory variable	Estimates	Standard errors	Residual deviance	Degree of freedom	Dev. diff	t-values	Sig at alpha 0.05	Mean deviance
Uncorrected	Constant	7.736	0.00693	5750.2	22		116.3	Yes	261.4
	Record	0.2073	0.01163	1763.0	21	3987.2	17.8	Yes	83.9
	System VPR	0.00007	1.92e-06	456.1	20	1306.9	36.4	Yes	22.8
Corrected	Constant	7.736	0.03245	261.9	22		238.4	Yes	11.9
	Record	0.2073	0.05450	143.1	21	118.8	3.8	Yes	6.81
	System VPR	0.00007	8.98e-06	20.7	20	122.4	7.8	Yes	1.03

Using the above model, the projected death figure for year 2000 was established. The model predicted some 9,127 deaths in 2000 if traffic exposure increased to the projected levels of 23.2 million population, 10 million registered vehicles and 72,400 km of road length. As such, to offset the forecasted figure of 9,127 deaths, it was decided that the business as usual (BAU) approach should be changed. Intervention programmes were formulated and government commitment was obtained in reducing the forecasted deaths. The road safety committee decided to maintain the earlier 30 per cent reduction target from the base year approach to the interventional approach, as shown in figure 3.

Figure 3. Fatality model and safety target in Malaysia



Pursuant to the target, various initiatives and interventions were carried out at the national and community levels. They included motorcycle safety programmes (MSP), pedestrian safety programmes (PSP) and car occupant safety programmes (CSP), with a special focus on behavioural modifications and a safe road system. An integrated road safety programme was introduced to prevent and reduce future road accidents, as well as to reduce injuries during and after accidents. Strategies were categorized into exposure control, crash prevention, crash reduction, behavioural modification, and injury control and post-injury programmes. Among the new initiatives were the following:

(i) The National Accident Database System
(ii) The Five Stages Road Safety Auditing
(iii) The National Blackspot Programmes
(iv) Road Safety Research and Evaluation
(v) Conspicuity Initiatives for Motorcycles
(vi) National Targeted Road Safety Campaign
(vii) Revision of the Road Transport Act (1999 Revision)
(viii) Integrated Enforcement
(ix) New Helmet Standard MS1, 1996
(x) New Children's Motorcycle Helmet Initiatives

In 2000, there were 6,035 reported road deaths, 5 per cent less than the target of 6,389.

Following the success of the earlier interventions, a new reduction target from 4.9 accident deaths to 4 deaths per 10,000 vehicles in 2010 was announced in 2002. This was based on the Autoregressive Integrated Moving Average (ARIMA) model developed by Law et al. (2005). The vehicle ownership rate was forecasted using the Gompertz growth (Dargay and Gately, 1997) and the ownership rate model was:

$$V_t = \theta\left(\gamma e^{\alpha e^{\beta GDP}}\right) + (1-\theta)V_{t-1}$$

Where V_t = rate of vehicle ownership at time t

θ = adjustment of vehicle ownership and per capita GDP growth

γ = the asymptotic vehicle ownership as time, t increases indefinitely

Parameters α and β are curvature parameters to be estimated. The data for the Gompertz growth model were fitted by using the Marquardt-Lebenberg algorithm. The goodness of fit was checked by estimation of the regression coefficient, coefficient of determination (R-square) and the p-values for the

parameters. Table 3 summarizes the results for the vehicle projections model.

Table 4. Estimated parameters of vehicle ownership model

Parameter	Parameter Definition	Coefficient
θ	Speed of adjustment	0.2671
γ	Saturation level	0.9621
β	Shape or curvature of the function	90.8862
α	Shape or curvature of the function	2.2921
R-square		0.9612

The high R-square value (0.9612) indicated that the Gompert growth model fitted the vehicle ownership well. The adjustment parameter, θ of 0.267 indicated that 26.7 per cent of the total response V_t could be attributed to per capita GDP changes at a particular year. The estimated saturation level was 0.96 vehicles per person, which would be achieved when per capita GDP reaches 66,000 Malaysian ringgit (RM) per year. GDP was assumed to increase by 2.2 per cent per year, resulting projections of 0.4409 vehicles per capita in 2010.

The ARIMA model was then used to model the road accident deaths for 2010. The advantage of ARIMA lies in its ability to analyse longitudinal data with the presence of correlation among the neighbouring data, which is usually found in time series data. Based on the auto-correlation function and partial auto-correlation function plots, the following ARIMA model with transfer noise function was established (Law et al., 2005).

$$Y_t = 3.0332 + 2.0694 \times 10^{-8} X_{1t} + 1.8825 X_{2t} + \frac{N_t}{(1 - 0.4288B^2)}$$

where Y_t = road accident death rate

X_1 = population number

X_2 = vehicle ownership

N_t = stochastic component

B = backshift operator[2]

[2] Backshift operator is a useful notational device used when differencing is performed, denoted by B or sometimes, L. The operator B is used to indicate the number of backward steps a time-series value may take. For instance, when the operator is applied to y_t, then $By = y_{t-1}$. This means that the data point y_t is shifted backward by one time period. (Mohd Alias Lazim, 2007).

The above model predicted that the death rate per 10,000 vehicles would steadily decrease from 4.9 deaths per 10,000 vehicles to 4.22 in 2010, at an average decline rate of 2.14 per cent per annum. However, due to intervention programmes which were in place by early 2006, the actual death rate per 10,000 vehicles reached 3.98, which was better than expected. A brief account of the programmes is highlighted in section III.

Due to this encouraging trend, in 2006, an ambitious National Road Safety Plan 2006-2010 (Road Safety Department, Malaysia, 2006) was introduced with following new revised and challenging targets:

(a) To reduce 52.4 per cent of deaths per 10,000 vehicles from 4.2 in 2005 to 2.0 in 2010;

(b) To reduce deaths per 100,000 population from the existing 23 (2005) to 10 deaths;

(c) To reduce deaths per billion VKT from the current 18 (2005) to 10 deaths.

As at end of 2008, the index values stood at 3.63 per 10,000 vehicles, 23.5 per 100,000 population and 17.3 per billion VKT. It may be noted that, the Malaysian road safety targets changed as and when new data were available. In the log linear model developed earlier, Radin (1998) used the VPR variable - a product of vehicles, road and population - as a proxy variable to measure exposures. Ideally, the exposure should be measured by calculating vehicle kilometres travelled. It is a method intended to measure the exposure patterns among Malaysian drivers including motorcycle riders. Recognizing the importance of VKT as a measure of exposure or risk, Malaysia has started collecting data for VKT since 2007.

III. STRATEGIC INTERVENTION PROGRAMMES

Motorcyclists are the most vulnerable road users. Each year, motorcycle fatalities make up more than 50 per cent of the total of road accident fatalities in Malaysia. One of the main reasons for their vulnerability is due to the exposed body regions and little protection offered by motorcycle safety devices during a collision. For example, approximately 80 per cent of the reported motorcycle crashes resulted in injury. In addition, the overall relative risk of motorcyclist deaths in Malaysia is about 20 times greater than that of passenger cars (Radin Umar et al., 1995).

In an in-depth study of 186 fatally injured motorcyclists derived from police and post-mortem reports (Pang et al., 2000), it was reported that 133

(71.5 per cent) motorcyclists had been certified dead at the scene of the accident. A further 47 (25.3 per cent) motorcyclists had died less than 3 hours after their crash. Injuries to the head, cervical spine, chest and abdomen have the greatest probability of being fatal. About one third of these injuries were the result of more than one severe vital organ injury causing death.

In view of the high incidence of fatalities and injuries among motorcyclists, any steps taken to reduce such fatalities and injuries were therefore considered important. The promotion of a motorcycle safety campaign and awareness was of primary concern to help and protect motorcyclists.

A. National motorcycle safety programme

The Road Safety Research Centre (RSRC), Faculty of Engineering of Universiti Putra Malaysia, was appointed by the Ministry of Transport Malaysia in 1997 to conduct research on motorcycle safety programme in Malaysia. In their first research report, Radin Umar et al. (1998) identified the major problems related to motorcycle accidents in Malaysia. This report was based on over 6,000 detailed crash data involving motorcyclists in Malaysia. Based on the analysis, the following programmes were implemented:

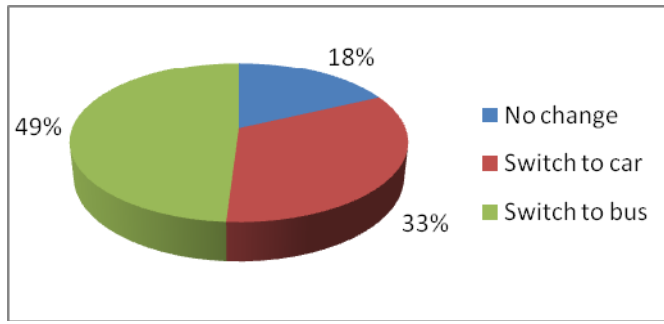
- Exposure control programme
- Conspicuity programme
- Behaviour modification programme
- Road engineering programme
- Injury control programme

B. Exposure control programme

Motorcyclists may suffer severe injuries during collisions, even at low speeds. This is supported by the fact that motorcycles are relatively less stable, physically more exposed to bodily impact and offer little protection to its riders/pillion. Thus, encouraging them to reduce their exposure, for example by using a safer mode of transport, would be an attractive approach to minimizing injuries among motorcyclists. Significant gains in traffic safety could be accomplished by shaping public policy in a way that actually reduces the amount of travel, or that substitutes less safer modes by safer modes of travel.

Universiti Putra Malaysia has conducted a survey on motorcycle commuters' receptiveness towards various policy changes, such as improvements to passenger transport, increase in the cost of insurance and change in vehicle ownership. The survey showed that factors such as improvement in bus travel time, increase in household car ownership and increase in insurance policy had potential to decrease the probability of motorcycle being the mode of choice. A descriptive analysis of the data has also shown that an increase of RM 100 in the insurance fee would result in about 48.6 per cent of the respondents changing to bus, 32.4 per cent switching to car and 18 per cent not changing their current commuting mode.

Figure 4. Effect of insurance premium on switching behaviour



C. Conspicuity programme

The conspicuity programme involved the day-time headlight programme, the reflective stripe initiative and the reflective vest and light-coloured clothing campaign. Throughout the programme, the day-time headlight programme was shown to be the most effective. A nationwide day-time headlight campaign was carried out in July 1992 and was followed by the establishment of a regulation on the compulsory use of headlights in September 1992. This initiative was the outcome of earlier research (Radin Umar et al., 1995 and 1996) that revealed the phenomenon of looking but failing to see during the day, especially when motorcyclists were at the peripheral vision of the other drivers.

The detailed analysis of the impact of the day-time headlight intervention to conspicuity-related motorcycle (MSTOX) accidents in Malaysia has been reported by Radin Umar et al. (1995a). In this analysis, MSTOX accidents were defined as all accidents involving motorcycles travelling straight or turning on right-of-way and colliding with pedestrian or other vehicles. The data structure and definition of variables involved are shown in table 4. Both univariate and multivariate analysis were used and the

best fit or parsimonious model ($p < 0.01$) to explain conspicuity-related accidents per week was:

$$MSTOX = 6.265[e^{0.008\,WEEK}][e^{0.337\,RECSYS}] X [e^{0.340\,FAST}][e^{-0.341\,RHL}]$$

Table 4. Data structure and definition of variables involved

Explanatory variable	Description	Two-level factors	Coding system	
WEEK	Week of the year	NA		1,2,3,…,156
RECSYS	Recording system used	2	(1)	Trial form + old form
			(2)	POL 27 (Pin 1/91)
FAST	Fasting in Ramadhan	2	(1)	Not fasting week
			(2)	Fasting week
RHL	Running headlights	2	(1)	Before intervention
			(2)	After intervention

This model revealed that the headlight intervention reduced MSTOX accidents by about 29 per cent. In terms of number, about 800 fewer motorcycle accidents were estimated from this intervention.

D. Behaviour modification programme

This approach involved systematic and targeted behaviour modification programmes directed at young motorcyclists. Under the seventh Malaysia Plan, a total of nine television commercials on strategic safety issues related to motorcyclists were produced and aired to the public. The campaign concentrated on "tactical issues" related to motorcycle day-time and night-time rear conspicuity, proper use of helmets, injury risk during crashes and the effects of speeding and weaving problems.

Since the implementation of the campaign, in-depth research has been carried out on the impact of the campaign on: (i) public understanding and acceptability; (ii) the compliance of targeted road users with safety propositions; and (iii) the effects of the intervention on accidents and casualties. Ahmad Hariza et al. (1999a, 1999b and 2002) found that:

(i) Over 82.7 per cent of motorcyclists heard the motorcycle campaign;

(ii) 78 per cent of the 750 respondents were able to recall the slogan;

(iii) 97 per cent agreed with the message of the campaigns;

(iv) 90 per cent claimed that they do follow the campaign propositions.

Monthly monitoring on helmet and clothing compliances has also been carried out. The study showed a significant ($p < 0.05$) increase in the proper usage of helmets, from 44 per cent before the campaign to 66 per cent after the campaign. The use of light-coloured clothing also increased significantly ($p < 0.05$) following the intervention.

E. Road engineering programme

There were a number of initiatives carried out under the road engineering programmes. Among these were the exclusive motorcycle lanes, paved shoulder and end treatment of non-exclusive motorcycle lanes.

Research undertaken by Universiti Putra Malaysia (Radin Umar et al., 1995b and 2000; Radin Umar and Barton, 1997) on exclusive motorcycle lanes revealed that:

(i) Reduction in motorcycle accidents was highly significant ($p < 0.05$) following the opening of an exclusive motorcycle lane, with an average reduction of about 39 per cent ($1 - e^{-0.471}$) based on the equation:

$$Link\ motorcycle\ accidents = 4.2 \times 10^{-8} \times Q^{3.314}\ exp^{-0.471 LANE}$$

where Q and LANE are defined in table 5;

Table 5. Data structure and definition of variables involved

Explanatory variable	Description	Two-level factors	Coding system
Q	Total traffic flow per month	NA	Flow X (10 000)/month
LANE	Effect of the motorcycle lane opening (18 Dec 1993)	2	(1) Before opening (2) After opening

(ii) Fatality reduction among motorcyclists was highly significant ($p < 0.05$) with a marked reduction of 83 per cent;

(iii) Benefit-cost ratio of providing an exclusive motorcycle lane ranged from 3.3 to 5.22, suggesting that the provision of exclusive motorcycle lanes was highly cost-effective in containing motorcycle accidents.

Under this initiative, a combination of exclusive and non-exclusive motorcycle lanes will be constructed depending on areas, access points, capacity and road corridors.

F. Injury control programme

Injury reduction measures need to be comprehensive to be more effective. They must involve the application of appropriate safety policies, vehicle and road engineering measures and medical and trauma management. These may be achieved by five distinct strategies, namely exposure control, crash prevention, behaviour modification, injury control and post-injury trauma (Trinca et al., 1998). Among the appropriate programmes planned under the injury reduction strategies were the revision of helmet standards (MSI-1996), a new helmet design for children and a campaign on the proper use of helmets.

In addition, research was undertaken on the design of motorcycle guard-rails. The safety performance of the existing guard-rail was evaluated through the investigation of potential injury risks to motorcyclists as well as the influence of impact speed and impact angle on the dynamic impact responses of the motorcyclists when colliding with the W-beam guard-rail.

G. Discussion and conclusions

There are various methods in setting up the national road safety target. As a developing country, where registered vehicles growth always outnumbers its population growth, linear models may not be suitable. Malaysia employed exponential model in modelling road deaths. A log linear model was developed using a series of independent variables namely VPR and data system. VPR was used as a proxy to exposures, as data on VKT were not available. VKT measures exposures accurately, as it takes into account the distance travelled by drivers.

The road death targets were set by comparing business as usual (BAU) and intervention models. Target setting was important as it provided the framework to consider appropriate interventions. In Malaysia, it has shown that interventions supported by Government commitment can help in reducing the number of deaths. A series of intervention programmes implemented is also discussed in this paper.

The yard-stick used for road safety progress in Malaysia is key performance indicator (KPI). There are 15 areas covering all aspects of road safety such as enforcement, legislation, road safety research, data management and others which still need to be evaluated. On the road safety research for example, Malaysia has surpassed the target by 80 per cent. This involved getting the research funding, conduct relevant research to reduce road fatalities and translating it into interventions. Monitoring existing countermeasures is also an area in which Malaysia is continuously working on.

The success of road safety is not based on reductions in total road deaths only; it also takes into account fatality indices, which include accident deaths per 10,000 vehicles, accident deaths per 100,000 population and deaths per billion kilometres travelled. Even though Malaysia managed to achieve its target in overall deaths, the success of this reduction should not cause excessive joy. Malaysia is still far behind the world standard, which is below 2 deaths per 10,000 vehicles, 10 per 100,000 population and 10 per billion VKT. The latest initiatives on the safe system approach and the recognition of zero fatality vision in Malaysian safety programmes is another milestone for Malaysian road safety improvement. It is hoped that this paper will provide some guidance for other developing countries in setting their own road safety targets and intervention programmes appropriate to their problems.

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EFFECTIVENESS OF SPEED ENFORCEMENT IN THAILAND: CURRENT ISSUES, NEED FOR CHANGES AND NEW APPROACHES

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ABSTRACT

Thailand has experienced a rapid growth in motorization. Consequently, speeding that prevails on highways and on roads in built-up areas has been found to be a key contributory factor to road traffic crashes. Although speed enforcement has been included as an integral part of the speed management policy, its effectiveness has been limited for a number of reasons. This paper identifies some gaps in knowledge concerning the speeding problem and the current practice of enforcement. Issues that need to be addressed for more effective speed enforcement as well as the potential alternative speed management strategies are discussed.

Keywords: speed enforcement, road accidents in Thailand

INTRODUCTION

One of the great benefits of modern road transport is the reduction of journey times by motorized vehicles. However, the level of speed that make possible these improvement in journey times have adverse effects in terms of energy consumption, environmental costs, and the occurrence of road crashes and consequent deaths and injuries (Allsop, 1998). The road crashes due to speeding imply the need to control vehicle speeds for improving road safety, despite encountering an enhanced capability of modern cars to go faster and an increasing demand to build roads with a higher standard of speed. As such, it is the management of speed that has become one of the challenges for policymakers and road safety professionals around the world.

