TRAFFIC SAFETY CONDITION IN INDONESIA: HOW FAR ARE THE DATA RELIABLE?

Tri TJAHJONO
Lecturer Staff
Department of Civil Engineering
University of Indonesia, Jakarta
Depok 16424 , Indonesia
E-mail: ttjahjon@its.leeds.ac.uk

Ellen S.W. TANGKUDUNG
Lecturer Staff
Department of Civil Engineering
University of Indonesia
Depok 16424 , Indonesia
Fax: + 62 21 7270028
E-mail: ellen@eng.ui.ac.id

Abstract: This study analyses the magnitude of traffic accidents in Indonesia over the nine years between 1989 and 1997 based on Indonesian Traffic Police Data. The analysis was carried out by the application of Smeed's Model to the Indonesian data and the traffic safety index introduced by Hakkert et al (1967).
An aggregation analyse was carried out at three levels: national (countrywide level), Java and Bali, and Jakarta. As general, the traffic accident figures are not consistent and tend to be under reported. It found that despite of systematically error by police, under-reporting police data caused by the social attitudes and low motorization level per capita.

Key words: traffic safety, Smeed model and safety index

1. INTRODUCTION

During the period of 1978-1996, Indonesia experienced relatively high economic growth, resulting in an enormous increase in the motorization rate especially in the urban areas. However, the rapid growth of the number of motor vehicles has not been matched by the growth of road infrastructure. This condition led to deterioration of the road traffic operations, such as high congestion levels in the urban areas and major inter-urban corridors, reduction of the environmental quality and an increase in the number of traffic accidents. Based on the nine years time series data between 1989 and 1997, the average annual growth of motor vehicles was 13% while the average growth of road length was only 9%. This growth in road lengths includes the development of low standard roads (AWCAS: All weather compacted aggregate sub-grade) in the rural areas.

Traffic accidents nowadays have become an increasingly urgent public issue in Indonesia, at least as seen in the media and government statements. However, the absence of accident database system and unreliable police reporting system makes it difficult to develop a comprehensive road traffic safety strategy in Indonesia. At present, the traffic safety programme is solely an *ad hoc* basis task by police without any coherent statistical support of countermeasures programme. According to the World Bank, Indonesia as a developing country is at the awareness level 2, where the government is already aware of the road safety problem but has given it little priority and the accident data are sparse

This paper has two objectives:

1. To describe the magnitude of traffic accident in Indonesia over the last nine years between 1989 and 1997.
2. To review reliability of the data by international comparisons.

2. LITERATURE REVIEW

2.1. Traffic Safety Indicators

Traditionally, there are two indicators of road safety for the international comparison purposes (Wegman, 1995). First, the traffic safety indicator indicates how safely the road transport function is performed i.e. the ratio of number of fatalities over 10,000 registered motor vehicles (F/V) or 100 million vehicle kilometres driven (F/VK). Second, the personal safety (mortality) indicator indicates the level of traffic accidents to the safety of the population i.e. the number of fatalities over 100,000 persons (F/P).

The F/VK indicator is the best measurement of traffic safety since it considers the amount of total vehicles driven, however it is difficult to obtain and usually is difficult to find in the country report. In Indonesia is almost unlikely to obtain this data, except on the toll roads since it makes possibly through recording traffic from both entry and exit ramps/toll booths.

Some difficulties in the use of safety indicators described by Pfundt (1969) for international comparisons: (1) different definitions, (2) different reporting levels, (c) variation of 'accident rate' with respect to traffic volume, and (d) heterogeneity of accident occurrence. It should be noted that different population density, road infrastructure density, motor vehicles ratio per capita and topographical condition of such countries are resulting to different traffic accidents magnitude. Therefore, the international comparison is established for understanding the magnitude of respective country to the other countries.

2.2. Traffic Safety Index

Smeed (1949) proposed a "law" which related the rate of road accident fatalities to the level of motorization derived using 1938 data for 20 developed countries. The general form of his law is described by the following equation:

$$\frac{F}{V} = \alpha \left(\frac{V}{P}\right)^{-\beta} \qquad (1)$$

F represents the number of road accident fatalities in a country, V is the number of registered motor vehicles, and P is the population. It follows from the equation (1) that F/V decreases as V/P increases. Based on the 1938 data for 20 countries, Smeed fitted this function deriving values of 0.0003 and 0.667 for α and β respectively or the fatality rate (F/V) is approximately inversely as two-thirds power of the proportion of vehicles to the population. He found that this law is still valid when he tested against data from 16 countries for the years 1957-1966 in 1968 and again when he repeated his work in 1970 by testing data from 68 countries for the period 1960-1967 (see Adams, 1985).

