ROAD FATALITY MODELLING IN TRINIDAD AND TOBAGO

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ABSTRACT

Road fatality modelling is the prediction of the number of road deaths in a region. The purpose of this paper is to identify a model based on easily obtainable parameters for estimating future road fatalities and to set up an economic model for determining the monetary value of fatal accidents.

1.0 INTRODUCTION

Road fatality modelling is the prediction of road deaths in a region. It is a branch of the more common road accident prediction methods and is generally undertaken at a macroscopic scale. The variable normally used to represent road fatalities are the number of road deaths per ten thousand persons, or the number of road deaths per thousand vehicle-kilometres. However, an accurate estimate of vehicle-kilometres is not always possible, especially where there are no adequate traffic counting mechanisms[1]. Therefore, the latter variable is seldom used. In this paper, the existing internationally accepted road fatality model is examined for usage under local conditions. R.J. Smeed tabulated the data for road fatalities, vehicles and population for the year 1938 from 20 mainly European countries and found them to be significantly correlated. He derived a relationship expressed by the formula

$$F/V=a(V/P)^b \quad \text{.............(1)}$$

where F is the number of road fatalities, V is the number of vehicles and P is the population. a and b are its two parameters with values of 0.0003 and -0.66, respectively. This was found to be a reasonable predictor for the same countries for several years later.

2.0 MODEL TESTING

The coefficient of determination (R^2) is used to give statistical model evaluation. R^2 is 0.6735. In an attempt to improve the performance of the Smeed model, the method of least squares is employed to re-calibrate the

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YEAR	1993	1994	1995	1996	1997
PoP (P)	1,371,690	1,417,457	1,463,224	1,492,276	1,521,328
Reg. Veh. (V) (1% growth)	283,973	289,653	295,446	301,355	307,382
RF (Smeed)	8	9	9	9	9
RF (Smeed) x V ÷ 10,000	241	248	255	260	265

RF = No. of road fatalities per 10,000 vehicles
V = No. of vehicles

Table 1: **Forecast Road Fatalities**

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	Kenya	Thailand		S. Rhodesia	S. Africa	Israel	Ghana	Turkey	Great Britain			
	(1965)	(1963)	(1964)	(1961)	(1963)	(1967)	(1970)	(1971)	(1963)	(1965)	(1968)	(1970)
GDP (₤ Mill)	300	1,720	1,900	310	3,800	1,710	810 (GNP)	2,780 (GNP)	26,700			45,000
Total Accident Costs (₤ Mill)	2.9								196	246	300	300
Total Accident Costs as a % of GDP	1.0	0.4	0.5	1.3	1.0	1.5	0.3	1.1	0.7			0.7
Ratio of Fatal Accident Costs to Total Accident Costs	0.76								0.11	0.12	0.34	0.28
Ratio of Number of Casualties to Number of Fatal Accidents									1.08	1.08	1.09	

Sources: References 3

Table 2: **Accident Costs in Several Countries**

Road Type	% (1981) [2]	Cost of Fatal Accidents per thousand veh. km (TT$1981) [1]	Total Accidents per thousand veh. km (TT$1981) [1]
Suburban	3	23.45	33.45
Urban	16	7.18	13.59
Rural	81	19.21	31.07

1. Source: Reference 4
2. Source: Reference 5

Table 3: **Road Types and Accident Cost Rates in Trinidad and Tobago**

YEAR		1993	1994	1995	1996	1997
1. Ratio of Fatal Accident Costs to Total Accident Costs	(A)	0.6	0.6	0.6	0.6	0.6
	(B)	0.3	0.3	0.3	0.3	0.3
2. Total Accidents as a Percentage of GDP	(A)	1.0	1.0	1.0	1.0	1.0
	(B)	0.5	0.5	0.5	0.5	0.5
Fatal Accident Costs = 1.x2.xGDP	(A)	148.6	151.6	154.6	157.8	160.9
($mill TT)	(B)	37.2	37.9	38.7	39.4	40.2
Cost of Fatal Accident ($thou TT)	(A)	616.6	611.2	606.3	606.5	607
	(B)	154.2	152.8	151.6	151.6	151.8
	Average	385.4	382.0	378.9	379.1	379.4