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Thailand has experienced rapid growth in motorization with the development of modern road infrastructure over the past decades. Consequently, speeding that prevails on rural highways and on roads in built-up areas has become a key contributory factor to road traffic crashes. Traffic law enforcement has been included as an integral part of the country's speed management policy. Since the Land Transport and Highways Acts were enacted, and the speed limit regulation was introduced in 1979, the Highway Police Department has the responsibility to enforce speed limits on national highways located outside cities. Physical policing has been the most common method used for speed enforcement on highways, though it is not undertaken on a regular basis. Speed offenders on the highways are detected by means of radar guns and they are immediately stopped by the highway police. For streets and highways in cities and metropolitan areas where regular police officers have been given the authority, it is sadly true that enforcement of speed limits has not been in practice, due partly to lack of speed enforcement equipment and training.

Apart from enforcement, speed management initiative also involves public education campaign which has been undertaken by various stakeholders. Information on the danger of speeding has been communicated to the public through media releases, featured articles, on-street boards and posters, government publications and websites. Yet, such publicity measures are neither carried out in a regular and coherent manner nor expressly designed from a perspective of supporting speed enforcement activities. The engineering approach taken as part of speed management measures on streets and highways mainly involves installing rumble strips to alert drivers that they are about to enter potentially high crash-risk areas. As the design and installation of such strips are not standardized, the question whether these strips contributed to any appreciable reduction in vehicle speeds still remains to be unanswered.

It seems that to some extent Thailand's speed management policy has to rely heavily on speed limit enforcement. Enforcing the speed limit influences speeding behaviour through its deterrent effects on the public at large and on the speed violators who actually get apprehended. While the effectiveness of speed enforcement in Thailand has rarely been examined, it is bound to be controversial for a number of reasons, including the existence of a large number of speeding-related accidents, the high prevalence of speeding behaviour, limited understanding of speed regulations and the negative public attitude towards the existing speed enforcement programme. Drawing upon evidence from relevant data and findings revealed by previous research, this paper attempts to identify some gaps between existing speeding problems and the current practice of speed enforcement in Thailand, which in turn offers important lessons that could be relevant for other developing countries with similar problems and institutional arrangements.

In the next section, the extent and nature of the problem of speeding in road traffic crashes are discussed. This is followed by a review of survey evidence on the frequency of speed limit violations, which could serve as an indication of the need for more effective speed enforcement. In section III, some obstacles to the effectiveness of the current practice of speed enforcement have been identified that needs to be taken into account for better speed compliance. Finally, the potential of alternative speed management strategies for Thailand is briefly discussed.

I. SPEEDING INVOLVEMENT IN ROAD TRAFFIC CRASHES

Data from the accident databases maintained by the Royal Thai Police and the Department of Highways (DOH) are primary sources of information that have been used to understand both the extent and nature of the speeding-related accidents in Thailand. The police data generally provide a summary of the number of vehicles involved, the number and gender of victims, estimated costs of property damages and probable causes of traffic accidents on all types of roads for the whole country by province. The data are gathered from police stations throughout the country and are available only in aggregate form. The highway accident database, despite being limited to reporting statistics for traffic accidents on highways under the responsibility of the DOH, is a partially computerized system and provides richer information. The data maintained by DOH are collected for each accident case, containing information on traffic crash events such as the location and probable cause of accident, type of accident, type and severity of injuries, date and time of occurrence, the number of vehicles involved, weather condition, etc. Nevertheless, it is important to note that the information on the cause of accidents in the DOH database does rely heavily on the police accident reports, where the identification of probable cause of crash events by police officers is questionable due to lack of training and standardized practice (Suriyawongpaisal and Kanchanasut, 2003), and considers mostly human factors (Tanaboriboon, 2004).

According to the police data for the period 2001-2007, speeding contributed to 15-23 per cent of all police-reported accidents on all types of roads (see table 1). When examining data for traffic accidents on national highways, which constitute about one fourth of the total road network, a different picture emerges. For the years 2001-2007, speeding involvement has been reported to be as high as nearly 80 per cent of all traffic crashes on national highways. This comes as no surprise as driving at high speed is more common on highways, compared to local roads and urban streets. In addition, the proportion of highway accidents due to speeding has risen in the recent years.

Table 1. Speeding-related crashes in Thailand, 2001-2007

Year	All types of roads		National highways	
	Total accidents	Speeding-related accidents (percentage)	Total accidents	Speeding-related accidents (percentage)
2001	77 616	17 156 (22)	15 341	12 060 (79)
2002	91 623	20 896 (23)	15 066	11 832 (79)
2003	107 565	21 259 (20)	15 171	11 683 (77)
2004	124 530	21 332 (17)	18 547	13 035 (70)
2005	122 040	18 349 (15)	16 287	11 910 (73)
2006	110 686	19 036 (17)	12 918	9 754 (76)
2007	101 752	17 278 (17)	13 655	10 581 (77)
2001-2007	735 812	135 306 (18)	106 985	80 855 (76)

Source: For all types of roads, Royal Thai Police; for national highways, Department of Highways.

Speeding is also the leading cause of fatal crashes on highways. The data from the highway accident database indicate that speeding has predominantly contributed to road traffic deaths. As can be seen in figure 1, about two thirds of fatal crashes on national highways between 2001 and 2007 were related to speeding. In fact, Thailand had experienced an increase in the proportion of speeding-related crashes on highways since 2003. Moreover, it was found that speeding as a factor in highway fatalities was more pronounced for late-night crashes than day-time crashes (see figure 2).

Figure 1. Speeding as a factor in fatal accidents on national highways, 2001-2007

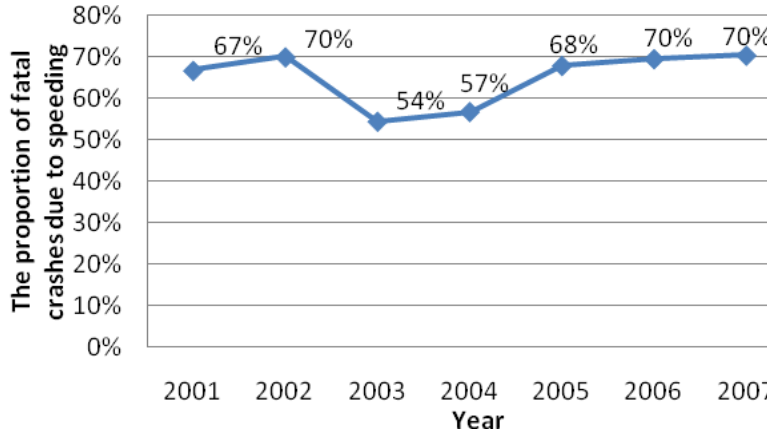
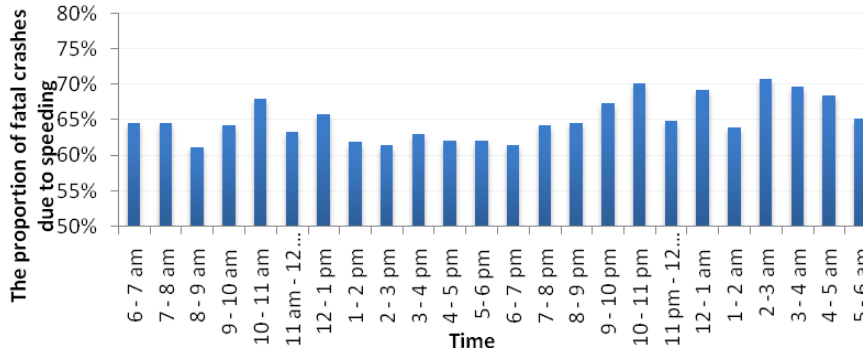


Figure 2. Speeding as a factor in fatal accidents on national highways by time of day, 2001-2007



II. SPEED LIMIT VIOLATIONS

The accident statistics discussed above highlight the seriousness of the speeding problem, which is the principal contributing factor to road traffic crashes and fatalities in Thailand. Despite the potential limitations in identifying the probable causes of accidents by police officers, the magnitude of crash and fatality risks associated with speeding could also be practically reflected by the simple fact that speed limits are violated very often in Thailand.

According to the Land Transport and Highways Acts of 1979, the speed limit for small and medium-sized vehicles (such as car, van, pickup and motorcycle) was set at 80 kph in cities or towns, and 90 kph on highways

outside of the cities or towns. For heavy vehicles such as large trucks and buses, the speed limit was set at 60 kph in cities or towns and 80 kph on highways in non-built up or rural areas. On motorways and expressways with full access control, the speed limit was set at 120 kph for passenger cars and pickup trucks, 100 kph for buses and ordinary trucks, and 80 kph for trailers. The maximum fine for speeding offences is currently set at 1,000 baht (approximately $30). The actual fines imposed range from 200 to 500 baht ($6 to $15), depending on the level by which the speed limit is exceeded and, perhaps, the discretion of police officers.

Although previous studies have shown some deterrent effects of speed enforcement at particular locations with the presence of police (Kulleab et al., 2006; Ponboon et al., 2009), the general deterrence of speeding on the public appears to have been minimal. Speeding has remained very common. Information on the speed limit violations have been obtained from on-site observations of vehicle speeds and automatic traffic counters. In 1995, a collaborative research team involving five universities in Thailand carried out traffic speed surveys in Bangkok and seven other major provinces in the country. It was found that the proportion of vehicles exceeding the speed limit ranged from 37 per cent to 54 per cent (Chongsuvivatwong et al., 1999). However, the results from some recent surveys, though not possibly comparable to the 1995 survey, reveal no significant improvement in the speed limit compliance rate. Table 2 presents a summary of observed speed limit violations on major arterial highways outside of cities, which are gathered from several survey studies. Typically, 40 per cent to 70 per cent of the car drivers exceeded the speed limit of 90 kph, while similar results were found for truck and bus drivers who were not allowed to exceed 80 kph. The speed limit violations among motorcycles were generally much lower. But it can be seen that the percentage of motorcycle riders not complying with the speed limit of 90 kph could be as high as 20 per cent and over in some locations.

Table 2. Violation of speed limits on major arterial highways outside the cities

Authors	Province	Route/site character-istics	Time of day	Exceeding the speed limit (percentage)		
				Car	Truck /bus	Motor-cycle
Siwarochana et al. (2004)[a]	Songkla	n/a	7 am - 9 am 1 pm - 3 pm 5 pm - 7pm	56	-	20
	Phuket	n/a		51	-	8
	Phetchaboon	n/a		31	-	3
	Pichit	n/a		69	-	20
	Nakhon Sawan	n/a		24	-	1
	Lampang	n/a		50	-	2
	Chiang Mai	n/a		49	-	10
	Khon Kaen	n/a		43	-	9
	Nakhonratchasima	n/a		28	-	13
	Chachoengsao	n/a		13	-	3
	Chonburi	n/a		15	-	2
	Pathumthani	n/a		41	-	8
Kullueb et al. (2006)[b]	Khon Kaen	Highway No. 2/ 4-6 lane divided	6 am - 5 pm	71	55	35
Thailand Accident Research Center (2008a)[a]	Ayutthaya	Highway No. 1/ 6 lane divided with frontage roads	9 am - 2 pm	65	48	-
			8 pm - 11pm	61	63	-
Department of Highways (2009)[c]	Prachuap Khiri Khan	Highway No. 4/ 6 lane divided	7 am - 9 am	47	27	4
			9 am - 4 pm	54	39	5
			4 pm - 7 pm	48	31	4
			7 pm - 7 am	49	44	6

Notes: The superscripts denote the data collection method used for spot speed surveys: [a] stopwatch; [b] hand-held radar gun; [c] pneumatic road tube.

The high prevalence of speed limit offences has also been observed in urban areas. Table 3 presents the results from roadside observation of vehicle speeds in Bangkok and 16 other urban cities throughout the country. This observational survey was carried out by Thailand Accident Research Center (2008b) in collaboration with other five universities. Speeds of vehicles were sampled during off-peak periods at 120 monitoring stations on a variety of road types and roadway characteristics, excluding motorways and expressways. It was found that, depending on the road environment, 6-37 per cent of cars and other small/medium-sized vehicles exceeded the urban speed limit of 80 kph. The percentage exceeding the limit tends to increase with the number of traffic lanes and the presence of a road median.

On several divided highways with six or more traffic lanes, more than 60 per cent of the drivers were travelling faster than the speed limit. The results for heavy vehicles and motorcycles exhibited similar trends.

Table 3. Distribution of vehicles exceeding the speed limit in urban areas (percentage)

Type of vehicles	Percentage exceeding the limit	2-lane roads (17 stations)	4-lane undivided roads (27 stations)	4-lane divided roads (18 stations)	6-lane divided roads (40 stations)	8-lane divided roads (18 stations)
Car/van/ pickup (80 kph limit)	None	5	7	2	2	0
	under 20 per cent	9	17	10	21	9
	20 per cent - 39 per cent	2	2	4	8	2
	40 per cent - 59 per cent	1	0	1	2	2
	60 per cent - 79 per cent	0	1	1	3	3
	80 per cent or over	0	0	0	4	2
Bus/Truck (60 kph limit)	None	5	12	3	1	0
	under 20 per cent	5	7	5	14	5
	20 per cent - 39 per cent	2	4	6	11	4
	40 per cent - 59 per cent	3	2	1	7	1
	60 per cent - 79 per cent	2	0	1	6	4
	80 per cent or over	0	0	2	1	3
Motorcycl e (80 kph limit)	None	5	8	5	4	0
	under 20 per cent	12	18	11	30	13
	20 per cent - 39 per cent	0	1	2	4	1
	40 per cent - 59 per cent	0	0	0	2	4
	60 per cent - 79 per cent	0	0	0	0	0
	80 per cent or over	0	0	0	0	0

Type of vehicles	2-lane roads (17 stations)	4-lane undivided roads (27 stations)	4-lane divided roads (18 stations)	6-lane divided roads (40 stations)	8-lane divided roads (18 stations)
Average percentage of vehicles exceeding the speed limit					
Car/van/pickup	*11*	*6*	*16*	*27*	*37*
Bus/truck	*22*	*12*	*30*	*33*	*44*
Motorcycle	*2*	*3*	*6*	*10*	*17*

Source: Thailand Accident Research Center (2008b).

III. OBSTACLES TO THE EFFECTIVENESS OF CURRENT SPEED ENFORCEMENT

Limited understanding of speed regulation

The Thailand Accident Research Center conducted a focused group survey in 2008 on 407 people in Bangkok, Chiang Mai and Phuket. Seventy-eight per cent of the survey participants considered speeding as a risky and undesirable behaviour. In order to prevent road accidents, an overwhelming majority of them (93 per cent) agreed the need of speed enforcement as a legal measure. However, it is also essential for motorists to correctly understand the speed limits required by law and how the speed limit is enforced. The survey also revealed an important fact that many people did not know the speed limit. From the survey it was found that only 32 per cent of participants correctly stated the speed limit enforced, whereas the others either did not know or incorrectly perceived the speed limit. About 57 per cent of them were, however, aware of the legal punishment for exceeding the limit.

Insufficient communication about the speed limit to motorists could be an important source of such confusion. In many countries, speed limit signs are provided along the roads to inform drivers of how fast they are allowed to travel on that particular road section. The police normally set the enforced speed limit for a road section in accordance with the posted speed limit. In Thailand, the issues of inadequate speed limit signs and inconsistency in their installation have been discussed for many years. The recent survey of speed offenders' awareness of speed law regulation was initially undertaken in 2008 by TARC (2008a); it has been followed by another study by Sontikul (2009), with a greater sample size. In the survey by Sontikul, 607 drivers of passenger cars, vans, and pickup trucks, who were stopped and penalized by the police for exceeding the speed limit on national

highways, were questioned about their perception and attitude towards the current practices of enforcing speed limits. The results show that 77 per cent of speed offenders paid little attention to or did not observe the posted speed limit signs along the highways. Of particular importance was that many of them were also unaware of the legal speed limit. Only 11 per cent were aware that the speed limit was 90 kph, whereas 53 per cent did not know and the rest believed that it was higher or lower. These findings must be interpreted cautiously, however, as some of those surveyed may have been accused of speeding and therefore may have a biased opinion. This study also interviewed 617 general drivers at a superstore and gas stations located in the same study area and found that the percentage of those who knew the speed limit correctly was just 18 per cent.

B. Public attitude towards the current speed limit

Successful speed enforcement requires wide support from the public. An issue that often evokes considerable debate in Thailand is the acceptability of the current speed limits: whether or not they are credible and logical in view of the improved road and the road environment.

According to survey results of speed violators by Sontikul (2009), 85 per cent were against the speed limit of 90 kph on rural highways. Among those opposed to the current speed limit, 52 per cent thought that the current speed limit was too low with no particular reason given, whereas another 17 per cent were of the opinion that they should have been allowed to travel at higher speeds on multilane arterial highways. Some others stated that the current speed limit could lead to sleepiness or congestion, and that it was not suitable for modern vehicles. Another attitude survey targeting general drivers by Yaktawong and Kanitpong (2009) also sheds some light on this issue. A total of 1,364 drivers in Bangkok and other six provinces in central and north-eastern regions were asked about their motivations for speeding on highways. While it was not surprising that 64 per cent tended to do so when in a hurry, almost half of the drivers interviewed (45 per cent) considered the current speed limit was set too low. The results of these surveys clearly demonstrate that there is a clear misconception in public mind concerning the necessity of speed limit and other levels.

C. Public attitude towards the current methods of speed enforcement

The survey by Yaktawong and Kanitpong (2009) also considered drivers' acceptability of the current and potential future methods for controlling and enforcing speeds. For highways outside cities, twelve different speed management strategies were considered covering four categories. The first category was speed information campaign related to installation of

speed warning and speed limit signs. The second category included engineering measures that consisted of roundabout and rumble strips. Smart vehicle design was the next category with three levels of intelligent speed adaptation (ISA) installed in vehicles. The last category was speed enforcement campaign in five strategies: automatic speed camera enforcement, speed detection by radar gun, stationary police vehicle, police checkpoint to slow down traffic, and increased punishment. It may be noted that only the use of radar gun for speed detection and police checkpoint are currently practiced. Findings from this opinion survey are presented in table 4.

The overall results suggest that the speed enforcement strategies were not strongly supported by drivers as one would have expected. The percentages of drivers who were against the speed enforcement campaign were higher, compared to information and engineering measures which were not associated with legal punishment. Focusing on the current practice of speed enforcement, it was found that speed detection by radar gun did not receive much support from those who drive with average maximum speed higher than 90 kph (33 per cent disagreement). The opinion was more unfavourable in case of police checkpoints. Motorists who often drive over the limit tended to be more strongly against the idea of blocking roadways to slow down the traffic. This also raises another concern about speed and safety. To some extent, it could increase the prevalence of speeding after passing the checkpoint as some drivers may want to compensate their lost time.