However, Hakkert et al. (1976) suggested that the Smeed's "law", in which α and □ are described as constants should be denoted as parameters connecting two quantities F/V and V/P. Therefore, the "law" that was previously described by Smeed becomes a "model" and it can be used for traffic safety comparison study between countries. For example, a cross sectional study by Jacobs and Cutting (1986) found that α and β are 0.00039 and 0.64 respectively for 35 developing countries; and they repeated to Smeed's first work found that α and β are 0.0021 and 0.72 respectively for 20 developed countries based on 1980 data.

The Smeed's method (is not longer as "law" since the constants become parameters) is also possible for studying a time-series data for a single country. For examples, Al-Ghamdi (1996) analysed for Kingdom of Saudi Arabia and he found that the constant values of α and β are 0.0003 and 0.795 (R^2 = 0.920) respectively. Karim (1995) analysed for Malaysia and he found that the values of α and β are 0.00027 and 0.8738 (R^2 = 0.958) respectively. Table 1 shows the values of α and β for the various studies.

The Smeed's model basically can be denoted as

$$F = \int(V, P) \qquad (2)$$

Table 1 Comparison of Smeed's parameters of α and β by various studies

Reference	Location of Study	α	β
Smeed, 1949	20 developed countries based on 1938 data	0.0003	0.667
Jacobs and Cutting (1986)	35 developing countries	0.00039	0.640
	20 develop countries (repeated work to Smeed) based on 1980 data	0.0021	0.720
Al-Ghamdi (1996)	Kingdom of Saudi Arabia (1971-1994 data)	0.0003	0.795
Karim (1995)	Malaysia (1970-1992)	0.00027	0.873

As the transportation system is a dynamic system, it could be true that changing in number of accidents or fatalities is should be reflected to such index. The index should be based on a model, which describes the relations between accident factors and the number of accidents or fatalities and is of a form (Hakkert et al, 1976)

$$F_t = A_t V_t^{\varepsilon} P_t^{\varepsilon-1} \qquad (3)$$

A_t is the safety index and equation (2) was followed to Cobb-Douglas production function (Baumol 1972)

$$F = A\ V^{1/3} P^{2/3} \qquad (4)$$

It can be seen that the production factor of vehicles has relatively low weight compared with population by a power of 1/3 and 2/3 respectively as described earlier by Smeed. Hakkert et al also emphasised that the indices of F/V and F/P are not proper safety indices, but

characterise the proportional contribution of vehicles and population to fatalities and nothing deals with the safety technology indices.

It has been shown by Smeed in 1968 (see Hakkert et al, 1976) that the annual number of fatalities relates to the number of vehicles and population. The relationship has been described by Smeed is as the following formulae

$$F = 3 \times 10^{-4} V^{1/3} P^{2/3}$$

In this case, if the constant value of A is less than 3×10^{-4}, and then becomes an indication that the level of safety of such countries achieved as developed countries.

3. Traffic Safety Condition In Indonesia.

3.1. Accident Data

Accident data were obtained from the Indonesian National Police Figures that are published annually. The data that were used for the first analysis are the nationwide data as can be seen in Table. 2.

Table 2 Accident Records in Indonesia 1988-1997

Year	Number of Accidents	Population	Road Length (km)	Number of Vehicles	Number of Fatalities
1999	12,769	209,491,825	406,628	18,224,149	9,954
1998	15,097	207,007,732	405,916	17,644,885	11,778
1997	17,101	204,159,704	397,411	16,520,311	12,308
1996	15,291	201,340,931	386,628	14,530,095	10,869
1995	16,510	199,170,208	379,941	12,750,501	10,990
1994	17,469	195,840,912	371,620	11,373,317	11,004
1993	17,323	192,378,107	347,496	10,237,069	10,038
1992	19,920	188,791,077	300,133	9,892,737	10,726
1991	22,587	185,270,929	274,094	9,230,741	10,887
1990	25,741	181,638,165	250,314	8,850,739	10,621
1989	26,984	178,076,632	227,946	8,243,982	9,819
1988	30,338				10,283
1987	36,756				10,692
1986	41,636				10,809
1985	42,082				10,456
Annual Growth	-5.12%	+1.83%	+9.23%	+12.55 %	+3.17%

