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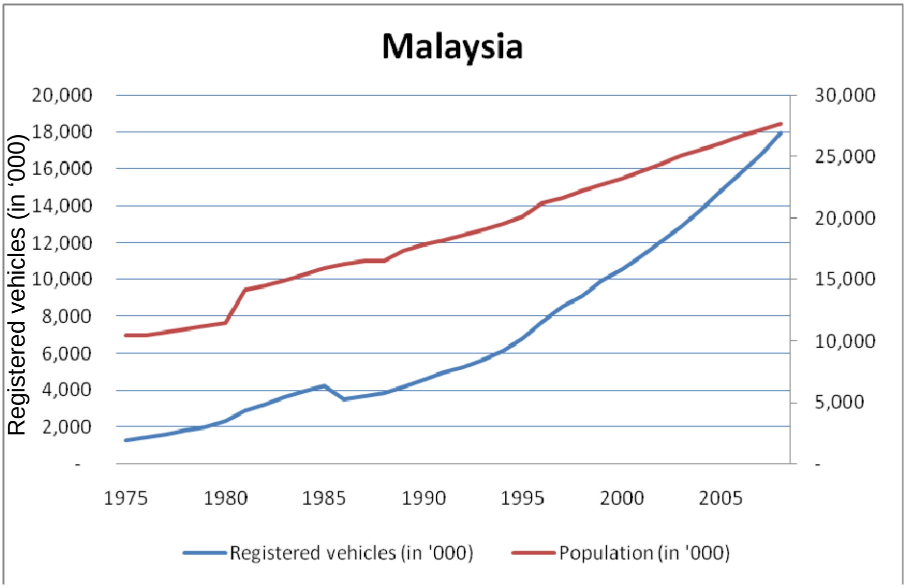
Since its independence in 1957, Malaysia has experienced a remarkable period of economic expansion and growth in population, economy, industrialization and motorization. Within a 10-year period between 1996 and 2005, Malaysian population has increased from 21.2 million to 26.4 million with an average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

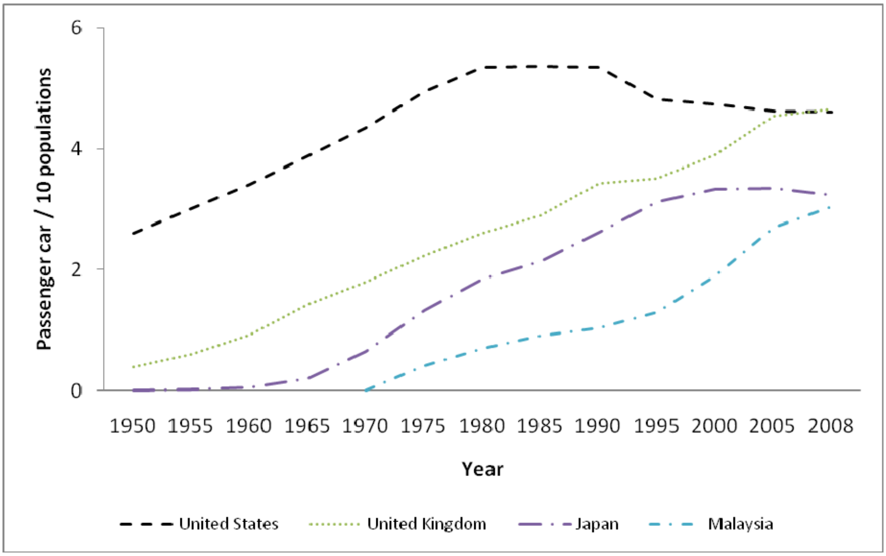
Together with the population growth, the number of registered vehicles has also grown to fulfil the need of mobility. The ability to move is a key to keep people connected and to conduct their activities. Over a period of 38 years (1970-2008), the number of registered vehicles has increased from 669,294 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:

$$Death = 0.08193\ (population \times number\ \ of\ vehicle)^{0.338}$$

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:

$$Death = 2289\left(e^{0.00007 vehicle.population.road}\right)\left(e^{0.2078 system}\right)$$

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;

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/)

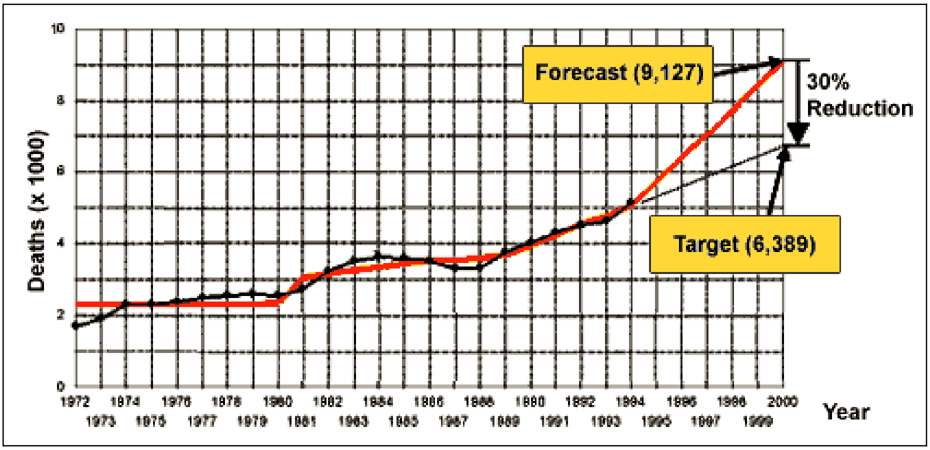
Homel, 1994; Maycock and Summersgill, 1994) also found that the shape of this model was suitable in explaining accident count although it required some corrections caused by over dispersion. To overcome the problem of over-dispersion, Radin used the "quasi-likelihood" method proposed by McCullagh and 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:

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

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).

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:

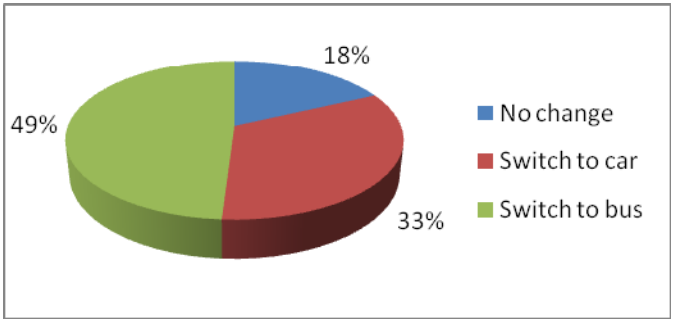
- Exposure control programme
- Conspicuity programme
- Behaviour modification programme
- Road engineering programme
- Injury control programme

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:

$$MSTOX = 6.265[e^{0.006\ WEEK}][e^{0.337\ RECSYS}]\ X\ [e^{0.340\ FAST}][e^{-0.341\ RHL}]$$

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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