Table 4. Public attitude to methods for managing speeds on highways outside of cities

No.	Speed management strategies	Percentage of disagreement		
		Drivers with average maximum speed > 90 kph (696 samples)	Drivers with average maximum speed ≤ 90 kph (668 samples)	Total (1,364 samples)
	Information			
1	Speed warning signs	6.9	4.2	5.5
2	Speed limit signs	22.2	15.5	18.8
	Engineering			
3	Roundabout	28.6	23.4	26.0
4	Rumble strips	2.5	2.3	2.4
	Smart vehicle design			
5	ISA: Advisory level	19.2	15.9	17.5
6	ISA: Mandatory level	42.1	42.1	42.1
7	ISA: Voluntary level	36.8	35.8	36.3
	Enforcement			
8	Automatic speed camera	30.2	17.0	23.5
9	Radar gun	32.8	21.0	26.8
10	Stationary police vehicle	45.2	30.6	37.8
11	Police checkpoint	43.3	24.4	33.7
12	Increase punishment	45.1	27.7	36.2

Abbreviation: ISA = intelligent speed adaptation.

IV. ALTERNATIVE APPROACHES FOR SPEED MANAGEMENT

The previous sections gave an account of the current situation concerning speed management in Thailand, which is characterized by insufficient and sporadic implementation of selected proven interventions. Consequently, speed management did not contribute much to curbing speed-related injuries or changing speeding behaviours and unfavourable attitudes towards speed enforcement. The current situation has prevailed due to a highly centralized bureaucratic system of management, policy manipulation by vested interest groups and limited country-wide participation by the population. Given this background, it is very difficult to translate widely

available knowledge and to use technologies for speed management through sensible policy formulation and actions.

In this section, the discussion will focus on ways forward in bridging the gap between knowledge and actions. Three major approaches will be explored: from the supply side, the demand side, and top-down vs. bottom-up.

A. Supply-side approach

A supply-side approach means dealing with a handful of players, such as road authorities, the vehicle industry and regulatory bodies. As a result, it usually requires less cost to get things done as compared to a demand-side approach, which means dealing with millions of drivers and the public.

Existing knowledge from road engineering perspectives provides a number of options for self-enforcing measures to control vehicle speeds in urban areas which include vertical speed control and horizontal speed control measures. Examples of vertical measures include speed humps, speed tables and raised crosswalks. Horizontal measures may include roundabouts, neighbourhood traffic circles, chicanes and other similar engineering interventions. Some of these physical speeding reduction measures are low cost interventions. Among them, evidence from a cost effectiveness analysis indicated that speed humps could cost $2-5 per disability-adjusted life year (DALY) averted, which compares favourably to the costs per DALY averted in other situations, for example, costs of vitamin A and zinc supplementation, with or without measles vaccination, which are $25 and $19, respectively (Debas et al., 2006). In developed countries, the implementation of road engineering measures and speed management excluding speed enforcement has been estimated to save lives in terms of percentage of fatality reduction by 16 per cent to 28 per cent (Koornstra et al., 2002).

Even though these road engineering measures seem to be attractive in terms of cost and effectiveness, their implementation in developing country settings might not be straightforward. The appropriate design and installation of engineering measures require capacity-building for road authorities and awareness among policymakers. Capacity-building should include knowledge transfer and awareness-raising when relevant actions are expected. In this regard, evaluation research could play a key role in providing feedback in making policy decisions; planning, design and installation; and providing the necessary funding support.

For roads and highways in rural areas (major arterials, urban ring roads and motorways) or where high speeds are desired, it is essential to ensure that the road quality is of an appropriate standard and that protection

from roadside hazards is adequately provided. As surveys indicated that the majority of drivers did not know the speed limit, attention needs to be given to installing a sufficient number of speed limit signs as a supplementary measure to encourage motorists to voluntarily comply with speed limits.

Finally, a supply-side approach could involve the industry providing safer vehicles. Given the fact that the engine size and speeding capacity of motor vehicles are closely related, evidence has shown an association between engine size and injury severity (Yannis et al., 2005). Previous experience in Thailand suggested that it was possible to induce the voluntary contribution of the industry, for example, the provision of new models of motorcycles with headlights automatically on. This success story was based on an evidence-based participatory approach to involve the industry in the policy decision forum. In many cases, however, regulatory measures are also necessary to control the action of the private sector, such as banning alcohol advertisements (Suriyawongpaisal et al., 2007).

B. Demand-side approach

As in many other countries, the demand-side approach in Thailand has been more popular than the supply-side approach in road safety promotion. Publicity campaigns and law enforcement are considered to be the essence of the demand-side approach. Both need to be implemented in a concerted way if maximum effect is to be achieved, as evidenced from reports in developed countries (Koornstra et al., 2002). However, this has not been the case in Thailand. A major obstacle is the competing priorities to mobilize the police force. As has been shown by the problem of drivers' speeding behaviour, the effectiveness of speed enforcement is subject to an active police presence.

So far, the top priority of the police department has been to deal with criminal cases. Even in their road traffic control function, the police have been engaged mainly in facilitating the flow of traffic. The application of labour-intensive technologies such as speed radar guns or mobile speed cameras would hardly fit the priority concerns of the police department. A trial of speed camera enforcement along several major arterial highways by the highway police in 2006 was unfortunately discontinued, due partly to the controversy regarding the allegation of speeding based on photographic evidence from speed cameras sent by post. This issue seems to have been resolved in the case of automatic red-light cameras that have been introduced recently in Bangkok by the police department. Although this is in keeping with the argument in support of automatic law enforcement technology, a long-term follow-up of the use of automatic red-light cameras is needed to shed light on the cost-effectiveness and sustainability of the technology. Besides, given the high upfront cost of this automatic technology, it raises a concern about return on investment. In the United States of

America, only two out of five local jurisdictions reported that revenues collected from photo enforcement programme (red-light camera and speed enforcement camera) exceeded the programme cost, according to a report by the Government Accountability Office (2003).

In parallel with making use of speed enforcement technology, police deployment at randomized locations is another way to enhance the effectiveness of speed enforcement with limited resources. The current practice of speed detection with police presence could have been applied at random times and randomly chosen locations, keeping motorists uncertain of speed enforcement zones. This could lead to increases in drivers' perceived risk of being caught as a result of speeding, which in turn improves voluntary compliance with speed limit. Evidence from Australia shows that implementations of the randomized scheduled enforcement resulted in an average 32 per cent reduction in fatal and injury crashes (Leggett, 1997).

Publicity campaigns need to be continued with greater concerted efforts, though these tasks have proved to be fairly difficult in making substantial impacts on behaviour. Communication strategies should be carefully developed for better public understanding about the necessity of speed limits. In order to change drivers' attitude and speeding behaviour, the design and contents of campaigns should not solely rely on mere imagination and inspiration. Limited researches have been conducted to gain insights of the speeding behaviour of Thai drivers. It is important to identify cognitive determinants of speeding behaviour in a more systematic and rigorous manner. The application of psychological theories, such as the theory of planned behaviour (TPB), has been successful in explaining drivers' speeding behaviour (e.g. Parker et al., 1992; Elliott et al., 2005; Warner and Åberg, 2006; Paris et al., 2007). An understanding of the mechanisms influencing drivers' decisions to speed could serve well as a knowledge base for the development of more effective interventions and campaigns to encourage speed limit compliance and the use of a speed that is appropriate under prevailing conditions.

Another interesting approach that has emerged is people's empowerment to voice their safety concern and take relevant actions. In Kenya, a simple evocative message posted inside a minibus could lead to passengers taking actions to counteract the risky driving behaviours of the drivers as confirmed by a randomized control trial (Habyarimana and Jack, 2009). This potential measure to empower the people has a comparative advantage over weak third party enforcement of the law. How the people's empowerment approach could be translated into speed management requires innovative practical interventions in conjunction with their careful evaluation in practice.

C. Top-down versus bottom-up approach in road safety planning and implementation

The planning and implementation of both supply- and demand-side approaches require public support in order to secure resources and overcome resistance from vested interest groups. Experiences suggest that a programme implementation without adequate public support could end up in failure or not be able to sustain (Howat et al., 2001).

To the contrary, when the people are well informed and alert, implementation of road safety measures could be initiated and sustained. It is reported that there are very few villages left in India without a road hump when the road goes through a village (Traffic Safety Center, 2009). Similarly, the authors encountered a village in the north-east of Thailand where speed humps are all over the road passing through it. Interestingly, the reason for putting the humps was not for road safety improvement but to calm the traffic disturbing them during sleep hours. This anecdotal record highlights the need to understand people first through their lens before introducing any interventions that outsiders think suitable.

These stories imply the importance of combining the top-down and bottom up approaches in the planning and implementation of road safety programmes. There is nothing new about this, yet the practice based on this principle is regrettably rare. In order to promote the practice, some countries have put in place systematic mechanisms to encourage the involvement of the community and local authorities in promoting their voices and giving choices. For example, the Local Government Road Safety Program (LGRSP) in the state of New South Wales, Australia, was established in 1993 with the goal of increasing the involvement of local governments and local communities in road safety planning and activities to reduce the incidence and severity of road trauma (Orange City Council, 2009). To achieve the goal, relevant local government staff and community representatives were sitting on the Steering Committee to oversee the development of action plans.

If participatory processes or mechanisms are to be successful, barriers to participation should be identified and dealt with systematically. The barriers could be classified into two groups: personnel and planning issues as documented by Howat et al. (2001). The former includes reasons why people are often reluctant to become involved in projects in their communities, lack of leadership, and lack of skills in designing and organizing a participatory process. The latter includes inappropriate programme focus, absence of programme evaluation, lack of resources, and concern about sustainability. There are, however, established methodologies to overcome these barriers that need to be tested for the planning and implementation of safety improvement programmes.

CONCLUSION

Despite the fact that the contribution of speeding to road traffic injuries is significant, public concern and actions pertinent to speed control have been unfavourable in Thailand. Perhaps the current top-down approach in planning and implementation of road safety programme by a highly centralized bureaucratic system and vested interest groups' manipulation in policy decisions have precluded mobilization of the knowledge and resources to get the things done. A combination of top-down and bottom-up approaches in making policy decisions and programme planning and implementation supported by a systematic monitoring and evaluation is suggested. It is worthwhile to put more emphasis on supply-side measures, since they require fewer resources than demand-side measures. The available evidence indicates that drivers are more receptive to engineering measures, which constitute a major part of supply-side measures.

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ROAD SAFETY PROBLEMS IN BANGLADESH: SOME MAJOR INITIATIVES, CONSTRAINTS AND REQUIREMENTS

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ABSTRACT

In this paper, an attempt has been made to present the magnitude and trends of the road safety problem and the prevailing accident characteristics in Bangladesh. This paper also reviews some major road safety initiatives undertaken by different governmental and non-governmental actors in recent years to control and reduce road traffic accidents and injuries and their effectiveness. Finally, the paper identifies the road safety improvement constraints in Bangladesh and future requirements for developing research-based scientific, pragmatic and cost-effective countermeasures to improve the situation.

Keywords: road accidents in Bangladesh, road safety action

INTRODUCTION

Of all the systems with which people have to deal every day, road traffic systems are among the most complex and the most dangerous. Despite great progress in international traffic safety work, traffic accidents still cause a large and increasing number of fatalities and severe injuries in developing countries. Worldwide, the number of people killed in road traffic crashes is estimated at 1.3 million, with another 50 million injured each year. More than 85 per cent of the casualties, including 96 per cent of child deaths, occur in low- and middle-income countries (iRAP, 2008a). It is predicted that the number of people killed on roads will rise by at least 80 per cent over the next 20 years in developing countries such as Bangladesh, whereas it is expected to decrease by 30 per cent in high-income countries (iRAP, 2008b). Sustained declining trends in road fatalities in developed countries have been attributed to concerted efforts in many areas, including effective coordination, community involvement, research on road safety initiatives, the promotion of good road safety practices and improved targeting of resources.

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Bangladesh has one of the highest fatality rates for road accidents, with over 50 fatalities per 10,000 on-road motor vehicles. Vulnerable road users (VRUs)—for example, pedestrians, children, bicyclists, and cycle rickshaw occupants and pullers—are the worst-affected victims and they account for nearly 80 per cent of road traffic accident fatalities. The Government is concerned about the growing problem and has considered various measures in the past. As part of government and private initiatives, some programmes have been undertaken to ensure safer transport. Efforts are underway to identify the specific roles and responsibilities of different governmental and non-governmental organizations in order to develop effective measures to tackle the road safety problem in the country.

I. MAGNITUDE OF THE ROAD SAFETY PROBLEM IN BANGLADESH

Accident statistics

The police are officially responsible for the reporting and recording of road accidents and casualties in Bangladesh. According to the official police data, there were 3,764 fatalities and 3,284 injuries in 4,426 accidents in 2008 (PFIR, 2008). Reported road traffic accident data for the last decade are provided in table 1. A study on Bangladesh road crash costing conducted by the Transport Research Laboratory (TRL) in 2003 showed that there were 885,056 accidents, of which 10,692 were fatal, 106,062 grievous, 147,660 minor and 442,981 resulting in only property damage (TRL, 2003). This study also estimated that the total number of casualties resulting from road traffic accidents was 529,880, of which 12,792 were fatalities and 165,464 were serious injuries. Significant differences in the numbers of fatalities and injuries, as reported by police, are clearly due in part to reporting problems and recording inconsistencies. Methodological issues involved in data collection and definition may also have contributed to these differences.

Table 1. Number of road accidents, fatalities and injuries in Bangladesh

Year	No. of accidents		No. of fatalities		No. of injuries		Total casualties		Traffic fatalities per 10 000 on-road vehicles**
	FIR*	MAAP	FIR	MAAP	FIR	MAAP	FIR	MAAP	
1998	4 769	3 533	3 085	2 358	3 997	3 297	7 082	5 655	78.24
1999	4 916	3 948	3 314	2 893	3 453	3 469	6 767	6 362	79.60
2000	4 357	3 970	3 430	3 058	1 911	3 485	5 341	6 543	78.09
2001	4 091	2 925	3 109	2 388	3 127	2 565	6 236	4 953	66.39
2002	4 918	3 941	3 398	3 053	3 772	3 285	7 170	6 338	67.18
2003	4 749	4 114	3 289	3 334	3 818	3 740	7 107	7 074	61.03
2004	3 917	3 566	2 968	3 150	2 752	3 026	5 720	6 176	53.71
2005	4 949	3 322	3 187	2 960	2 754	2 570	5 941	5 530	52.86
2006	3 794	3 549	3 193	3 160	2 409	2 123	5 602	5 283	50.44
2007	4 869	3 910	3 749	3 250	3 273	2 102	7 022	5 352	56.41
2008	4 426	-	3 764	-	3 284	-	7 048	-	53.93

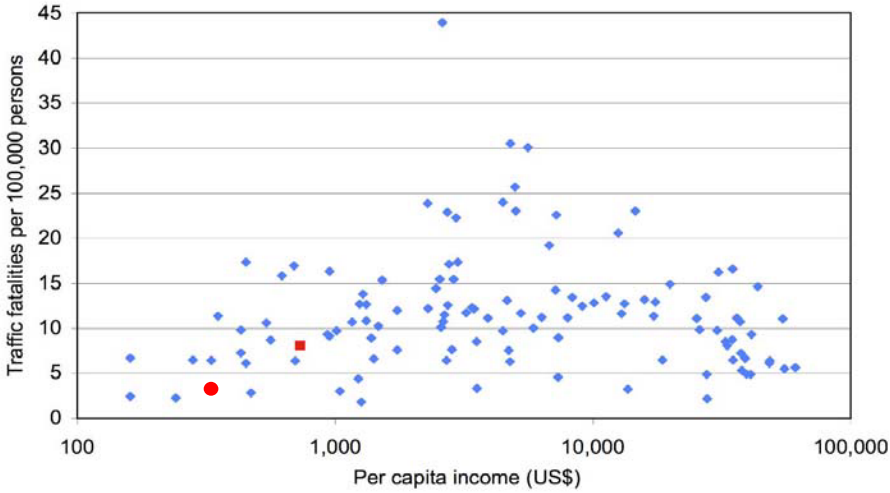
Source: Police-reported Micro Computer Accident Analysis Package (MAAP) database.

Notes: * FIR: First Information Record, the case entry record in the police log-book.
** Traffic fatalities per 10,000 vehicles were calculated considering the FIR data.

B. Fatality rate

Figure 1 shows fatality rates in various countries as a function of per capita income. The fatality rate in India (represented by the red square) is in the middle of the range for low-income countries (Mohan, 2004) and the fatality rate in Bangladesh (represented by the red circle) is in the bottom of the range for low-income countries. The much lower rate in Bangladesh could be attributed to a significant level of underreporting and to high population density coupled with a low motorization level. As incomes in Bangladesh increase along with its motor vehicle population, the experience of middle-income countries suggests that fatalities could see a dramatic rise before they start to drop, consistent with the so-called Kuznets curve.

Figure 1. Traffic fatality rates per 100,000 persons in 116 countries



Source: Mohan, 2004.

The fatality rates in Bangladesh in terms of the number of fatalities per 10,000 on-road motor vehicles (over 50) is very high compared with developed countries. The corresponding fatality rates in developed countries are only about 2 per 10,000 on-road motor vehicles (for example, 2 in the United States of America and 1.4 in the United Kingdom of Great Britain and Northern Ireland). A study conducted by Jacobs and Thomas showed that Bangladesh had one of the highest fatality rates, with over 40 deaths per 10,000 registered motor vehicles (Jacobs et al., 2000).