Source: Traffic Directorate, the Indonesian Police Headquarter-Jakarta

As with other developing countries, these data seem suffering from under-reporting especially for the non-fatalities accident. In fact, the police accident data are not done entirely for the traffic safety purpose, but as a part of liability to fulfil the law. The number of fatalities is the only data that perhaps more accurate, since the fatality report by police is needed for the evidence in the court. Most small accidents (property damage only and slight

injuries) can be handled by the conflicting parties without needing police involvement, therefore the total number of accidents does not give the real picture to the magnitude of traffic accidents in Indonesia.

Moreover, the fatality figures probably are still under-reported due to some reasons:

1. The fatality rates are most likely based on deaths *insitu* recording. According to the regulation, traffic accident deaths should be based on any deaths caused by traffic accidents up to 30 days after the accident occurred. Therefore any deaths in the hospital during that time should be up dated to the data, however these are very unlikely done by the police.

2. If the accident happened in the remote areas where traffic police does not have a presence in the location, or if the fatality accidents can be covered by all parties without police involvement e.g. if the victims family agreed such amount of compensation. In same extent, this case is caused by social attitude to avoid police's involvement as far as possible.

This under reporting evidence can be found by comparison to the data compiling by the stated insurance company of Jasa Raharja. By law, all road accident victims can claim compensation from this state insurance company since the vehicles yearly tax and public transport passenger ticket have a component of mandatory accident insurance. In the year 1995, the company paid Rp. 51.8 billion (£ 14.1 million) in compensation for the deaths of 16,245 people and the suffering of 29,262 people who were injured and 146 who became permanently disabled caused by traffic accidents (The Jakarta Post, 31st March 1996). The fatality figure by Jasa Raharja insurance company therefore is approximately 1.5 times greater that the police figure.

It is also should be noted that the number of accidents and the number of fatalities have an unusual trend compared to the developed countries trend. The number of fatalities was growth in an average of 3.17 percent, while almost developed countries have enjoyed reducing the number of traffic accidents as well as the number of traffic fatalities. On the other hand, the number of traffic accidents was reduced by 5.12 percent. This is the first indication that the data are almost incorrect.

3.2. Traffic Accidents Magnitudes

Table 3 shows the traffic safety, personal safety (mortality) indicators and the index of safety (based on equation 4) in Indonesia over nine years between 1989 and 1997. It can be seen in this table that the safety and personal indicators have decreased over this period. It did not happen because of the success of traffic safety countermeasures programme but it caused by the growth of motorization is higher than the growth of traffic accidents occurrence. The safety index of A is also below the value of A = 3 x10-4. However, it should be careful to say that Indonesia is already achieved such a level of safety as developed countries perform.
Applying the Smeed's model based on the Indonesian data between 1988-1997 (Table 1) revealed that the parameters of α and β are 0.00006 and 0.970 ($R^2 = 0.944$) respectively.

Compared to the other countries result as can be seen in Table 1, the value of α is very low in Indonesia. Two possibilities could be happened: First, the fatality numbers were under

reporting. Second, the condition of road traffic in Indonesia is extremely different compared to the other countries i.e. the ratio of vehicle per population is still very low. Motorization ratio in Indonesia was only 0,06 and increased to 0.08 vehicles per ten thousand persons in 1993 and 1998 respectively.

Table 3 Traffic and Personal Safety Indicators and Safety Index in Indonesia

Year	Population	Number of Vehicles	Number of Fatalities	Traffic Safety Indicator [1]	Personal Safety Indicator [2]	Safety Index (10^{-4})
1997	204,159,704	16,520,311	12,308	9.81	5.22	1.39
1996	201,340,931	14,530,095	10,869	9.68	5.62	1.30
1995	199,170,208	12,750,501	10,990	8.62	5.52	1.38
1994	195,840,912	11,373,317	11,004	7.48	5.17	1.45
1993	192,378,107	10,237,069	10,038	7.45	6.03	1.39
1992	188,791,077	9,892,737	10,726	10.84	5.68	1.52
1991	185,270,929	9,230,741	10,887	11.79	5.88	1.60
1990	181,638,165	8,850,739	10,621	12.00	5.85	1.60
1989	178,076,632	8,243,982	9,819	11.91	5.51	1.54
Average growth per annum (%)				- 2.20	-0.66	-1.15
Average values between 1989 and 1997				9.95	5.61	1.46