(A) = Probable Highest Cost
(B) = Probable Least Cost

Table 4: **Forecast Road Fatality Costs**

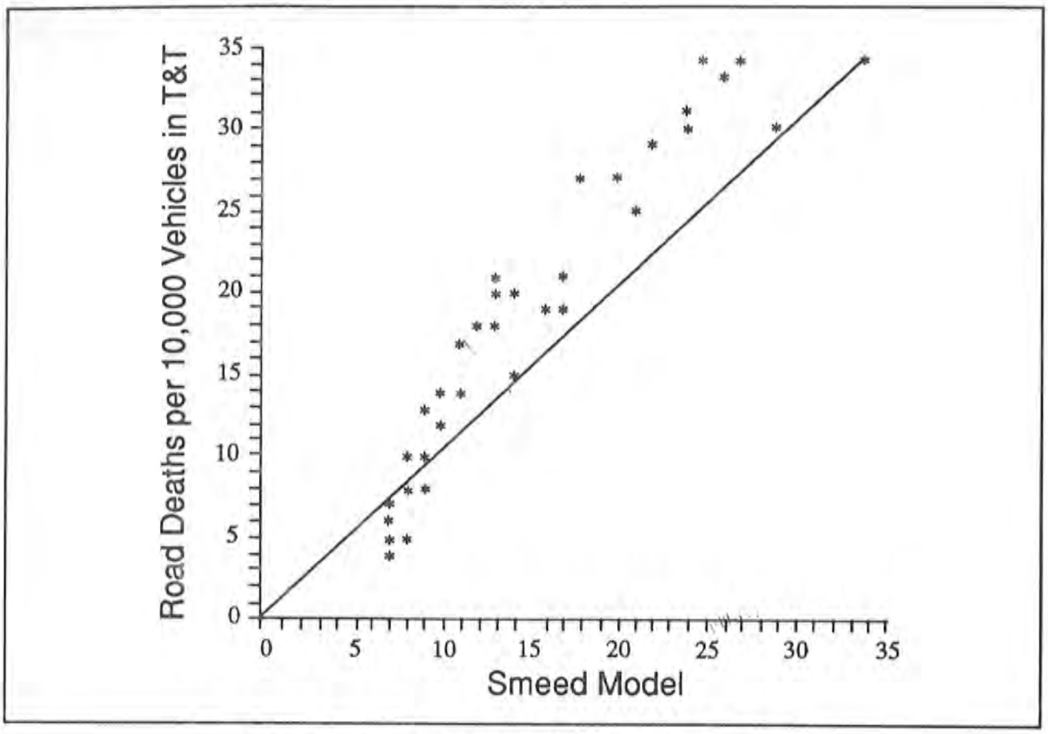

Figure 1: **Goodness-of-Fit for the Smeed Model**

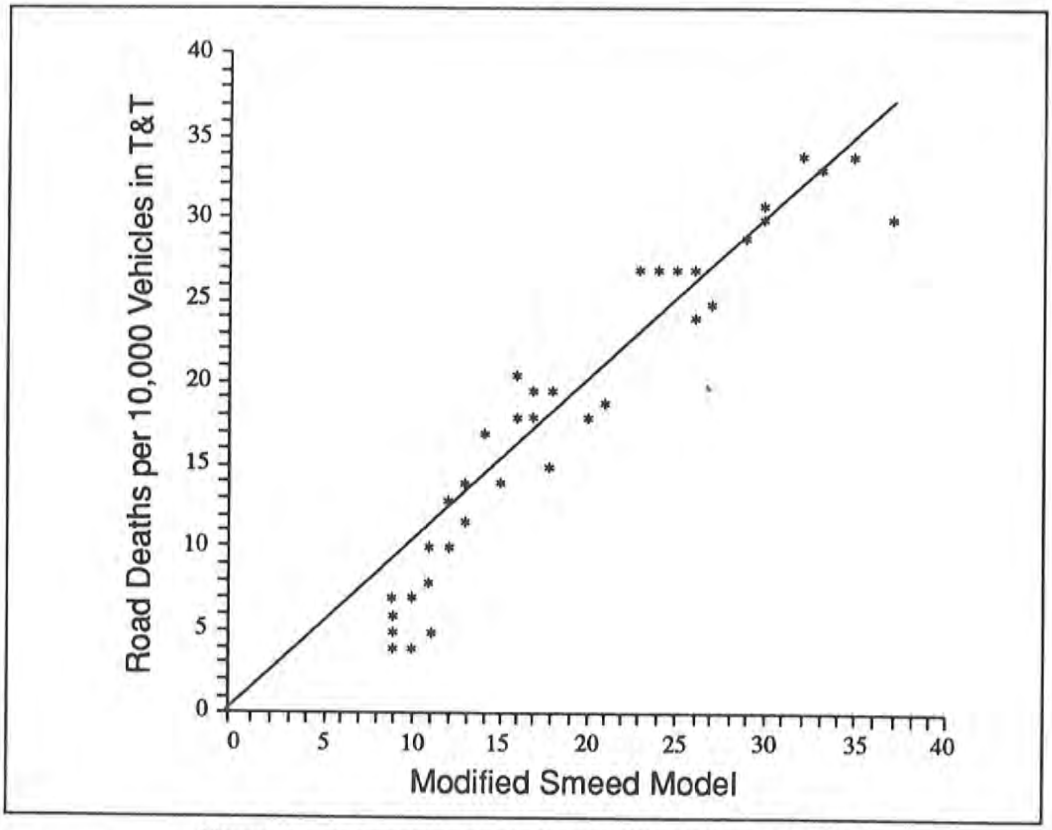

Figure 2: **Goodness-of-Fit for the Modified Smeed Model**

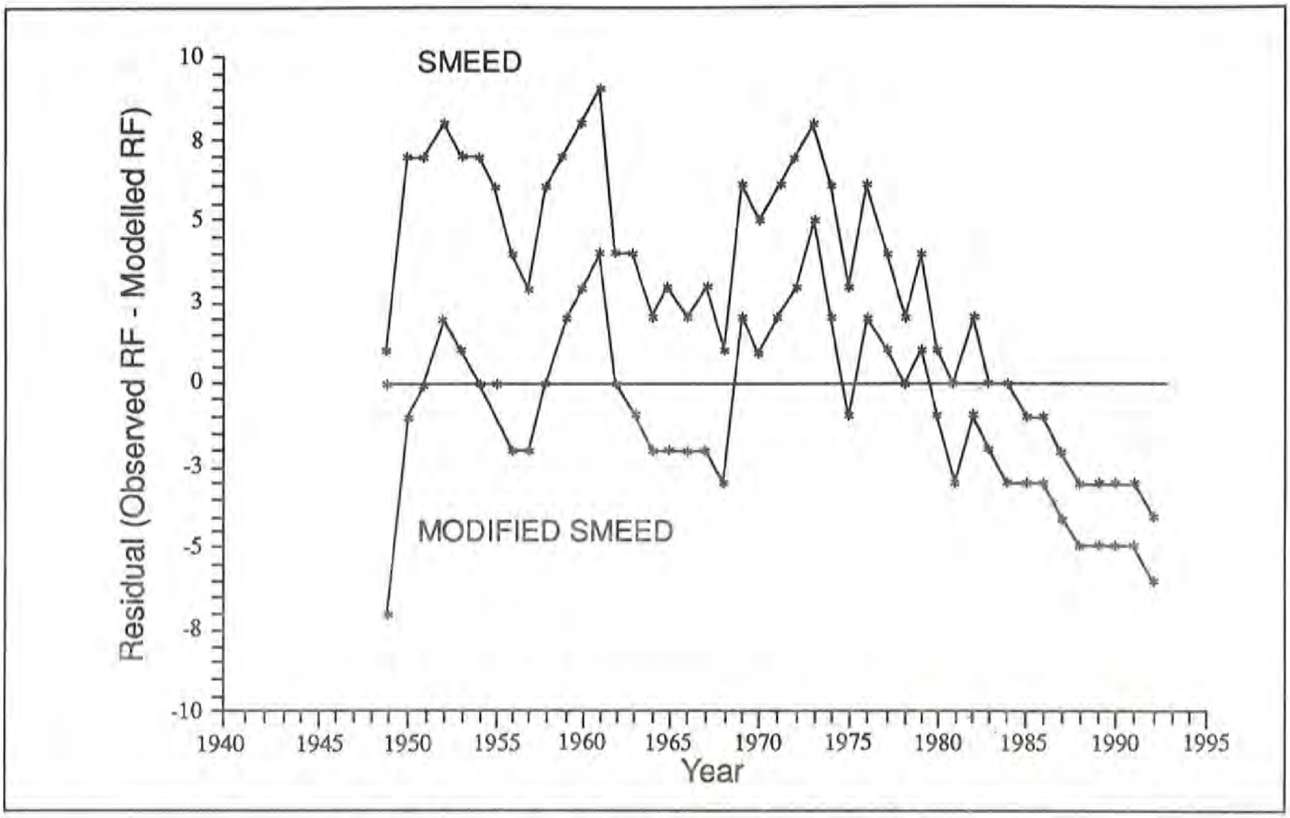

Figure 3: **Road Fatality Rate Residuals for Both Models**

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model while varying its two parameters for optimum fit. R^2 for the modified Smeed model is 0.9067, with a and b equal to -0.0004019 and -0.6424, respectively.

Statistics give a global value for the series of cell-to-cell (observed versus estimated) fit. Another way of looking at this goodness-of-fit is by examining the curves of observed data versus modelled data. **Figure 1** gives such a diagram for the Smeed model. (Note the straight line is the ideal fit line). This formula mainly underestimates the observed data. **Figure 2** gives the diagram for the modified Smeed model. Smaller values are not adequately handled.

A third approach to analysing the goodness-of-fit is through an examination of the fatality rate residuals. These are the differences between the observed and modelled road fatality rates. **Figure 3** gives the residuals over time for both