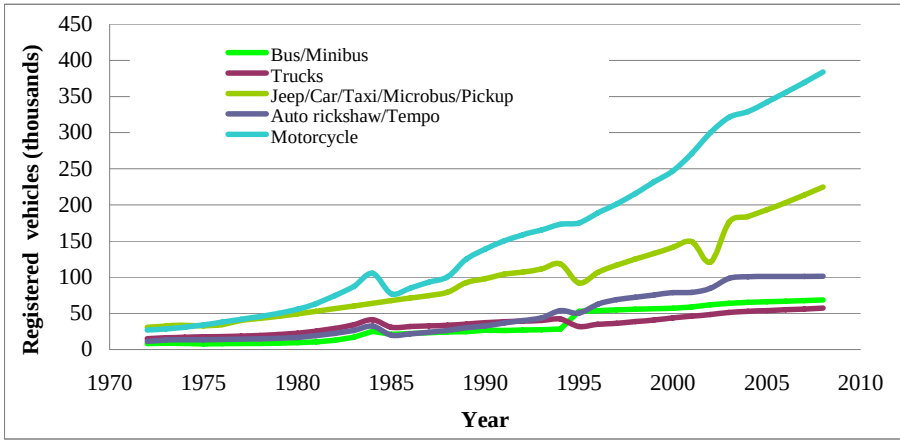
C. Statistics on vehicles and their involvement in road fatalities

The motor vehicle population increased from 94,960 in 1972 to 871,853 in 2008. The number of motor vehicles on the road is about 30 per cent lower than the number of registered vehicles, as many of the vehicles are out of service or under maintenance (BBS, BRTA, 2008).

The growth of different types of registered vehicles between 1972 and 2008 is shown in figure 2. Motorcycles comprise more than 1 1/2 times the combined population of other vehicle types and their rate of growth is also much higher than other vehicles. This pattern is very similar to the pattern of neighbouring countries. For example, in India, the number of registered motorcycles is five times higher than that of cars (Mohan et al., 2009). The composition of vehicle fleets in developed countries is quite

different from that in high-income countries, which has also affected their fatality rate patterns. In the United States of America in 2005, for example, passenger cars constituted 66 per cent of vehicles; trucks and vans, 30 per cent; motorcycles, 3 per cent; and buses, 1 per cent (Mohan et al., 2009).

Figure 2. Registered vehicles, 1972 through 2008



Source: Bangladesh Bureau of Statistics (BBS) and Bangladesh Road Transport Authority (BRTA).

Table 2 shows data on registered and on-road vehicles by type and by fatality rates per 10,000 vehicles for each type.

Table 2. Number of vehicles, fatalities and fatality rates

Vehicle types	Number of vehicles (registered)[1]	Number of vehicles (on-road)[2]	Average fatalities per year	Average pedestrian fatalities per year	Fatalities per 10 000 vehicles (on-road)	Pedestrian fatalities per 10 000 vehicles (on-road)
Bus/ minibus	40 469	29 717	1 005	545	338	183
Trucks	65 239	48 753	673	426	138	88
Jeep/car/ taxi	189 287	78 236	133	63	17	8
Microbus/ pickup	18 492	14 743	193	112	132	76
Auto rickshaw/ tempo	116 242	77 700	246	58	31	8
Motorcycle	328 294	220 225	147	45	7	2
Rickshaw/ rickshaw van	N/A	N/A	129	3	N/A	N/A
Bicycle	N/A	N/A	105	4	N/A	N/A
Others	26 324	15 854	172	89	108	56
Total	784 347	485 228	2 805	1 346	57	28

Source: Bangladesh Country paper, 2007.
Note: The total number of vehicles registered includes data up to 2003 and the number of vehicles on the road was 485,228 in 2001-2002.

D. Trends in road traffic accidents and fatalities

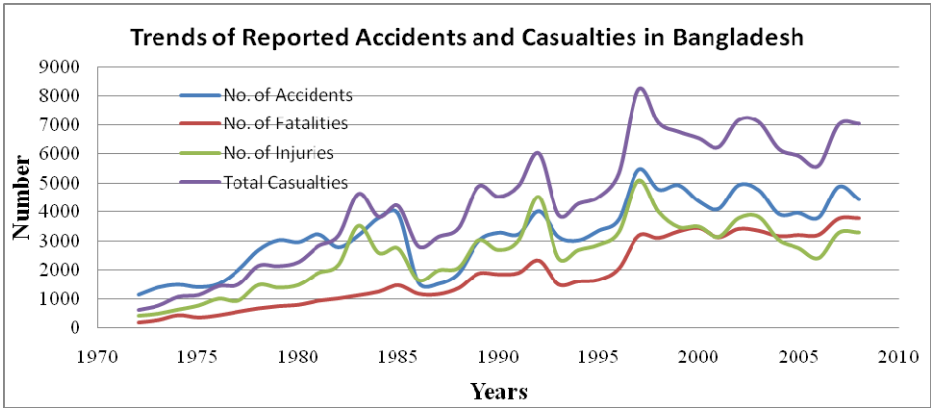
Total number of accidents and fatalities

According to the police-reported accident records, the number of fatalities increased from 187 in 1972 to 3,764 in 2008, which represented nearly a 10 per cent increase per year over a period of 37 years. In the last decade, however, the rate of increase has decreased significantly. The actual numbers increased from 3,314 in 1999 to 3,764 in 2008, representing about 2 per cent per year, although there was significant growth in the population and the number of personal trips and vehicles, as well as expansion of the road network. This positive trend is attributable to the improvement of road

conditions, the construction of national and regional highways incorporating a road safety auditing approach, an increase in the number of higher standard vehicles on the road, improved road user education and awareness levels, the enhancement of a coordinated official policy to control the problem and police enforcement.

Figure 3 shows traffic accidents and fatalities during the period 1972-2008. As can be seen, there were sudden increases in numbers between 1997 and 1999, which were perhaps due to changes in accident reporting and data collection methods. A newly developed accident reporting form was introduced and a series of training programmes for police personnel was organized to enhance their capacity in accident recording and reporting.

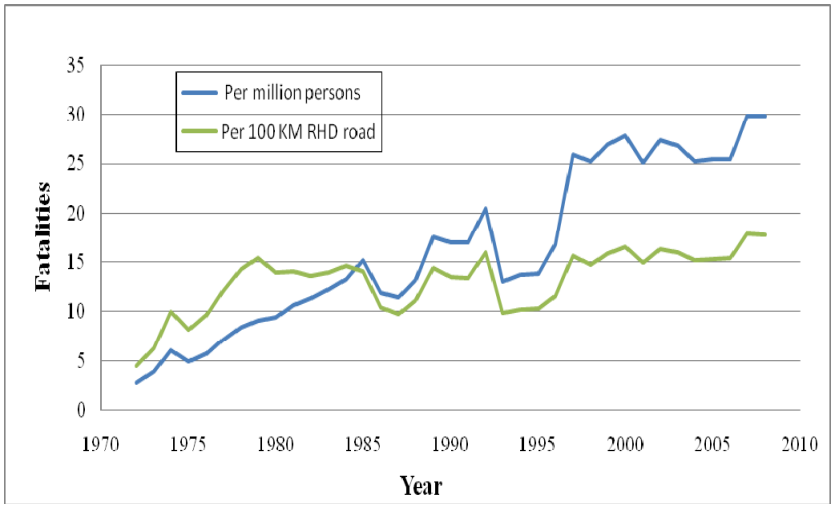
Figure 3. Traffic accidents, fatalities, 1972-2008



Fatalities per million persons and per 100 km roads

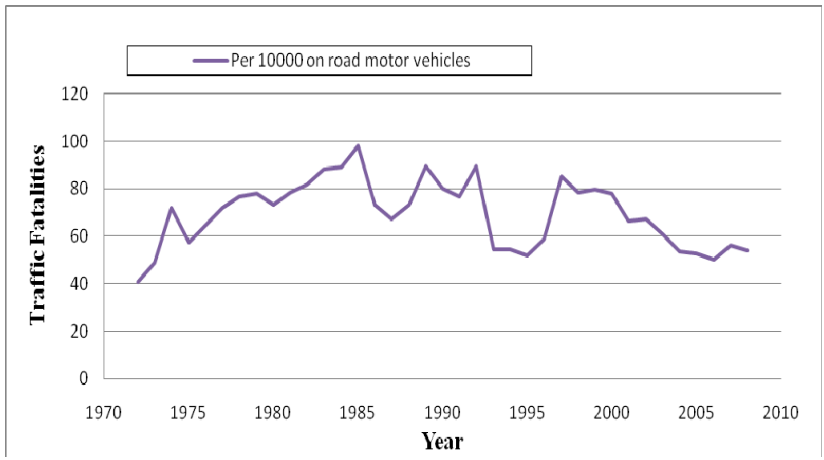
Figures 4 and 5 show the trends in fatalities per million persons and per 100 km Road and Highways Department (RHD) roads. Fatalities increased from 2.74 (per million persons) and 4.48 (per km of 100 RHD roads) in 1972 to 29.8 and 17.83, respectively, in 2008. In the last decade, however, their increases were much less pronounced (15.81 to 17.83 and 26.91 to 29.81, respectively). Overall fatalities per 10,000 on-road motor vehicles increased from 40 in 1972 to 53 in 2008. However, the rate has decreased in the last decade by about 31 per cent (from 78 to 53 fatalities per 10,000 on-road motor vehicles). Sudden upsurges in particular years reflect the methodological and reporting issues discussed earlier.

Figure 4. Traffic fatality per million persons and per 100 km RHD roads, 1972-2008



Source: Data from Police, RHD and BBS

Figure 5. Traffic fatality per 10,000 on-road motor vehicles, 1972-2008



Source: Data from Police and BRTA

The declining trend in fatality rates suggests that, although the degree of accident exposure in terms of the number of trips, vehicles and road users, as well as the length of the road network, have increased, there has not been a corresponding increase in fatalities.

Fatalities per 100 million vehicle kilometres

Accident and fatality rates with respect to vehicle-kilometres (veh-km) are calculated based on vehicle operation survey data conducted by RHD in different years. Table 3 depicts the total veh-km travel by motorized vehicles and the corresponding accidents and fatalities per 100 million veh-km in recent years.

Table 3. Accidents and fatalities per 100 million vehicle kilometres

Year	Total veh-km	No. of accidents	No. of accidents per 100 million veh-km	No. of fatalities	No. of fatalities per 100 million veh-km
1999	13 419 385 000	4 916	37	3 314	25
2000	12 719 533 000	4 357	34	3 430	27
2002	14 125 435 000	4 918	35	3 398	24
2004	21 042 770 900	3 917	19	2 968	14

Source: RHD (1999, 2001, 2003, 2005a).

Between 1999 and 2009, while the total annual veh-km increased by 57 per cent, the corresponding accident and fatality rates decreased by as much as 49 per cent and 43 per cent, respectively. Significant reductions in these rates also indicate a positive trend in traffic safety improvements in the country.

II. ROAD TRAFFIC ACCIDENT CHARACTERISTICS IN BANGLADESH

A. Accidents statistics: urban vs. rural areas

The distribution of reported road traffic accidents and fatalities in urban and rural areas for the period 1998-2007 is shown in table 4. In this period, at least 12,960 accidents occurred in urban areas, accounting for 35 per cent of total accidents in the country. These accidents resulted in 7,635 fatalities and 9,243 injuries. About 26 per cent of the total fatalities occurred in urban areas. The data presented in the table show some possible reporting inconsistencies in the distribution of urban-rural accidents, which require further investigation.

Table 4. Trends of accidents and fatalities in urban and rural areas

YEAR	Reported accidents				Reported fatalities			
	Urban		Rural		Urban		Rural	
	No.	Percentage of corresponding total	No.	Percentage of corresponding total	No.	Percentage of corresponding total	No.	Percentage of corresponding total
1998	1 754	50.2	1 743	49.8	795	34.1	1 534	65.9
1999	1 499	38.1	2 439	61.9	733	25.4	2 152	74.6
2000	1 504	38.0	2 451	62.0	775	25.4	2 276	74.6
2001	960	33.0	1 948	67.0	593	24.9	1 785	75.1
2002	1 366	34.8	2 557	65.2	752	24.8	2 283	75.2
2003	1 413	34.7	2 662	65.3	826	25.0	2 476	75.0
2004	1 079	30.7	2 435	69.3	697	22.4	2 416	77.6
2005	854	26.3	2 394	73.7	580	20.0	2 321	80.0
2006	1 043	30.1	2 418	69.9	768	24.9	2 313	75.1
2007	1 488	39.0	2 323	61.0	1 116	35.3	2 045	64.6
TOTAL	**12 960**	**35.7**	**23 370**	**64.3**	**7 635**	**26.1**	**21 601**	**73.9**

Source: Police reported MAAP Database.

B. Fatalities by road users

The distribution of road fatalities across road user groups for urban and rural areas is shown in table 5. Nearly 80 per cent of road fatalities in urban areas involved VRUs (pedestrians, bicycles, cycle rickshaws and motorcycles), with pedestrians being the largest group. They were also the largest group in rural fatalities, accounting for about 65 per cent.

Table 5. Fatalities by user groups in urban and rural areas (1998-2006)

User Groups	Urban	Percentage	Rural	Percentage
Pedestrians	4 083	63	8 878	46
Bicycles and rickshaws	782	12	1 226	6
Motorcycles	207	3	740	4
Baby taxi/ tempo/microbus	394	6	1 686	9
Car/jeep/pickup	136	2	738	4
Buses	436	7	3 669	19
Trucks	298	5	1 922	10
Others	166	3	594	3
Total	6 502	100	19 453	100

Source: Hoque et al. (2008a).

C. Temporal distribution

Analysis of the police-reported accident data revealed that 64 per cent of accidents occurred during the day (6 a.m. to 6 p.m.), while 36 per cent occurred at night (6 p.m. to 6 a.m.) in urban areas, whereas in rural areas the day-time share was 75 per cent. It was found that accidents and fatalities remained fairly evenly distributed in day-time, with the peak occurrence between 10 a.m. and 12 noon.

More accidents tended to occur on Thursdays, with fairly equal distribution among the other weekday and weekend days. Relatively speaking, more accidents occurred in the months of January, February and March, probably because of foggy weather conditions on many days in those months.

D. Vulnerable road user group: pedestrians

Pedestrians were by far the largest group involved in road traffic fatalities. Their share varied between 37 and 73 per cent, with an average of 65 per cent in metropolitan areas. Pedestrians also accounted for nearly 56 per cent of road traffic fatalities in non-metropolitan urban areas. Further analysis revealed that most of the pedestrian fatalities occurred while the pedestrians were crossing the road (41 per cent), closely followed by those walking on the road (39 per cent). The very high involvement of pedestrians in road fatalities indicates the need for special attention to be paid to this group.

E. Involvement of children in road accidents

The involvement of children in road accident fatalities was found to be very high, accounting for about 21 per cent. A recent study revealed that road traffic injuries were the leading cause of fatalities in children 10-14 years of age (Hoque et al., 2007). Of the total number of child road fatalities, nearly 80 per cent were pedestrians. About one half of the child pedestrian fatalities occurred on roadsides while the children were walking along the road, and nearly one third occurred while they were crossing the road. Heavy vehicles such as buses and trucks were the main contributors to child road traffic fatalities. Children were also vulnerable as bicyclists, accounting for nearly 16 per cent of the total cyclist fatalities.

F. Involvement of trucks and buses

Heavy vehicles such as trucks and buses, including minibuses, were major contributors to road accidents (bus/minibus—33 per cent, trucks 27— per cent), while their shares in fatal accidents were 35 per cent and 29 per cent, respectively. This group of vehicles was also responsible for most pedestrian accidents, accounting for about 68 per cent (bus/minibus—38 per cent, trucks—30per cent). The combined share of buses and trucks for road fatalities was 68 per cent, while their share for pedestrian fatalities was 72 per cent (Bangladesh Country paper, 2007).

G. Accidents on national highways

Of the total reported accidents, nearly 37 per cent occurred on national highways. A study on the identification of hazardous road locations on national highways revealed that accidents and fatalities on national highways were clustered on selected sections, identified as hazardous road locations (HRLs). Nearly 40 per cent of accidents were concentrated on about 2 per cent of the highway network (Hoque et al., 2006).

H. Predominant accident types

An accident type analysis showed that the “hit pedestrian” scenario was the dominant accident type, both in urban and rural areas; 45 per cent of accidents of this type were fatal. Other common accident types were: rear end collision (16.5 per cent), head-on collision (13.2 per cent) and overturning (9.3 per cent). These four accident types accounted for nearly 85 per cent of the fatal accidents. In rural areas, the types of accidents which

resulted in fatalities and injuries were categorized as follows: hit pedestrian, head-on collision, running-off-the-road and out-of-control vehicles.

I. Contributing factors in road accidents

Various studies comprising on-site field investigations, systematic safety checks and audits, comprehensive analyses of accident reports, eyewitness and victim interviews, drivers' observations and opinion surveys, and expert opinion surveys, have been conducted by different organizations to identify the causative factors of road accidents. Those studies revealed that the principal contributing factors to accidents were deficiencies in land-use and road network planning, adverse roadway and roadside environments, the absence of or inappropriate pedestrian facilities, defective bridges and bridge approaches, inappropriate intersection designs, reckless driving, vehicle defects, the presence of non-standard informal vehicles on main roads and unauthorized vehicle modifications. In addition, driver incompetency, road users' low level of awareness of the safety problem, and inadequate traffic law enforcement and sanctions were also among the major causes of accidents. However, it is difficult to quantify which factors were responsible for how many accidents due to the fact that a large number of contributory factors are not covered by the current accident reporting system.

III. MAJOR ROAD SAFETY INITIATIVES IN BANGLADESH

In order to improve the road safety situation, several initiatives have been taken by various government, non-governmental and donor agencies in the form of policy formulation and implementation, institutional development, geometric improvement of roads, legal sanctions and enforcement, capacity-building for professionals and academics, and awareness creation among the general public. Some of the major initiatives are summarized below:

Adoption of the National Land Transport Policy (NLTP)

The National Land Transport Policy (NLTP) was adopted in 2004 by the Planning Commission, which sets a vision for "providing safer roads". The NTLP has also set policies on various matters, including: (i) road safety auditing at all phases of road projects, road construction and road maintenance; (ii) speed restrictions on roads; and (iii) safety improvements on existing roads, which were considered vital in achieving the vision (RHD, 2005b).

Preparation of a safety manual, handbook and guidelines

RHD has prepared a set of manuals, handbooks and guidelines on road safety, which include the Guidelines for Road Safety Audit, Road Safety Improvement Works Manual, Road Safety Users Guide, Road Geometric Design Manual, Police Training Handbook, Road Safety Engineering Toolkit, Pavement Design Guide, Guidelines for Identification of Sites for Road Safety Improvement Works, and A Guide to Safer Road Design. In addition, a Traffic Sign Manual was developed by the Bangladesh Road Transport Authority (BRTA) in 2000. The police department has approved and adopted a revised traffic training syllabus and curriculum and, since 2004, all traffic training courses have been conducted as per the revised curriculum.