1) Number of fatalities per 10,000 registered motor vehicles
2) Number of fatalities per 100,000 persons

4. INTERNATIONAL COMPARISONS

4.1 Fatalities Rate Comparison

Figure 2 shows the international comparison of traffic safety indicator (fatalities per 10,000 vehicles) in the year of 1991 based on the TRRL with adding the Indonesian figure in the same year. It shown that roads in Indonesia relatively safe compared to other developing countries, however is still high compared to the developed countries.

4.2. Comparison with Thailand and Malaysia

Thailand and Malaysia are two Indonesian neighbouring countries that joint together in the ASEAN with seven other countries in this region. Table 4 shows comparison between Indonesia, Thailand, and Malaysia.

In terms of traffic safety indicator (fatalities per 10,000 vehicles), Indonesia is the worst compared to Thailand and Malaysia, but in terms of personal safety (mortality) indicator, Malaysia is the worst. It should be noted that all of these three countries have a high proportion of motorcycles that denoted as a vulnerable vehicles.

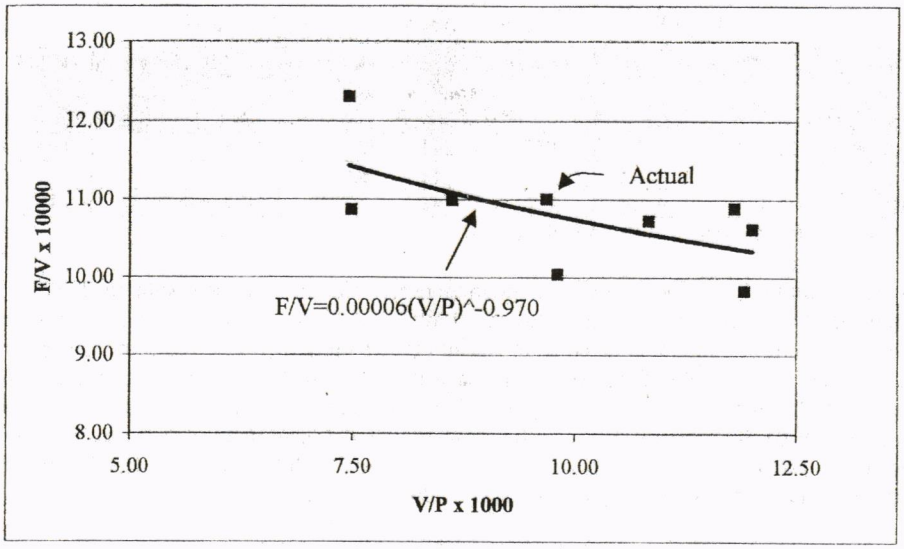

Figure 1 Actual and fitted values for relationship between fatalities and motorization

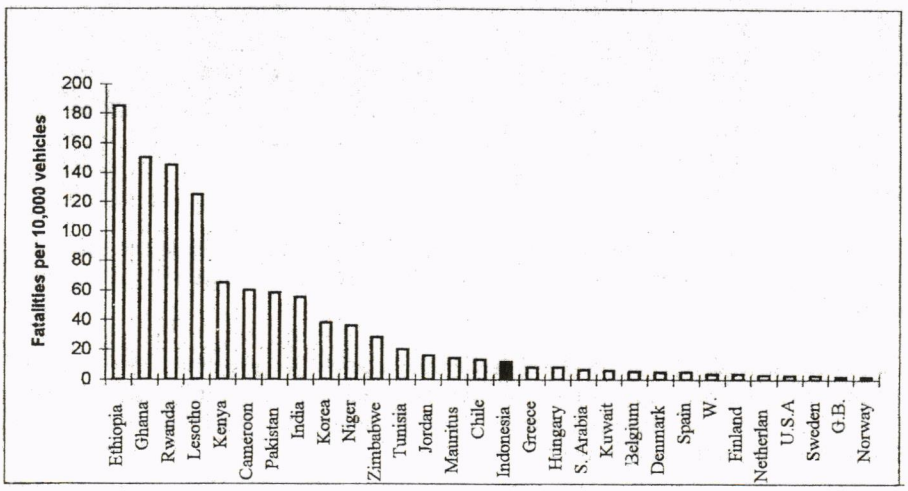

Figure 2 International Comparison based on 1991 data
(Source: TRRL, 1991 plus Indonesian data)