Establishment of the National Road Safety Council (NRSC)

The National Road Safety Council (NRSC) was established in 1995 under the auspices of the Ministry of Communications, with the support of a World Bank-funded road improvement project; it is now a unit of BRTA. The secretariat of NRSC sorely lacks manpower, logistics and facilities and has yet to become fully functional. NRSC comprises representatives of all key stakeholders, including transport owners, workers associations, professionals in the field, transport regulators, law enforcers and road authorities (Hossain, 2002). It acts as the apex body for approving and driving forward the national policy and plans and has formulated the National Road Safety Action Plan. In addition, NRSC is responsible for holding periodic meetings to provide policy-level decisions and directives to road safety-related organizations, such as RHD, BRTA, the police, Dhaka Transport Co-ordination Board (DTCB), city corporations and local governments., For various reasons, however, NRSC was not able to undertake any major activities in the last two years.

Preparation of national road safety strategic action plans

NRSC drew up the first National Road Safety Strategic Action Plan, covering the period from July 1997 to June 1999. Subsequently, plans for the periods 2000-2002, 2002-2004 and 2005-2007 were developed. NRSC also formulated an updated National Road Safety Strategic Action Plan 2008-2010, with the hope that it would provide an important framework for improving safety in a comprehensive way and address the issue holistically. A vision of a 50 per cent reduction in fatal road accidents within the next 15 years and the goal of a 10 per cent reduction in road accident fatalities by the end of the year 2007 were stated in the plan.

The Road Safety Action Plan identified nine priority areas for improvement. The nine areas are further subdivided and actions are

proposed under each sub-area. The activities of the strategic action plan follow the ADB/ESCAP road safety guidelines (ADB, 1997). Non-governmental groups have a key role to play in implementing the Action Plan.

Establishment of the Road Safety Cell and the District Road Safety Committee

An independent organization called Road Safety Cell (RSC) was set up to act as the secretariat to NRSC at the Bangladesh Road Transport Authority (BRTA). RSC is responsible for the preparation of plans, the coordination, and the monitoring and evaluation of the activities assigned to different agencies and for the implementation of programme activities assigned to it. It also disseminates information on road safety to all relevant organizations and to members of the public. Besides NRSC, district road safety committees at the district and metropolitan levels have been formed with the involvement of the local administration, BRTA and road authority and other transport/road user agencies; they implement the programmes and policies of NRSC. The committees are required to undertake road safety programmes according to local needs.

Establishment of the Accident Research Institute at the Bangladesh University of Engineering and Technology

The government realized that there was a need for scientific study and research on accidents and for remedial measures to address them. The commitment in this regard came from the highest level of government to establish an independent accident research centre as one of the top priority programmes. Accordingly, the Accident Research Centre (ARC) was established at Bangladesh University of Engineering and Technology (BUET) in 2002 to carry out scientific research with a view to understanding the safety problems and ascertaining the underlying causative factors that contribute to accidents on roads, railways and waterways. After successful completion of the project period, ARC became an institute under the Education Ministry at BUET in 2007.

Development of the Road Safety Unit at RHD and LGED

With the technical assistance of the Department for International Development (DFID) of the United Kingdom, RHD established a road safety division in January 1999 with a view to dealing with the safety aspects of national, regional and feeder roads. The Ministry recently approved the upgrading of the Unit and its roles and functions. The Local Government

Engineering Department (LGED) has also planned to create a similar road safety unit within the Department.

Establishment of the highway police

With the aim of improving safety and traffic management on highways, the Government created the highway police in 2005. The highway police are responsible for maintaining and ensuring discipline, enforcing traffic rules and regulations, managing traffic, preventing highway crime, collecting and sharing intelligence, undertaking police patrolling and ensuring road safety. The highway police are working under two units, namely the Traffic Unit and the Investigation Unit. Currently, the highway police have a workforce of 2,042 personnel.

Formation of road safety voluntary and advisory groups

Many non-governmental voluntary or advisory road safety groups have been formed at the national and local levels. *Nirapad Sarak Chai*, Work for Better Bangladesh (WBB), Safe Community Foundation and *Poribesh Bachao Andolon* are some of the major groups at the national level.

Approval of speed limit zoning and speed restriction rules

Excessive and inappropriate speed is one of the most important factors contributing to road accidents. A number of studies have clearly identified speeding as being a particular problem (GRSP, 2007). In cognizance of this fact, speed limit zoning and speed restriction rules have been developed for different highways in Bangladesh. They were approved and published in a gazette by BRTA in 2005 for the major highways in the country.

Development of an accident database

A standard format for accident information recording was designed in 1995 as an initiative under the Institutional Development Component (IDC) programme and was adopted by the police department. The department promulgated appropriate rules for its mandatory use as part of the first investigation report of accidents by the police. An accident database system based on MAPP5 software was developed and the database has been in use since 1998. In addition, RHD conducted a road inventory survey and prepared an inventory book to identify accident locations and black spots, and to treat those locations through different site-specific interventions. A

computerized database for recording registered motor vehicles and licensed drivers' data has also been established at BRTA.

Preparation of the road traffic accident annual report

BRTA has been preparing accident reports based on the National Road Traffic Accident (RTA) database. The system of accident data collection and analysis was set up with assistance under the Institutional Development Component (IDC) programme funded by DFID. Since 2005, BRTA has been undertaking data collection and analysis by itself without external assistance.

Training of road safety professionals

Efforts are underway to strengthen the capacities of the key agencies by organizing long- and short-term training programmes at home and abroad.

Safety awareness and training

Safety awareness campaigns and training programmes have been undertaken at different levels for professionals, transport owners and workers, students and the general public by different governmental and non-governmental organizations.

Implementation of road safety audits

Road safety audits as an accident prevention tool are a relatively new and highly cost-effective approach to improving road safety. Road safety audits are of particular importance as national road networks are still being developed, and unless safety checks are undertaken, the result will be unsafe networks in the future. In recognition of its importance, the RHD road safety unit has introduced formal road safety audits at different locations or spots on national highways.

Road safety initiatives of non-governmental organizations

Non-governmental organizations (NGOs) are becoming active in the area of road safety. The activities of two leading NGOs—Bangladesh Rural Advancement Committee (BRAC) and the Center for Rehabilitation of the Paralyzed (CRP)—are quite noticeable (Quazi, 2003). The major programmes being undertaken include the following: community road safety, training of students, road safety training for office staff, a community road

safety NGO network, publicity and awareness, research, driver training, and the treatment and rehabilitation of paralysed people.

Geometric improvement of roads

Significant improvement works have been undertaken on the national highways and regional and feeder roads all over the country. They include the construction of new and strategic roads, the realignment of existing roads, the widening of roads, surface treatment, road and roadside improvements such as shoulder improvements, the removal of vision obstructions, and the preview of loading and unloading facilities. In addition, some hazardous road locations have been improved on national highways.

International and regional cooperation

Concerned organizations have developed linkages with different institutions and organizations at the local, international and regional levels—including Asian Development Bank (ADB), the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP), The Global Road Safety Partnership (GRSP), the Road Engineering Association of Asia and Australasia (REAAA), The Transportation Research and Injury Prevention Programme (TRIPP), Transport Research Laboratory (TRL), Swedish National Road and Transport Research Institute (VTI), World Bank (WB) and other donor agencies and specialized institutes—to facilitate the exchange of knowledge and technologies. They have also initiated exchange programmes with overseas counterparts to share knowledge and information. Efforts are underway to establish a network of road safety researchers, professionals, academics and practitioners.

Progress in road safety research

Long-term research work has started in recent years. Financing of traffic safety research is at present the responsibility of the government. Research institutes and universities can apply for funds for research projects. No industry or private organization has shown interest in safety research issues and funding support yet. Work on a joint traffic safety research programme is progressing in collaboration with donor agencies.

IV. MONITORING AND EVALUATION OF ROAD SAFETY MEASURES

Since 1995, a significant number of road safety measures have been implemented. Unfortunately, no major or comprehensive evaluation study

has been conducted to assess the effectiveness of the implemented measures. A few studies have been conducted by students as part of their research work. More detailed evaluation is necessary to determine the effectiveness and applicability of the measures to local traffic, land-use, social and behavioural characteristics.

A. Impact of implemented and ongoing initiatives

Development of awareness and understanding

RHD prepared a report entitled "Road Safety Initiatives in Bangladesh—A Brief Report" in collaboration with Finnroad in 2005. Some of the main findings of the report are the following:

- At the government policy level, a significant level of awareness and recognition of road safety as a national problem was observed.
- At the planning and policy level of stakeholder agencies (RHD, police, BRTA etc.), a significant level of awareness and recognition of road safety was observed. However, there was a need for a clearer understanding of what had to be done in future.
- Among the road engineering community, some awareness and understanding was observed. Road safety improvement was often confused and mixed with capacity improvement of road infrastructure, due mainly to the lack of traffic engineering practices.
- Among the field level of staff of other stakeholder agencies and road users, no awareness and recognition of road safety as a national problem was observed.
- The impact of general public awareness creation activities by BRAC and other NGOs was not conclusive for the lack of monitoring and post-impact assessment study.

Concerning capacity-building in related government agencies, the report observed:

- Activities for capacity-building in and the strengthening of the NRSC secretariat and the Road Safety Unit of RHD were not significant. Greater efforts are needed to make these institutions functional.

- Trainings for local engineers were minimal and engineers were not trained on the use and application of standards, manuals and guidelines.
- Training of police has been negligible and no initiative has been undertaken to strengthen the Traffic Training School of the police.

Safety manual, handbook and guidelines

Almost all of the manuals and guidelines were prepared by foreign consultants funded by government and donor agencies. Local engineers and professionals were not involved in their preparation and no training workshops were organized. Local professionals had little or no understanding of these manuals and, as a result, they failed to appreciate the utility of these documents in their work.

Evaluation of geometric improvement

The implementing agencies have not undertaken studies to evaluate the performance of the geometric improvement measures on different roads. A study was conducted to evaluate the effectiveness of black spot improvement measures on Dhaka-Aricha Highway. The major improvement measures included widening of the carriageway, along with alignment correction, the construction of bus bays, the installation of concrete guard posts and warning gates with speed limit signs at both entry and exit points.

The study revealed that the limited site-specific safety improvement measures were very effective in reducing the frequency and severity of accidents. However, in a few places the implemented accident countermeasures did not produce the desired level of positive effects for reasons such as the presence of intense roadside hawking and non-motorized activities, the conflicting use of road space and the absence of enforcement measures. Further details can be seen in Muniruzzaman (2004).

NRSC has been preparing national road safety strategic action plans for three-year periods and has prepared a fifth plan. The implementation of the plans, however, is very insignificant for the following reasons:

- The action plans are merely the compilation of some activities of different organizations on road safety or related issues. They are not prepared on the basis of priority needs, goals to achieve or a strategic vision and established targets.

- There has been no mechanism in place to oversee plan implementation.
- There has been no indication of budgetary requirements or how funding requirements would be met.
- No time frame for implementing the activities has been provided.

Accident Research Institute (ARI)

ARI is carrying out its activities in two broad areas, namely road safety research and training:

- *Road safety research and investigations.* ARI has conducted road safety research and investigations to better understand accident characteristics.
- *Road safety training and awareness programmes.* ARI has organized a series of capacity-building activities for professionals, practitioners and other interested parties at the national and local levels. It has also established a network with various departments, institutions and organizations to promote road safety. These initiatives have contributed to raising the level of awareness and capacity of policymakers, professionals and other stakeholders.

Road Safety Cell and district road safety committees

The Road Safety Cell and the district-level safety committees made important contributions in creating awareness at local levels. However, these institutions are currently not very functional.

Highway police

A separate highway police act has yet to be enacted. The police lack manpower and the necessary logistics support, including vehicles. Most of the staff work on deputation from the regular police force. They do not have any power to prosecute the traffic law violators and depend on the support of the national police.

Speed limit zoning and speed restriction rules

Speed limit zoning was promulgated through a Gazette notification in 2006. Subsequently, speed limit signs and markings were posted along the roads. Ex-post evaluations conducted by ARI and other organizations have

shown that most of the drivers did not have a sufficient understanding of these traffic signs and markings. It was also revealed that even those who understood did not comply. In addition, due to the high resale value of steel posts and plates, the theft problem was acute and it was difficult to maintain the traffic signs.

Traffic accident database

It is widely recognized that the road traffic accident database is not complete and does not contain adequate information on road accidents. Since DFID technical support ended in 2005, BRTA has not had the resources to continue training police on the collection and entry of road traffic accident data. Due to the lack of continued training and monitoring, the level of underreporting has increased, particularly on injury and property damage only (PDO) accidents. ARI is making efforts to reduce this problem by training the police personnel who are responsible for data recording and storing, and also by providing technical support.

V. RELATED ISSUES, CONSTRAINTS AND REQUIREMENTS

Increasing road network, motorization and urbanization

The government is making substantial investments in building the country's road network. With the expansion of the road network and the increase in vehicular traffic, road transport has become the dominant mode for the carriage of freight and passengers in the country. Further, with rapid urbanization, the urban transport issues of mobility, congestion, safety and environmental aspects are becoming increasingly important. The rapid increase in the level of motorization and urbanization could critically worsen the safety situation and become unmanageable unless well-coordinated and systematic approaches are considered at this time.

Underreporting of accidents

Widespread underreporting and incomplete collection of specific details on accidents are a major problem. Most of the injury and property damage accidents are not reported at all. Many fatal accidents in remote areas are also not reported. A case study on selected police stations adjacent to highways has shown that there is a significant difference in the number of accidents between the MAPP5 accident database and the First Information Report (FIR).

Institutional weaknesses

Road safety improvement efforts and initiatives have been seriously affected by institutional weaknesses. Lack of support, coordination and collaboration among safety stakeholders are among the leading barriers to institutional capacity-building. Fragmentation of responsibilities between agencies with insufficient inter-agency coordination, low levels of staffing and lack of professional capacity, lack of trained traffic police for effective enforcement and traffic regulations, inadequate dissemination of road safety research-based knowledge, and too few resources directed towards tackling the safety problem are some of the major reasons for agencies not being able to discharge their responsibilities. Activities implemented so far have generally not been coordinated or integrated, resulting in isolated efforts providing unsustainable benefits.

Lack of national commitment and targets

Many countries, including some developing countries, have formulated national road safety targets for reducing road accidents and fatalities. Unfortunately, no such commitments or targets have been set by the highest-level authorities.

Resource constraints

Road safety projects in Bangladesh are dependent on insignificant levels of local financing. Without a stable and sufficient flow of funds for road safety, attempts to address road safety problems would not meet with much success. It is necessary to establish a national road safety fund which could be financed through road user charges and levies on insurance company revenues and automobile company revenues.

Wrong policy

Until now, more focus has been given to increasing road length and the construction of bridges without much consideration for road maintenance and road safety. Road construction has followed standard geometrics with little concern for road safety. Undertaking/implementing road safety programmes/initiatives as a component or a sub-component of other large road improvement projects has resulted in lower attention by the concerned road-building agencies.

Lack of government and private partnership

Without the full participation of all concerned actors in the public and private sectors, it is difficult to make any significant progress in improving the road safety situation in the country. In this respect, partnership of the government agencies with non-governmental actors in planning, project implementation, funding support, capacity-building and public awareness campaigns is vital. Unfortunately, such initiatives are extremely rare in Bangladesh. There is a strong need to develop a global partnership with international aid, funding and social welfare organizations, and academic and research institutions.

Non-standard, informal, defective and road unworthy motor vehicles

A large number of non-standard and illegal informal vehicles are operating all over the country, particularly in rural areas. These vehicles pose a serious threat to safety on roads. The most common defects that these vehicles appear to have are faulty brake and indicator lighting systems, worn-out tyres, loose wheels, and overloaded axles. There are no data on these vehicles and there has been no assessment of their performance and ability to operate and manoeuvre in the road traffic flow. There is an urgent need to consider this issue. Further, a significant number of formal vehicles are also thought to be defective and road unworthy. They are also a threat to road traffic safety. The current vehicle inspection regime of BRTA has failed to tackle these issues.

Incompetent drivers

A study was carried out by Hoque et al. (2007) to assess drivers' practical driving experience and skill. It was found that 92 per cent of drivers did not have any formal training. The study also revealed that a considerable number of drivers (about 53 per cent) had obtained their licences by illegal means. Incompetent drivers driving with fake licences appear to be a major concern to safety. Strict licensing requirements are critically important. Effective driver testing, good control and registration of driver training schools and driving instructions are priority requirements.

Road engineering and environmental deficiencies

Improper planning, design and implementation are prevalent in the country. The unplanned development of road networks, uncontrolled roadside development, poor layout design and inappropriate roadway

interfaces pose significant and serious road safety hazards. There is a specific need and much scope for road environment improvements aimed at correcting the most common deficiencies through wider application of road safety audits and risk assessments. Safety should be incorporated and integrated into planning, design, construction, operation and maintenance phases rather than being applied as a retrofit.

Inadequacy of police inspection and legislation

It is important to intensify enforcement and educational programmes to alleviate the problems of road accidents. Current levels of traffic law enforcement, vehicular regulations and road users' education are exceedingly low. The problem of law enforcement needs to be urgently tackled.

Lack of safety education and awareness

Lack of safety education and awareness among all road users, including children, women, pedestrians, passengers, drivers and vehicle owners, is one of the major safety issues in Bangladesh. However, road safety education and awareness, especially for children and rural people, is an effective tool for improving the behaviour of road users. Public education should be carried out on a continuing basis by community leaders and local officials. Voluntary organizations and governmental and non-governmental organizations can be encouraged to prepare educational films on safe walking, crossing, alighting and boarding, and safe driving practices.

Poor accident data recording system

Currently, the only accident database in Bangladesh is based on police reports. No hospital or insurance-based accident database has yet been developed. ARI is continuing its efforts to develop a newspaper-based accident database but newspapers have large reporting inconsistencies and generally highlight major fatal accidents. Accidents resulting only in injuries or those occurring in remote areas are almost unseen in newspaper reports. Multiple independent databases are needed to reduce underreporting and to maintain and improve the quality of information as well as to meet various requirements.

CONCLUSION

Road traffic crashes are predictable and therefore preventable. In order to combat the problem, there is a need for close coordination between

all concerned public and private agencies. Appropriate resources need to be allocated to improve safety, which is currently far below what is required. Addressing the road safety problem is a considerable challenge for transport and road safety professionals in Bangladesh. There remains much scope for improving road safety and, for that, known and proven interventions need to be implemented with due urgency, ranging from education, engineering and enforcement. Initiatives to improve the conditions would require renewed government commitment and resources, trained personnel, safety specialists and researchers to build up local capacity. One fundamental aspect that may be considered by the government would be to create an organization dedicated to initiating and coordinating road safety activities. Realistic fatality and casualty reduction targets need to be established and adequate technical and financial resources to bring about the required improvements need to be made available. It is believed that regular and sustained monitoring and evaluation of safety initiatives will help in determining appropriate and proven measures which can be incorporated into the design and planning of transport infrastructure.

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SUSTAINABLE AND REPLICABLE ROAD SAFETY SOLUTIONS FOR THE LOWER- AND LOWER MIDDLE-INCOME COUNTRIES BASED ON THE VIET NAM MODEL FOR INCREASING MOTORCYCLE HELMET USE

Kathryn Lankester and Greig Craft*

ABSTRACT

Viet Nam's experience in increasing motorcycle helmet use offers a replicable model for countries seeking to decrease the high and rising costs of road traffic accidents. Achieving universal helmet use was a critical step to reducing high fatality rates in a country where motorcycles represent 95 per cent of personal vehicles. Helmet use rates in Viet Nam rose from between 3-30 per cent in 2007 to over 95 per cent in 2008; during the same period accident fatalities declined 12.2 per cent, despite the rise in motorization rate. This paper outlines the model for successfully increasing helmet use in Viet Nam. The model addressed (1) market failures that made helmets unaffordable and unappealing; (2) weak legislation and enforcement; and (3) public ignorance of the safety benefits of helmets. The sustainable and replicable Vietnamese model is useful for the consideration of policymakers and public health advocates in low- and lower-middle income countries, particularly where motorcycles compose a large part of personal vehicles and road accidents.

Keywords: Viet Nam road accident, motorcycle accident, helmet use

INTRODUCTION

Low- and lower-middle income countries (LICs and LMICs)[1] face a growing crisis from road traffic accident fatalities and injuries. All such countries must seriously improve road safety to avert major loss of life and of economic productivity.[2] To do so, developing countries should and will be

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[1] According to the World Bank definition, low income is $935 or less and lower middle income is $936 -$3,705 per capita. See www.worldbank.org.

[2] Road traffic accidents, unlike many causes of premature death, strike the most economically active segment of the population. For example, in 2000, RTAs were the second killer worldwide of those 5-29 and third of those 30-44 (Peden et al., 2002). They also incur significant costs on society, often 1-3 per cent of GDP (ADB, 2005a).

looking for model strategies that address the particular challenges of rapid motorization in the developing world. Increasing motorcycle helmet use is a key road safety intervention in developing countries because: motorcycles are often a large proportion of personal vehicles; high helmet use quickly reduces fatalities and high-cost brain injuries; and helmet use is an affordable, high return investment (see WHO, 2004 and 2006). This paper draws on the experience of Asia Injury Prevention Foundation[3] and presents Viet Nam's path to achieving near-universal helmet use on motorcycles as a best-practice model that can be replicated in other developing countries to decrease high and rising costs of road traffic accidents (RTAs).

For the people of Viet Nam, the explosion of motorcycles on the streets symbolizes a new kind of freedom and represents the country's vibrant future. The country has seen a more than 330 per cent increase in the number of registered motorcycles from 1999 to 2008 (NTSC, 2008). The increase is a result of factors that include: (i) the increase in purchasing power and market access to products such as motorcycles that have occurred during the *doi moi* period of economic opening; and (ii) a very dense, growing population.

Motorcycles likely emerged as the dominant personal vehicle because: (i) they are less expensive than cars;[4] (ii) the country's climate is tropical or temperate, on average, making motorcycles comfortable year round; and (iii) there are still portions of Vietnamese cities that are unreachable by car because of the narrow residential alleyways. As of 2004, motorcycles accounted for an estimated 95 per cent of personal vehicles (NTSC, 2008).

The mobility brought by motorcycles unfortunately puts a generation of riders at considerable risk. Motorcycles are involved in a large percentage of the RTAs that lead to fatalities and serious injuries. In South-East Asia, an estimated two thirds of RTA fatalities are motorcyclists (Cable, 2008). For example, in Cambodia, road traffic accidents are the country's largest non-communicable health burden[5] (Hassan, 2008), and motorcycles the greatest source of RTA deaths and injuries, within which unhelmeted riders are a significant at-risk group (Ouellet and Kasantikul, 2006).

[3] Asia Injury Prevention Foundation (AIP Foundation or AIP) is an internationally operating nonprofit organization dedicated to combating the epidemic levels of road accident casualties in South-East Asia. The Foundation was established in 1999 and is a United States-registered 501(c)3 charitable organization. In addition, AIP Foundation owns Vietnam Safety Products and Equipment Company (VSPEC) which produces Protec-brand helmets distributed in Viet Nam and neighbouring countries.

[4] For example, a new Honda Wave (a popular model in Viet Nam) costs in the range of $800.

[5] Deaths and injuries.

Head injuries represent the most devastating injury subcategory (Peden, 2004). Victims who survive a head injury often suffer brain damage that impedes their ability to continue as a breadwinner, and in fact may require a lifetime personal care that can drain resources from already impoverished families (Hanh et al., 2008 cited in Hill et al., 2009). The logic for using helmets to address this issue is straightforward.

Helmet use makes a difference. The recently released Cochrane study recognized that helmets can reduce the risk of fatality by an average of 42 per cent and of severe injury by 69 per cent (Liu et al., 2008). A crash-case study of motorcycle accidents from Los Angeles and Thailand similarly found that unhelmeted riders were two to three times as likely to be killed and three times as likely to suffer a "disastrous outcome". Universal helmet use would prevent about 80 per cent of fatalities and brain injuries in survivable crashes (Ouellet and Kasantikul, 2006). By extension, high rates of helmet use lead to fewer deaths, shorter hospital stays, and speedier recoveries (Peden, 2006), all of which reduce the economic burden on society and the emotional burden on families.

Despite these simple truths, helmet use remains low in many countries. Until December 2007, only 3-30 per cent of Vietnamese riders wore a helmet when on a motorcycle (AIP Foundation, 2007). This was not due to lack of exposure to the devastating impacts of RTA head injuries. A survey conducted in preparation for the Asia Injury Prevention (AIP) Foundation public awareness campaign found that all respondents had been involved in some form of motorcycle accident in the past 18 to 24 months and knew of someone who had been killed or seriously injured in a motorcycle accident. Despite their exposure to the consequences of being involved in a motorcycle accident and the prevalence of accidents, none of the respondents felt it was necessary to wear a helmet when driving anywhere other than on major highways.

This research indicated that variations on simple, everyday excuses were the nearly ubiquitous reasons given for helmet non-use. They included: (i) wearing a helmet is uncomfortable and hot; (ii) you look stupid wearing a helmet when no one else is; (iii) it won't happen to me; (iv) I drive very slowly in the city, so it's not necessary; and (v) I can't hear when I'm wearing a helmet; it's like wearing a rice-cooker on your head.[6] Notably, these excuses continued to dictate behaviour despite laws that were supposed to increase helmet use. RTAs continued to kill people on the order of 13,000 people a year and to leave another 30,000 injured, some to face the life-altering consequences of severe head trauma or disability (NTSC, 2008).

[6] See also Craft (2008).

Then overnight, on 15 December 2007, Viet Nam's millions of motorcyclists began wearing helmets, with nearly 100 per cent compliance. That date, 15 December, marked the first day of a new helmet use law. Immediately, adult peak[7] helmet use rates in Viet Nam rose from 3-30 per cent to 98-100 per cent (AIP Foundation, 2008a). Over the course of 2008, Viet Duc Hospital[8] reported seeing 700 fewer cases of brain trauma patients than during 2007—a 10 per cent decline (Ministry of Health, 2008b). The number of head trauma patients arriving who had been wearing helmets increased 196.7 per cent, while head injuries themselves declined 75.2 per cent (Ministry of Health, 2008a). During the course of 2008, RTA fatalities dropped 12 per cent and RTA injuries dropped 24 per cent relative to the previous year (National Traffic Safety Committee, 2008).

Viet Nam's conversion to nearly universal helmet use is remarkable. Why was it so effective where previous attempts had failed?

AIP Foundation found the model for successfully increasing helmet use in Viet Nam was one that addressed: (i) the market failures that made helmets unaffordable and unappealing; (ii) weak legislation and enforcement; and (iii) public ignorance of the safety benefits of helmets. In addition, a holistic approach achieved through the collaboration of cross-sector partners at all levels was key. Piecemeal solutions to address helmet use had been attempted since 1994, but they had all been unsuccessful. The difference in 2007 was that all stakeholders were mobilized and coordinated to address this multifaceted problem in a multifaceted way.

This paper outlines key steps that created the success of the 2007 helmet use increase. It concludes with a summary of lessons learned for other developing countries. Viet Nam's experience demonstrates that, without a clear understanding of the different facets of the problem, solutions will be ineffective and unsustainable. Another key resource and guide for this process is the World Health Organization report, *Helmets: A road safety manual for decision-makers and practitioners* (WHO, 2006).

[7] Adult indicates over age 14 and peak indicates during weekdays.

[8] A major hospital and trauma center in Hanoi.

I. MARKET FAILURE: MAKE MORE AND MORE APPROPRIATE HELMETS

In 2000, helmets available to Vietnamese consumers were hot, heavy, uncomfortable to wear, and most helmets did not allow ventilation. The majority were imported rather than being produced locally. Low helmet use continued through the early 2000s, during which time the motorcycle fleet in Viet Nam surged, putting more people at risk. Changing this situation meant creating comfortable, fashionable helmets that were affordable.

First, revision of the helmet standard was necessary to bring comfortable helmets to the market—a process for which AIP Foundation provided technical assistance to the Government. The new Vietnamese helmet standards are comparable to other international level standards, but they endorse features for a "tropical helmet" regarding head coverage areas, open hearing areas, allowance for peripheral vision and ventilation slots for air flow. Not all international standards allow for ventilation, for example. This was critical for public acceptance of a helmet in a hot climate. The Viet Nam Motorcycle Standard for Adults TCVN 5756-2001 was approved on 11 May 2001.

Second, safe, quality helmets needed to be widely available. AIP Foundation established a subsidiary, Vietnam Safety Products and Equipment (VSPEC or Protec), the world's first helmet factory owned by a non-profit organization. The Protec helmet company sells TCVN-compliant helmets, produced in a factory whose workforce is 20-30 per cent in wheelchairs, and AIP Foundation dedicates all profits of VSPEC to advocacy work and helmet donation to children. This socially entrepreneurial model was made possible by financial support from corporations and charities that enabled the helmet factory to be constructed with minimal debt.

In May 2002, the non-profit Protec factory opened to produce high quality, affordable helmets. A helmet testing lab was installed where special equipment tested safety elements ranging from the strength of helmets' chin straps right through the ability to withstand side-impact collisions. Specifically designed for the unique climate and traffic conditions of Viet Nam and Asia, Protec "tropical" helmets are lightweight, well-ventilated and do not obstruct hearing or peripheral vision. The tropical helmet quickly caught on, and there are now several reputable producers of these helmets, which continue to be the most common model seen on the streets of Viet Nam today.

Reducing the cost of helmets was critical to sustain high helmet use as sustainability is enhanced when people purchase their own helmets without subsidies. Similarly, helmets must be inexpensive enough so that people will wear them every day, instead of saving them for special occasions, and will be able to replace them as often as necessary, especially

after an accident or after 2-3 years of use.[9] People must be able to afford a "real", high-quality helmet—if those helmets are too expensive then people will likely opt for cheaper "fake" helmets that do not protect them.[10]

A. Legislation and coordinated, collaborative government involvement

Successive laws were passed in the 1990s and early 2000s to increase helmet use, and yet were ineffective.[11] In 1995, Decree 36/CP (29 May 1995) provided no penalty for riders without helmets, leaving the legislation with no enforcement mechanism. With Resolution 02/2001/NQ-CP (02/3/2001), the Government regulated that helmet wearing on motorcycles was compulsory on certain roads starting June 2001. Covered roads included national highways but not inner city or provincial roads. In 2003, Decree 15/2003/ND-CP (19/2/2003) regulated that police could either impose a warning or a fine of 10,000-20,000 dong for people who did not wear a helmet on the regulated roads. The fine was moderately increased in 2005. The triviality of the fine along with limited enforcement resulted in low compliance.

When limited coverage legislation was introduced, many international stakeholders, including AIP Foundation, Global Road Safety Partnership, UNICEF and WHO, began advocating a universal mandatory helmet law that covered all riders and passengers on all segments of the road network.

In the spring of 2007, the Minister of Transport Mr. Nghia Ho Dung committed to the promulgation of a mandatory universal helmet law.[12] A new law might easily have gone the way of the ignored and poorly enforced previous mandates. However, by 2007 education, awareness-raising, and advocacy around helmet use was substantial, which created an enabling environment for change. Nevertheless, securing that all relevant government agencies became invested stakeholders was critical. This time the new law

[9] Over the course of a helmet's lifetime, heat, exposure, and the natural process of wear and tear mean that the expanded polystyrene (EPS) lining's shock absorbing impact will decline.

[10] Viet Nam's high helmet compliance rate is currently inclusive of imitation helmets. One report by the Saigon press indicated that 78 per cent of checked sample helmets in Ho Chi Minh city did not meet the TCVN Standard (Saigon Giai Phong, 2007).

[11] 29 May 1995—Decree No. 36/CP, Item c.34. Helmets must be used outside populated areas; in 2001, Decree 36/2001/ND-CP, Item 3.28 managed universal helmet use and a 20,000 dong fine, with the fine increased in 2003 and 2005.

[12] For a more detailed history of helmet legislation in Viet Nam see: Passmore, J. et al. (unpublished) *the implementation of Vietnam's national mandatory helmet law.* (WHO, Viet Nam), forthcoming.

had that strong support from multiple ministries, coordinated by the National Traffic Safety Committee (NTSC).

The NTSC played a critical role in Viet Nam's success, and as similar coordinating body should be considered in other countries. The NTSC created clarity at a national level about road safety policy. Working with a variety of groups, it brought key national players into the process of drafting and preparing for enactment of the legislation, including the Prime Minister, the police, and the army. Similarly, it facilitated collaboration with international non-governmental organizations such as AIP Foundation, the Global Road Safety Partnership, the World Health Organization, national aid programmes and others including private sector partners. Government commitment was effective because it was created through multilateral cooperation within different ministries and outside bodies. The NTSC achieved this because it had strong leadership and was appropriately positioned to engage decision makers within relevant agencies.

On 29 June 2007, the Government established Resolution 32/2007/NQ-CP on urgent solutions to limit traffic accidents and traffic jams. Resolution 32 regulated that from 15 September 2007, all motorcycle riders and passengers on all highways had to wear helmets, and from 15 December 2007, helmet wearing would be compulsory *on all roads*. An accompanying decree in September established a 100,000-200,000 dong fine for not wearing a helmet, followed up by a Ministry of Police instruction to enforce the decree.

The initial legislation still left some loopholes open. First, it did not explicitly require helmets to be buckled, which created difficulty for enforcement. Second, there were conflicts with previous legislation preventing monetary fines against children; hence legislation provided no means to penalize adults carrying unhelmeted children. Those two loopholes, as well as the need for more stringent rules regarding helmet quality, have been, or are being, addressed. This carries lessons for other countries to address such details in the initial legislation.

II. EDUCATION AND AWARENESS

A key difference in the implementation of the 2007 helmet legislation, as opposed to earlier legislation, was the undertaking of significant education and awareness activities.
Viet Nam is a young country, with 25.6 per cent of the current population under the age of 14 (United States Central Intelligence Agency, 2008). That context provides Viet Nam the opportunity to train a large section of its future drivers now with primary and secondary school programmes.

Traffic safety education programmes in Vietnamese primary schools have been phased in over the course of the past 15 years, with the support and cooperation of the Ministry of Education and Training (MoET). Basic traffic safety education was first implemented in 1993-1994 and books were first introduced in 1999 without any supporting materials.

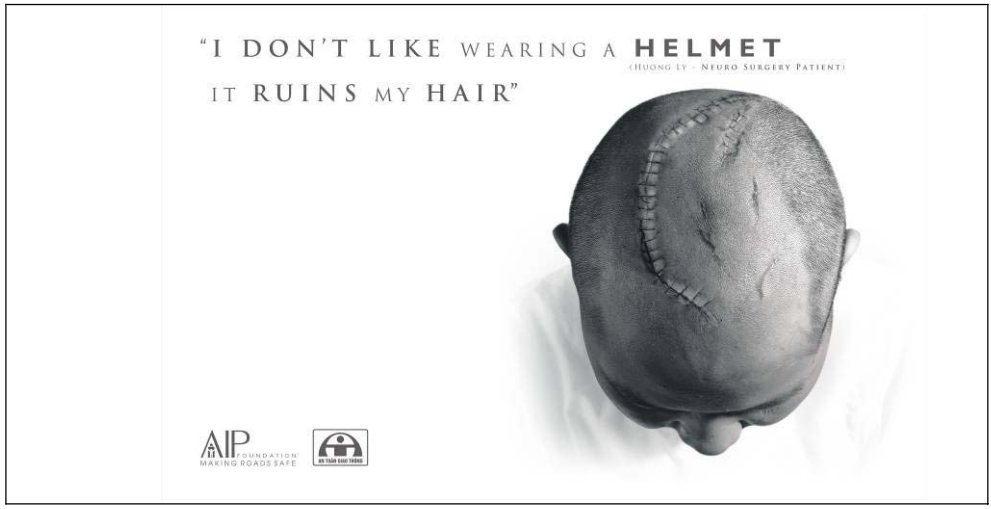
In 2001, AIP Foundation developed, in coordination with MoET, an active teaching methods training manual and designed a traffic safety curriculum for students. Parts of this curriculum were then adopted by the Vietnamese education system and made mandatory. This curriculum consists of 4.5 hours of age-specific activities related to road traffic safety each year, at each grade of primary school.