Smeed's time-series model and Safety Index are carried out based on the data that it obtained from the country report prepared by Tanaboriboon, Y (1994) and Umar, R (1994) for Thailand (between 1983-1991) and Malaysia (between 1970-1992) respectively. The comparisons are not perfect since the time series yearly data are different among the countries. However, the analysis intends to give a picture of the traffic safety condition in Indonesia compared to two neighbouring countries.

Table 4 Road Accident Fatalities and Fatality Rates in 1993

Country	Fatalities	Number of Vehicles x 10^3			Population x 10^3	Fatalities		Veh/ 10^3 pop
		≥ 4 wheel	m/c	Total		/10^3 pop	/10^3 pop	
Indonesia	10,887	3,256	6,987	10,243	179,379	10.6	6.1	0.058
Malaysia	4,666	3,229	3,483	6,712	19,050	7.0	24.5	0.352
Thailand	9,496	4,136	7,106	11,242	58,336	8.4	16.3	0.193

Sources: IRF (International Road Federation)

Since the number of motor vehicles jumped nearly double between 1986 and 1988 in Thailand, the Smeed's model results have the lower R^2 compared to two other countries. The Malaysian Smeed's model is taken from Karim (1995) study that used the same data period as the Umar report. Table 5 shows the comparison results of Smeed's model parameters for Indonesia, Thailand and Malaysia. Figure 3 shows the Smeed's model curves for these three countries. Figures 4, 5 and 6 show the comparison of traffic safety index, traffic safety indicator (fatality/ten thousand vehicles) and personal safety indicator (fatality/million persons) between these three countries respectively.

Table 5 Comparison Results

Country	Smeed's Model Parameters			Traffic Safety Indicator (1991)	Personal Safety Indicator (1991)	Safety Index (A x 10^{-4}) (1991)
	α	β	R^2			
Indonesia	0.00006	0.970	0.944	11.79	5.88	1.60
Thailand	0.00005	0.212	0.673	7.45	11.09	2.09
Malaysia	0.00027	0.873	0.958	7.37	23.83	3.47

It can be seen from Figure 3 that the fatality trend in Indonesia and Thailand decreases, whilst in Malaysia it increases over time. Thailand has the highest fatality rate and Indonesia is the lowest.

From Figure 4, both Thailand and Indonesia have a safety index below $A = 3.0 \times 10^{-4}$ as described by Hakkert et al (1976) as an indication of achievement of traffic safety condition as developed countries. However, particularly in Indonesia, it is doubtful because of some reasons as already discussed at above.

5. CONCLUSION

Although the figure of traffic accident fatalities in Indonesia was under-reported, it can be seen that the statistical descriptive of traffic safety indicators are still higher, especially the accident fatality rate per vehicles. However, in the application of Smeed's method, it reveals that the parameters of Smeed's model gave a different direction that the Indonesian traffic accident magnitude tends to be the safest compared to Malaysia and Thailand. This in fact is due to the high growth and low car ownership per capita as well as the under-reporting data occurrence in Indonesia.