AIP Foundation has continued its engagement with primary schools nationally, including a full traffic safety curriculum, complete with interactive teaching methodology training, non-class activities, and additional school supplies. Over the past 10 years it has provided nearly 450,000 helmets to children throughout the country through school-based programmes. The Government is also continuing to stress the issue, evidenced by their issuing of Resolution number 32/2007/NQ-CP on 29 June 2007 regarding urgent solutions for restraining traffic accidents and congestion, in which MoET was assigned to be responsible for working out a suitable traffic safety education programme in schools. Other foundations, such as Toyota Foundation, have taken note and also begun to provide resources to support traffic education programmes.

In addition to school-based programmes, in 2007, AIP Foundation initiated the Viet Nam Helmet Wearing Coalition (VHWC),[13] which launched a public awareness campaign before the announcement of the new legislation. It was designed to target quotidian excuses that were threatening people's lives. In response to the striking importance of debt to family in Vietnamese culture, the campaign highlighted family members who were indirectly affected by an accident and emphasized the burden victims could inadvertently place on their entire family. The emotional texture of the campaign was designed to appeal to Viet Nam's young population. The look of the campaign changed over its three phases. For instance, phase one began with black and white images of road traffic victims juxtaposed with a common excuse for not wearing a helmet. In a second phase, Vietnamese celebrities were shown wearing helmets in their daily lives, as an ironic reminder to wear helmets at all times.

[13] The VHWC is chaired by AIP Foundation and members include the Royal Danish Embassy, the Australian Embassy/AusAID, the United States Embassy, the World Bank, the Asian Development Bank, Intel Product Viet Nam, Michelin Asia, the FIA Foundation for the Automobile and Society, the World Health Organization, Talisman Energy, UNICEF Viet Nam and Safe Kids Worldwide.

Figure 1. Viet Nam Helmet Wearing Coalition phase I billboard image in English



Initially, the VHWC campaign met several challenges. First, a comprehensive multimedia national campaign demanded considerable funding to reach a significant part of Viet Nam's 86 million people. Second, the country's culture and government infrastructure had not created an enabling environment for such a campaign. Until recently, any critique of the status quo in the public arena was tantamount to directly criticizing the Vietnamese Government. Additionally, public service announcements continued to rely on painted-poster aesthetics and lecture-like radio broadcasts popularized during the 1970s and 1980s. A public education campaign run by a non-State organization with a stylish, marketing edge had not been conducted before.

VHWC campaign activities included concerts with appearances by road traffic safety victims to give testimonials, billboards, bus-side advertisements, television commercials, and newspaper advertisements. VHWC campaign evaluations found the campaign images had high recognition rates in Can Tho, Danang, Hanoi, and Ho Chi Minh City. AIP Foundation evaluations found that people who attended concerts or saw billboards repeatedly mentioned that they identified with the "excuses" or behaviour of traffic victim spokespeople, and the campaign made them aware that they were also exposed to the same risks as those who had already suffered traffic accidents. Surveys found that the campaign's television advertisements were widely considered to be "appropriate" by the Vietnamese public, despite being drastically different than any previous public education campaign (AIP Foundation, 2008b). In follow-up surveys,

people with exposure to the campaign were more likely to cite "safety" as the reason for wearing a helmet.

People additionally began to be increasingly informed about helmets by the national media. Once the legislation was announced, newspaper media included coverage of implementation, justifications, helmet quality, purchasing helmets, and other benefits (Hill 2009). Though the impacts of the VHWC campaign and the general media coverage are difficult to disaggregate, it was observed that helmet use increased before the legislation was enacted. Within four months of the campaign's launch—and before the legislation was enacted—the percentage of people wearing helmets tripled from roughly 3 per cent of motorcycle users to 10 per cent. Within Hanoi and Ho Chi Minh City, helmet wearing rates doubled from 10.8 per cent to 19.1 per cent (AIP Foundation, 2007). On highways, there was a measured increase of 15.7 per cent.[14] Those figures indicate that increased public awareness can change behaviour. However, in conjunction with legislation, helmet wearing rates tripled again, underlining the fact that government support and enforceable legislation may be necessary to achieve very high helmet use rates.

III. RESULTS AND BENEFITS

There is no true natural experiment with which to test the efficacy of universal helmet use in Viet Nam. Directly measuring its impact is complicated by the fact that other factors which may have connections to motorcycle RTA fatalities and injuries continued to change over time in Viet Nam. These include GDP per capita, population, number of vehicles registered and the number of accidents. See table 1 for a summary of the trends over time in some of these variables.

[14] Sample size: 800 motorcycle users.

Table 1. Yearly data for Viet Nam

	1999	2000	2001	2002	2003	2004	2005	2006	2007
Accidents per 1 000 000 population				15.9	16.4	19.0	20.3	36.6	52.8
Motorcycles per 100 population	7.7	9.0	11.3	13.6	14.9	17.3	20.4	23.2	26.5
Population (millions)	76.6	77.6	78.7	79.7	80.9	82.0	83.2	84.4	85.6
GDP per capita (hundreds of purchasing power parity (PPP) dollars)		14.2	15.3	16.5	17.8	19.5	21.4	23.6	26.0
Fatalities per 100 000 population	9.1	9.7	13.3	16.1	14.0	14.3	13.4	14.7	15.0

Source: National Traffic Safety Committee, IMF.

In addition, many accidents that once would have been serious or fatal (and therefore reported), might now be minor (and therefore go unreported). Evidence exists that this may have occurred as reporting by the Ministry of Health comparing the first quarter of 2007 (pre-campaign, pre-helmet law) to the first quarter of 2008 (post-campaign, post-helmet law) revealed that traffic injury patients arriving at hospitals declined by 89.5 per cent (Ministry of Health, 2008a). The decline in the number of traffic patient admissions implies that existing data collection systems in Viet Nam may be unable to capture a non-biased before and after sample.

To generate a basic sense of what Viet Nam's RTA fatality rate might have been under a business as usual (BAU) scenario in 2008, AIP Foundation generated three counter-factual projections. The first one was based on the number of motorcycles per 100 population; the second one was based on the number of accidents per 1,000,000 population; and the final one was based on GDP per capita. Using a simple correlation, this generates the following predicted values for 2008.

Table 2. Alternative projections of 2008 fatalities under business as usual

	RTA fatalities per 100 000	R-squared	Difference	Percentage different from actual
Actual in 2008	12.95			
2008 Projection (based on GDP per capita)	16.45346	0.4072	-3.37894334	-26.1%
2008 Projection (based on accident rate)	14.80041	*0.0229*	-1.84837334	-14.3%
2008 Projection (based on motorcycle density)	16.59608	0.4581	-3.64085683	-28.1%

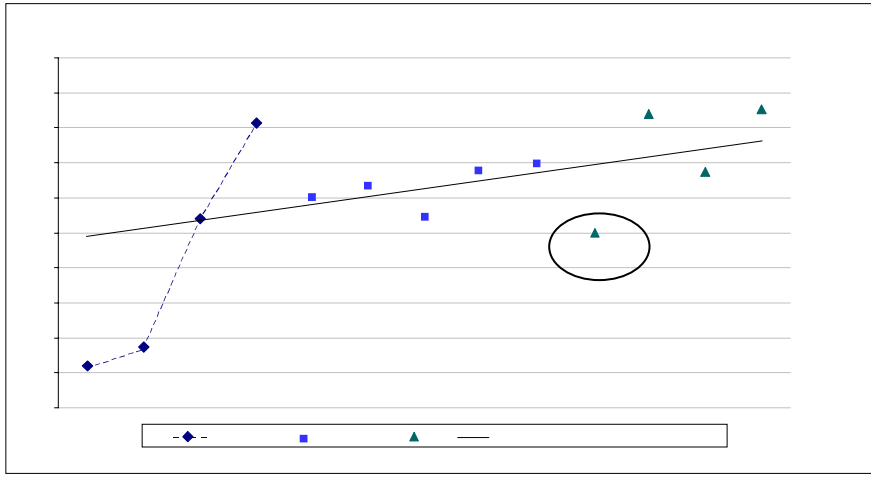
Source: Data on fatalities, accidents and number of motorcycles from National Traffic Safety Committee (NTSC, 2008); Data on population, GDP per capita (purchasing power parity (PPP) dollars) from the International Monetary Fund (IMF, 2009).

This table indicates the number of recorded road traffic accident fatalities per 100,000 population during 1999-2008. Using time-series data on the number of motorcycles per unit population, accidents per unit population, and GDP per capita (PPP dollars), simple linear correlations were used to generate three different business as usual counterfactual projections of fatalities per 100,000 population in 2008.

The figure below charts three series of RTA fatalities per 100,000 population: (i) 1999-2002, until a new definition was adopted; (ii) 2003-2007, including with a linear projection for these values; and (iii) 2008 actual values and the three projected values. By all three projections, 2008 RTA fatalities per 100,000 were lower than expected under a business as usual scenario (ranging from 14.3-28.1 per cent lower). The actual number of recorded fatalities was 11,243.

While none of these projections should be taken as a robust BAU estimate, they do corroborate the fact that expected RTA fatalities in 2008 were higher than the observed RTA fatalities, and that no trend in GDP per capita, motorization, or the number of accidents immediately explains the differential. This further supports on-the-ground assessments that the increase in helmet wearing in 2008, as the key road safety shift from 2007 to 2008, is likely responsible in large part for the decline in RTA fatalities.

Figure 2. Projected and actual RTA fatalities in 2008 in Viet Nam



Source: Data on fatalities, accidents and number of motorcycles from National Traffic Safety Committee (NTSC, 2008); Data on population and GDP-PPP per capita from the International Monetary Fund (IMF, 2008).

Note: This figure graphs the number of recorded road traffic accident fatalities per 100,000 population during 1999-2002, under the first definition used by the Government and separately graphs the same statistic for 2003-2007. A third series shows three counterfactual projections for 2008 fatality rates as well as the actual 2008 fatality rates. Counterfactual projections were made using simple linear correlations with the number of motorcycles per unit population, accidents per unit population, and GDP per capita (PPP dollars).

IV. LESSONS LEARNED AND BEST PRACTICES

From the Viet Nam model, several lessons emerged:

- *Universal and complete*. Some of the difficulties that emerged early on were the result of covering only certain cities or roads. Ongoing difficulties occurred because of the differences in enforcement between children and adults, as well as the fact that enforcement is generally lower in the evenings and on weekends. Similarly, some countries have passed laws covering only motorcycle drivers, but not passengers. These practices may initially be justified as politically necessary and expedient, but measures must be in-built to expand the coverage. Without doing that, people begin to perceive a health-related justification for the restriction (for example, drivers are at greater risk than passengers, children are too weak to wear helmets). This undermines people's comprehension of the safety need for helmets and the protection they offer. Finally, the law should

specify that the helmet should be buckled or otherwise fixed to the person's head so that it will remain on during an accident.

- *Quality*. Standards should be put into place immediately to control helmet quality and a plan should be put in place to eliminate fake or low-quality helmets from the market, as they give the appearance of compliance without actually providing any health benefit. Cost is a major factor in this issue; if a standard helmet is very expensive when a law comes into effect, then fake helmets are likely to be popular. This issue has implications for industrial intellectual property protection that should be discussed in advance inasmuch as possible.
- *Coordination*. There is a role for multiple sectors to play in creating success, yet these steps must be coordinated because, in isolation, they are unlikely to generate much improvement. As with many road safety issues, a multitude of actors are involved—for example, the ministries of education, health, industrial standards, and transport, and police. A strong coordinating body in the National Traffic Safety Committee with the power to advise the Prime Minister on the issue was able to galvanize these governmental and non-governmental actors into coordinated action.

In addition to these three lessons, a follow-up study of the history of the Viet Nam helmet success, led by Mary McDonnell, Van Bich Thi Tran and Nina R. McCoy of the Social Science Research Council, identified the following as some of the key factors that enabled the success of the 2007 legislation:

- Credible evidence built government commitment to the issue of road safety and to helmets as a means of responding to it.
- Public education and communication complement legislation, without which there can be little to no expected additional conformity to the law that is not generated from enforcement mechanisms alone.
- Regulations and regulatory changes must be clearly emphasized to the public and to all relevant government agencies; they should be timed in conjunction with education and awareness efforts.
- Adequate fines or sanctions are essential to changing risky behaviour.
- Sustaining change demands a planned approach for which it can be more difficult to generate resources once it seems a problem has been solved.

- Shared knowledge and information between sectors and actors enables successful collaboration, despite being difficult to accomplish; this is one area in which coordinating bodies are particularly critical.
- Social conformity generates major challenges. Cultural practices may be the root cause of conformity, in which case they must be addressed carefully. Be aware of the underlying motivations that can dictate a behaviour.

These best practices were also included in the WHO helmet manual framework.

CONCLUSION

In summary, RTAs are the second leading cause of death for young people between the ages of 5 and 29, and around the globe, they kill 1.2 million people each year—the majority in the developing world. Lost output, combined with property damage, administrative costs, medical and human cost, are taking a toll on developing economies.[15] This jeopardizes the public health systems of developing countries, undermines their efforts to fight poverty, and destroys families. The injury or death of a primary breadwinner can drop a family into poverty, with fewer opportunities for the second generation.

Innovative solutions are urgently needed so that countries can begin planning now to enable interventions to take effect as soon as possible. Wealthy countries have had decades to develop expertise and infrastructure, and these experiences will certainly be amongst the models that are looked to. However, many of these interventions can be quite costly and may not all be suited to the average stage of infrastructure development or driver awareness in developing countries. Viet Nam's experience demonstrates one example of how developing countries can tackle road safety issues that involve changing individual and institutional behaviour, in this case motorcycle helmet use.

Behavioural change strategies as a means to deal with public health challenges exhibit a non-linear relationship between beneficiaries and benefits. As Resnicow and Page discuss, public health-related behavioural change: (i) is often a quantum event rather than a linear one; (ii) is sensitive to initial conditions, highly variable and difficult to predict; and (iii) occurs

[15] In Viet Nam, Asian Development Bank (ADB) estimated the costs of RTA fatalities and injuries at 2.7 per cent of Viet Nam's GDP in 2002 (ADB, 2005b).The impact can be unevenly distributed; for example Ho Chi Minh City, which has a high volume of RTAs, may bear a burden equivalent to 6 per cent of the city's economic output (Anh, 2005).

within a complex system of multiple components that interact in a non-linear fashion and which, through adaptation, lead to results that are greater than the sum of their parts. An example of non-linearity in behavioural change campaigns is "tipping points"—dramatic changes in social behaviour that arise unexpectedly and can be started off by something as simple as a jingle or slogan (Resnicow and Page, 2008).

Viet Nam's experience with helmet use is an example of such a tipping point. For almost a decade, work had been done piecemeal and had not been reflected by the number of helmets on the road. Finally, on 15 December 2007, Viet Nam clearly reached the other side of a tipping point when helmet use skyrocketed to nearly 100 per cent. What developing countries can glean from Viet Nam's experience is that success is possible, though it may not be possible to observe it incrementally. Countries should begin with a solid assessment of the extent of the problem of helmet non-use and a survey of institutions; identify the required actions needed to address gaps in these areas; and then continue building awareness and enforcement of helmet use. In Viet Nam, even up until the day before the new helmet regulation took effect, expectations were not very high for resulting helmet use rates. However, the groundwork laid ahead of time generated dramatic and sudden results on day one.

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SOCIOLOGICAL ANALYSIS OF THE ROAD SAFETY SITUATION IN CAMBODIA: HISTORICAL, CULTURAL AND POLITICAL ASPECTS

Socheata Sann*, Sophea Sok, Tom Brijs** and Marjolein De Jong

ABSTRACT

The objective of the study is to explore the conceptual understanding of road crashes as a social issue among the general road users and to understand better the behavioural determinants of motorcycle helmet wearing among young people.

One of the conclusions is that the target population was very much aware of the fact that wearing a helmet protects them from head injuries (i.e. knowledge about the benefits of helmet wearing). The actual wearing of a helmet, though, was linked to the perceived risks and not all situations were considered risky by the road users. Therefore, further effort needs to focus on changing the perception of which situations constitute a risk, namely that all situations without a helmet are risky. The aim will be to make wearing a helmet a habit at all times by raising public awareness, targeting youth and strengthening helmet law enforcement.

Keywords: motorcycle accidents in Cambodia, helmet use behaviour

INTRODUCTION

Road traffic injuries are a huge public health and development issue, killing more than 3,000 people and disabling for life more than 15,000 every day in the world. They are the second leading cause of death globally among young people aged 5 to 29. About 90 per cent of fatalities related to road crashes occur in low- and middle-income countries (WHO, 2004). Whereas in recent decades, high-income countries have steadily and systematically reduced the number and severity of road crashes by implementing coordinated multisector prevention programmes, their numbers have increased in developing countries.

Cambodia's relative stability and growth in recent years has been characterized by a rapid increase in the volume of road traffic (20 per cent per

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year, on average). The growth in vehicle numbers, insufficient law enforcement, the lack of road safety (RS) education, speed increases and the inadequacy of health services have led to a rapidly rising number of road fatalities and injuries.

In 2007, according to Cambodia's Road Traffic Accident and Victim Information System (RTAVIS), more than four persons died and many others were injured daily on the roads of Cambodia. Between 2001 and 2007, the number of fatalities has more than tripled. With fatalities at 17 per 10,000 registered vehicles, Cambodia has the highest fatality rate in the Association of Southeast Asian Nations (ASEAN) region.

Motorcycles are the most common mode of transport in Cambodia and head injuries from motorcycle accidents account for more than 80 per cent of all fatalities. Data from RTAVIS show that only 3 per cent of victims of fatalities involved in a road crashes were wearing motorcycle helmets, while 19 per cent of the casualties suffered from fractures and more than 50 per cent suffered from serious cuts/wounds.

I. OBJECTIVE AND METHODOLOGY OF THE STUDY

Objective

The objective of this study was twofold. The first objective was to understand better the attitude of Cambodian citizens towards road safety when compared to other social problems, the confidence that Cambodians have in government agencies to do something about road safety, their confidence and support for particular countermeasures and their personal road safety experiences. The second objective was to measure the behavioural determinants of motorcycle helmet wearing among young people between the ages of 16 and 25. The study should reveal elements that can be adopted in setting up awareness-raising campaigns and educational and enforcement activities with respect to helmet wearing.