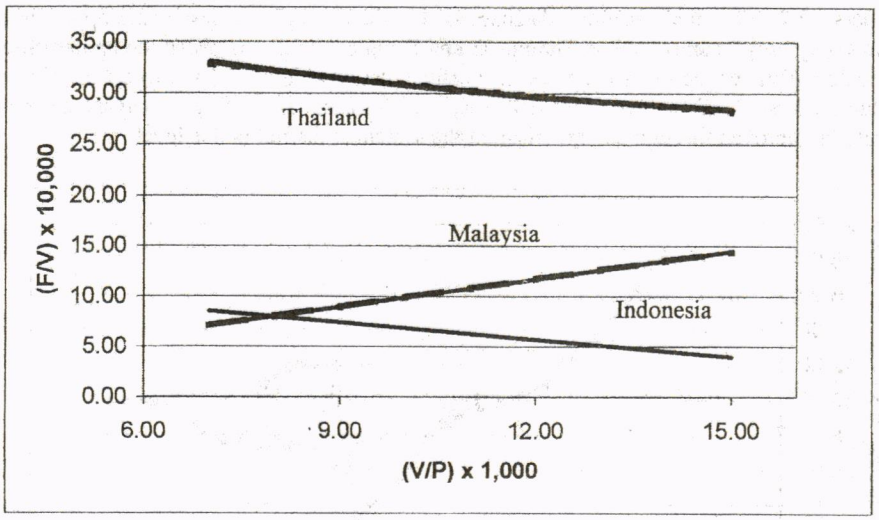

Figure 3 Comparison Smeed's Curves between Indonesia, Thailand and Malaysia

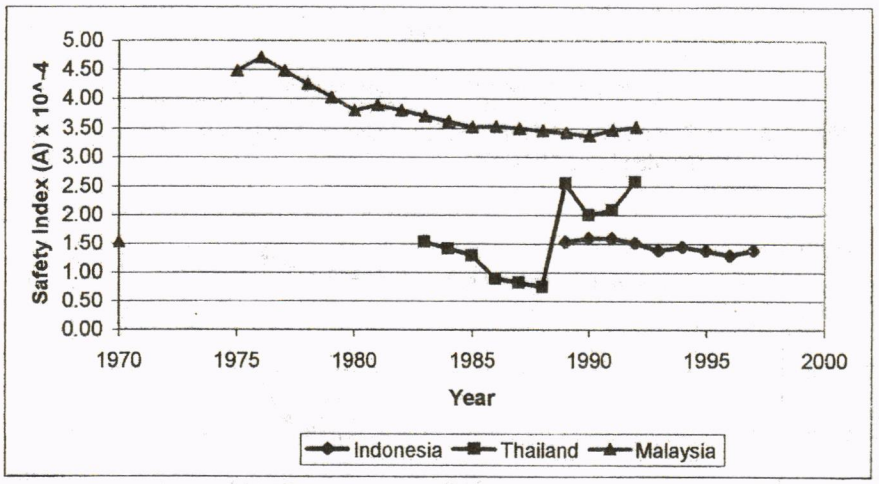

Figure 4 Comparison of Safety Index (A) between Indonesia, Thailand and Malaysia.

It is suggest that the traffic accident analysis should be disaggregated to the regions. It is recommended that Java and Bali islands should be analysed separately with other parts of Indonesia since the level of motorization, the population density and the road infrastructure density have the highest compared to the others.

Crosscheck with the data compiled by the state insurance company of PT. Jasa Raharja will be give a better picture of the safety index of Indonesia. In the big cities, it is possibly to link with the hospital data to extend the reliability accordingly the Indonesian highway regulation for any deaths caused by traffic accidents up to 30 days after the accident occurred.

It understands that reliable accident database is the foundation for a systematic approach to traffic safety programmes, and as Thompson and Rudjito (1992) suggested, computerisation of accident data collection should be established nationwide. A pilot project in city of Bandung (West Java) shown that reliability of database as well as analysis accident magnitude improved through computerisation the system at district police level.

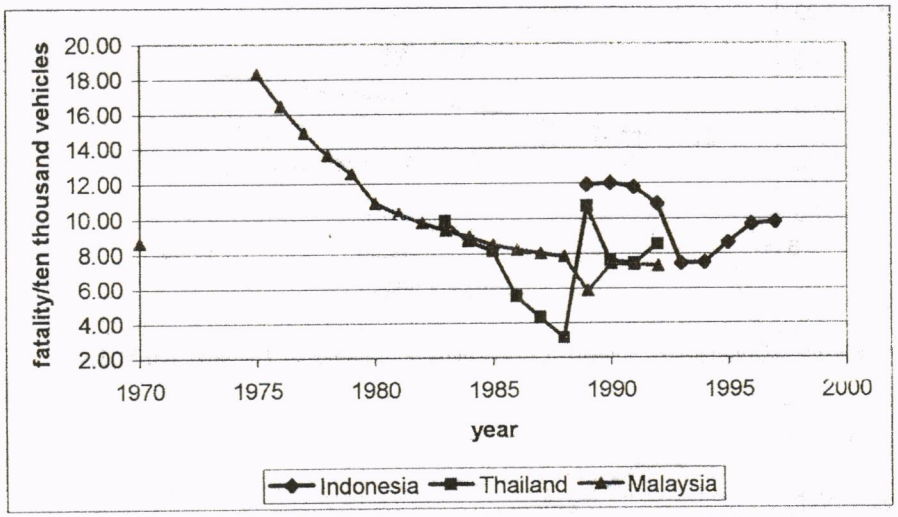

Figure 5 Comparison of Traffic Safety Indicator between Indonesia, Thailand and Malaysia