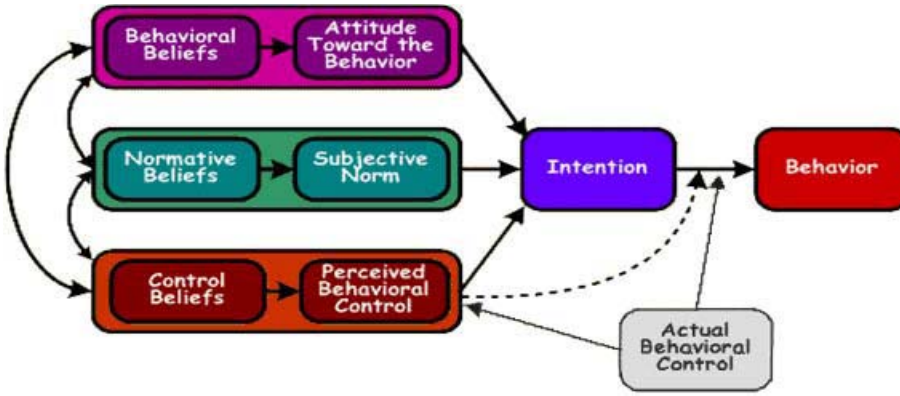
B. Methodology

In order to fulfil the first objective, a road user survey was carried out among a random sample of 729 road users in Phnom Penh city and Battambang province. For the second part of the study on the behavioural determinants of helmet wearing, 344 adolescents within Phnom Penh city were interviewed. The general road user survey consisted of several parts. The first part focused on the importance of road safety compared with other social problems, such as domestic violence, unemployment, drug use, HIV/AIDS and traffic congestion. It also enquired about the confidence that Cambodians had in government-sponsored measures to address those problems. In the second part of the survey, road users were probed about their attitudes toward particular road safety problems (such as drunk driving, speeding, not wearing a helmet, talking

on a cell phone while driving and running red lights) and the perceived effectiveness of and support for several road safety countermeasures (such as awareness campaigns, stricter enforcement, stricter laws, infrastructural improvements and improved road safety education). The interview questionnaire was pre-tested. Based on this pre-test, the questionnaire was slightly changed and the interview procedure was improved to minimize the influence of the interviewer. It was, for example, not mentioned that the interviews dealt with road safety. The general road user survey was specifically adapted to the local Cambodian situation by adding extra options related to motorcycle use and rephrasing the questions in a way that they were understandable to Cambodians.

The helmet questionnaire targeting the young people focused on the beliefs, attitudes and behavioural intentions towards helmet use and its design was based on the theory of planned behaviour (Ajzen, 1991)

Figure 1. Theory of planned behaviour



Source: Ajzen, 1991.

The theory states that behaviour (for example, wearing a helmet) is determined by people's intentions to carry out the desired behaviour and the individual's perceived behavioural control (in this case, the individual's perceived ease or difficulty of wearing a helmet). Intentions to wear the helmet, in turn, are dependent on people's attitude towards helmet wearing (positive and negative attitudes), subjective norms (the individual's perception of how important others' thoughts are about whether he/she should wear a helmet) and perceived behavioural control. The basic theory of planned behaviour model was, however, expanded using concepts from other theories, which include the protection-motivation theory (Rogers, 1975 and 1983) and the health-belief model (Rosenstock, 1966 and 1974). These additional concepts were related to:

- perceived vulnerability (does the individual consider himself

vulnerable to the risk of having a motorcycle crash?)

- perceived severity (does the individual think that the consequences of having a motorcycle crash while not wearing a helmet are severe enough?)
- response cost (the effort/cost associated with wearing a helmet)
- response efficacy (perceived effectiveness of wearing a helmet)
- behavioural willingness (to what extent the individual is willing to wear a helmet in specific circumstances)

Before designing the interviews, in-depth interviews were conducted with key stakeholders, such as the National Road Safety Committee (NRSC), the Cambodian Red Cross (CRC), the Japan International Cooperation Agency (JICA), a local non-governmental organization (the Coalition for Road Safety), the Ministry of Education, Youth and Sports (MoEYS) and the Office of the Municipal Traffic Police, in order to get an overview of the road safety situation in Cambodia. The results of the interviews were discussed with a focus group consisting of a mix of people of different ages and professions and the stakeholders mentioned above.

II. RESEARCH RESULTS

General road user survey

The majority of the people interviewed lived in a town/city (44 per cent) or along a national road (42 per cent) and only 14 per cent lived in rural areas. The numbers of women and men were almost the same. More than half of the interviewees (58 per cent) were younger than 25. The overall educational level of women was lower than that of men. Only 17 per cent of the young females and 8.6 per cent of the women older than 25 had at least a high school degree compared to 27 per cent of the young males and 37.3 per cent of the men older than 25.

The perceived importance of road safety compared with other social problems was quite high. About 64 per cent of Cambodian road users expressed that they were extremely concerned about road crashes. The importance of drug use, crime and unemployment were similar. Traffic congestion and global warming were considered important by 24 and 18 per cent of those interviewed, respectively. Other problems, such as domestic violence, petrol price sand HIV, were considered important by 38-55 per cent of those interviewed. It was remarkable that respondents were more positive about the abilities of the government to address road safety and traffic problems than to address the other problems.

About 80-90 per cent of the people interviewed perceived speeding,

drunk driving, driving through the red lights, dangerous overtaking and driving while not alert as very serious problems. The interviewees were aware of the fact that they should wear a helmet to protect themselves from injury. Stricter traffic laws (57 per cent), reduction of speed (73 per cent) and helmet use (69 per cent) were considered the most effective ways to prevent accidents.

The presence of pedestrians on the street and the bad condition of roads were considered serious problems by less than half of the people. The interviewees also stated that the government should mainly focus on motorized modes of transport and not on cyclists and pedestrians. In considering the most effective way to prevent injuries from road accidents, it was found that almost all proposed measures were supported by more than 65 per cent of the interviewees, with the exception of the increase of fines, which was supported by only 20 per cent. Two types of measures received stronger support: those dealing with wearing quality helmets and those dealing with education and awareness. A State-approved driving course received the support of almost 100 per cent of those interviewed. Generally, there was a rather high level of awareness about the need to wear a helmet. This may have been the result of a recent change in law which made wearing a helmet by drivers compulsory and of media campaigns to communicate the new law. Although the general level of awareness was rather high, only 50 per cent of the interviewees answered that driving without a helmet was unacceptable. On the other hand, speeding, driving through red lights and driving when not attentive were considered unacceptable by more than 80 per cent of the interviewees. The survey results clearly demonstrated the difference in attitudes towards measures that had to be undertaken by the interviewees and those that have to be undertaken by others. The study also indicated that family had more influence on behaviour than friends or colleagues.

The research also examined general knowledge and perceptions of traffic accidents. About 40 per cent of survey participants stated that they considered the probability of getting personally involved in an accident to be very small or small, and another 41 per cent considered the risk as medium. At the same time, more than half of them stated that they had no or limited control over whether they would be involved in an accident or not. Only 15 per cent stated they had good or total control. A general perception was that accidents happen sometimes and not much can be done by an individual to prevent them from happening but that wearing a helmet reduced the severity of the injuries.

B. Helmet survey

The helmet survey focused on students and, consequently, most of the persons interviewed were younger than 25 and had a relatively high level of education; about 60 per cent of them had a Bachelor's degree. The survey was based on the theory of planned behaviour (see methodology) and aimed at gaining a better insight in perceptions about helmet wearing. Different analyses, including factor analyses and calculation of means and regressions, were carried

out on the data. The findings from the analyses highlighted a number of factors associated with observed helmet use and the actual intention of wearing a motorcycle helmet.

Behavioural intentions are considered to be an important step towards actual behaviour. Therefore, it was interesting to note that the interviewees expressed a very strong *intention* to wear a helmet the next time they would drive a motorcycle. The study also showed that there was a high correlation of *attitudes* and *perceived behavioural control* to *behavioural intention* (see Figure 2).

Figure 2. Most important behavioural intentions regarding helmet wearing

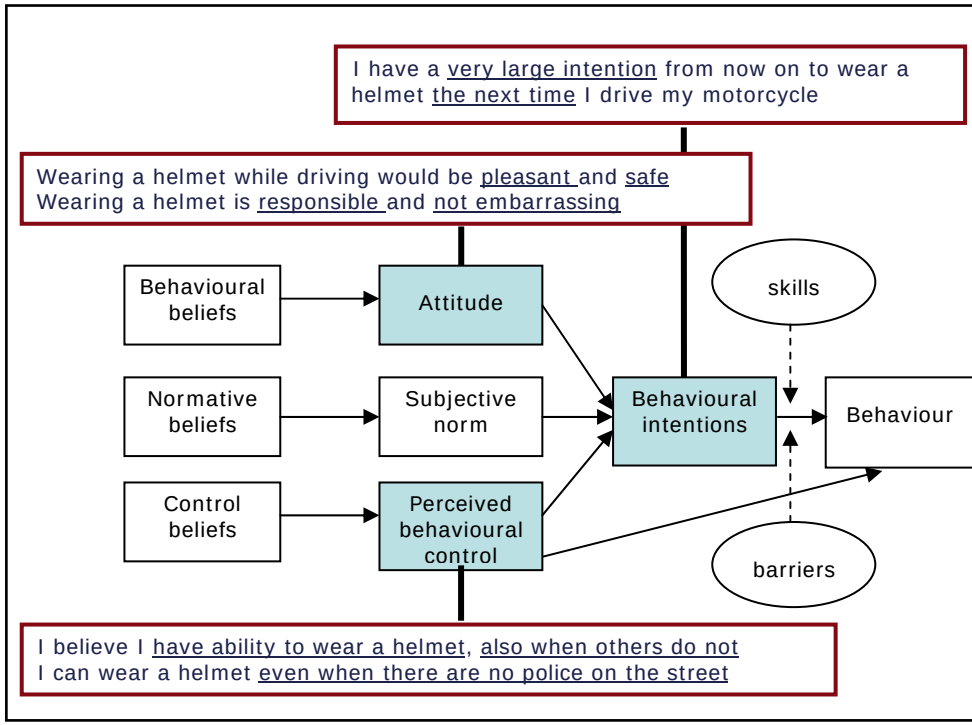
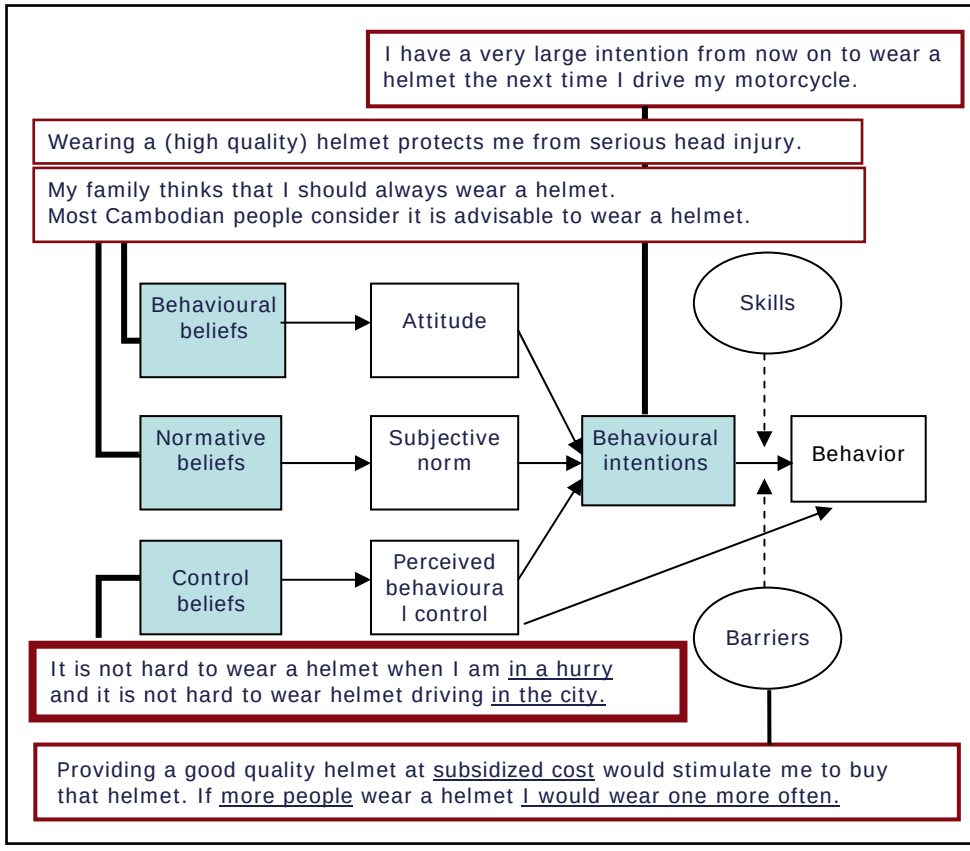


Figure 3. Most important behavioural beliefs regarding helmet wearing



Attitude is influenced by *behavioural beliefs* (figure 3). The factor analyses on responses to behavioural beliefs provided two clearly different groups of answers: one group dealing with positive attitudes and one with negative attitudes. More than 50 per cent of the respondents had a positive attitude towards the behavioural intention to wear a helmet while driving their motorcycle. The positive beliefs played a more important role than the negative beliefs, but the predicting power was not very high. Therefore, the details of the responses to individual questions dealing with positive attitudes were also examined. It was confirmed that wearing a good quality helmet to protect from head injury was more important than getting into trouble with police or protection from dust. It may be concluded that most interviewees have a good general awareness about the risks of getting injured when driving a motorbike and the fact that wearing a helmet protected them from head injuries. This was also supported by the results of responses to questions about the perceived vulnerability and severity of injuries when not wearing a helmet.

With a factor analysis on *perceived behavioural control,* a set of three related questions was found to have a high explanatory value that we related to a strong internal ability to wear a helmet even if others did not or if there was no police presence on the street. The examination of the *control beliefs* revealed that the interviewees considered it easy to wear a helmet when driving in the city and when they were in a hurry. These responses had a strong correlation with the perceived behavioural controls. On the other hand, it seemed to be more difficult to wear a helmet when driving slowly, or for a short distance, or when it seemed inconvenient, such as when the interviewees were formally dressed up, or during the night. This could mean that wearing a helmet was related to a perceived risk and that not all situations were perceived to be equally risky. Being in a hurry, for example, could be considered more dangerous than driving slowly or only on a short distance.

The third element having an influence on behavioural intentions were *subjective norms* and *normative beliefs* (see figure 3). Here, the pattern was not as clear as with behavioural beliefs and perceived behavioural controls. Two tendencies were noticed. The first one dealt with normative beliefs about the opinion of the family and Cambodian society in general. There was a correlation between the opinion that one should wear a helmet and the *behavioural intentions,* meaning that the interviewees stated that the opinion of their family and society in general was important. However, when one looks at the relation between the *normative beliefs* and the *subjective norm*, it seemed that the behaviour of friends played a more important role. The effect of what others do can also be found if one looks at the barriers to effectuating behavioural intentions into actually wearing a helmet. The two elements perceived as a barrier were whether other people were using helmets and the cost of buying a high quality helmet.

III. DISCUSSION

The analysis of the survey results from the two surveys showed some interesting similarities about what the interviewees thought about wearing a helmet. Both surveys revealed that there was good understanding of why one should wear a helmet and the respondents had a positive attitude towards helmet wearing. Moreover, the helmet questionnaire showed that most of the people surveyed believed that they were able to wear a helmet.

Although people expressed the intention to wear a helmet, in practice, there were many people not wearing helmets. From the helmet research, it was learned that there were a few important reasons for not wearing helmets. Although respondents agreed on the fact they should wear a helmet, they also stated that there were specific situations in which they found it more difficult to wear a helmet, including situations that were perceived as safe (driving slowly or for a short distance) and when it was not convenient (formally dressed up). Another important matter was the fact that the opinion of the family was important for the intention to wear a helmet but that the actual behaviour of

friends often played a stronger role in the final decision to wear a helmet. It was likely that, although family was very important, people mirrored the behaviour of their friends and, more generally, people on the street. Seeing more people wearing a helmet can encourage others to wear a helmet. The general awareness of the need to wear a helmet was very high but wearing a helmet was not a habit, but rather part of a decision-making-process. This could explain the difference between the intention of people and the actual helmet wearing rate.

CONCLUSION

The study clearly indicated that the majority of the respondents had a high level of awareness of the importance of wearing a helmet. The respondents had a positive attitude towards helmet wearing and they believed they were able to wear a helmet. Still, the rate of wearing a motorcycle helmet was low among young people. It was linked with perceived risk and not all situations were considered risky by road users. Therefore, in order to increase the helmet wearing rate, efforts need to focus further on changing the perception of the target population - the young motorcycle drivers and riders - of which situations constitute risk, namely that all situations without a helmet are risky and dangerous. The aim will be to make helmet wearing a habit at all times through public awareness-raising targeting youth and strengthening helmet law enforcement. The role of peers (friends) in an awareness-raising campaign must be further studied since the survey showed that young people were more influenced by the opinions of their close friends.

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Transport and Communications Bulletin for Asia and the Pacific

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1. Manuscripts

One copy of the manuscript in English should be submitted together with a covering letter to the Editor indicating that the material has not been previously published or submitted for publication elsewhere. The author(s) should also submit a copy of the manuscript on computer diskette, labelled with the title of the article and the word-processing programme used, or by e-mail as an attachment file. MS Word and WordPerfect are the preferred word-processing programmes.

The length of the manuscript, including tables, figures and bibliographical references, may not exceed 7,500 words. Manuscripts should be typed on one side of A4 paper in double spacing and pages should be numbered. A list of references should be included. Manuscripts are subject to editorial revision.

The title page should contain: (a) title; (b) name(s) of the author(s); (c) institutional affiliation(s); (d) complete mailing address, e-mail address and facsimile number of the author, or of the principal author in the case of joint authors; and (e) an abstract of approximately 150 words clearly stating the main conclusions of the article. Acknowledgements, if any, should appear at the end of the text.

Articles should include a final section containing the main conclusions, which should be broadly intelligible to a non-specialist reader.

2. Tables

All tables should be clearly headed and numbered consecutively in Arabic numerals. They should be self-explanatory. All tables should be referred to in the text. Full source notes should be given below each table, followed by general notes, if any. Authors are fully responsible for the accuracy of the data.

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All figures should be provided as camera-ready copy and numbered consecutively in Arabic numerals. All figures should be referred to in the text. Full source notes should be given below each figure.

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Footnotes, if any, should be brief and numbered consecutively in superscript Arabic numerals. Footnotes should not be used for citing references.

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[Book]
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[Article in journal]
Wachs, M. (1990). "Regulating traffic by controlling land use: the southern California experience", *Transportation,* vol. 16, No. 3, pp. 241-256.