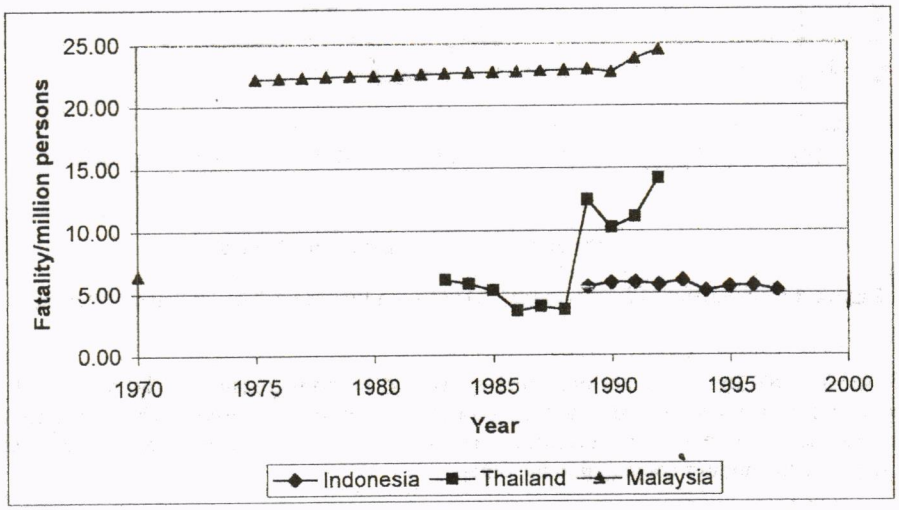

Figure 6 Comparison of Personal Safety Indicator between Indonesia, Thailand and Malaysia

REFERENCES

Adam, J (1985). Smeed's law, seat belts, and the emperor's new clothes. In Evans, L and RC Schwing (Eds). **Human behavior and traffic safety**, pp 193-248. Plenum Press, New York.

Al-Ghamdi, AS (1996). Road accidents in Saudi Arabia: a comparative and analysis sytudy, In Recio and Sucharov (Eds). **Urban transport and the environment II**, pp 231-253. Computational Mechanics Publications, Southampton.

Baumol, W.J. (1972). **Economic theory and operation analysis**, 3rd edition. Prentice-Hall, London.

Hakkert, A, Livneh, M and Mahalel, D (1976) Levels of safety in accident study – a safety index. **Australian Road research Board (ARRB) Proceeding Volume 8 (5) 23-27 Aug 1976**, Perth.

Jacobs, G.D and Cutting, C.A (1986). Further research on accident rates in developing countries. **Accident analysis and prevention, 1986. Vol. 18**, pp 119-127.

Karim, M.H. (1995). An investigation on fatal road traffic accidents. **IATSS Research, Journal of International Association of traffic and safety sciences, Vol. 19, No. 1**, pp 69-73.

Pfundt, K (1969). Three difficulties in the comparison of accident rates. **Symp. On the use of statistical methods in analysis of road accidents**. Road Research Laboratory, Crowthorne, Berkshire, England.

Smeed, R.J (1949). Some statistical aspects of safety research. **Journal of the Royal Statistical Society: Series A (General), Part I, 1949**, pp 1-23.

Tanaboribon, Y (1994). Road Accident in Thailand. **IATSS Research, Journal of International Association of traffic and safety sciences, Vol. 18, No. 1**, pp 86-88.

Thompson,NM and Rudjito, D (1992). Traffic Accident Investigation in Indonesia. **Proc. 7th Conference of the Road Engineering Association of Asia and Australasia, Vol 3**, pp 27-34. Singapore.

Umar, R. (1995). Road Accident in Malaysia. **IATSS Research, Journal of International Association of traffic and safety sciences, Vol. 18, No. 2**, pp 82-83.

Wegman, F (1995). **Road Accidents: Worldwide a problem that can be tackled successfully**. PIARC, Paris.