models. The modified version has taken a downward shift. Since the basic structure has not been tampered with, all that has happened is that model underestimations are generally smaller, while overestimations are larger. Because the actual accident fatality rate has declined somewhat over the last few years, these modelled overestimations are significant. Therefore the original Smeed model is retained for the development of the fatality cost model.

3.0 FORECAST

Table 1 gives the forecast results for the years 1993 to 1997. Population is extrapolated according to the Central Statistical Office's latest projection. Growth of vehicles has shown a recent upward trend of 1 to 2 percent; so 1 percent is used. The total cost of a road accident comprises the following:

(a) Resource costs - lost output. This is the average wage or earnings loss of the person(s) involved in the accident; police and administration; medical and ambulance; damage to property[2].

(b) Subjective costs - pains, suffering and shock; loss of amenities of life; loss of expectation of life; inconvenience and discomfort; exemplary damages[3]. **Table 2** gives the total accident costs for several countries as a percentage of GDP. Also included are the ratio of fatal accident costs to total accident costs and, the ratio of the number of fatal casualties to number of fatal accidents. A good approximation for the accident cost as a percentage of GDP is 1.0 percent and a low approximation is 0.5 percent. Similarly, a low approximation of the Ratio of fatal costs to total accident costs is 0.3. A good (high) value cannot be approximated since there is only one high value. One is computed shortly.

Table 3 gives percentages of various road types in Trinidad and Tobago and the fatal and total accident costs per thousand vehicle kilometres. These costs were computed for the CALTRANS (State of California) study and were modified for inflation and retail prices between Trinidad and Tobago and the USA[4]. The ratio of the cost of Fatal Accidents to Total Accident Costs is then equal to

$$\left[\frac{(23.45\mathrm{x}0.03\mathrm{xSF}) + (7.18\mathrm{x}0.16\mathrm{xUF}) + (19.21\mathrm{x}0.81\mathrm{xRF})}{(33.05\mathrm{x}0.03\mathrm{xSF}) + (13.89\mathrm{x}0.16\mathrm{xUF}) + (31.07\mathrm{x}0.81\mathrm{xRF})}\right] \qquad \text{...........(6)}$$

where SF is a factor representing vehicle kilometres (veh-km) on suburban roads; UF is a factor representing veh-km on urban roads; RF is a factor representing veh-km on rural roads, and SF + UF + RF = 1. When several combinations of SF, UF and RF are substituted, the ratio always converges to 0.6 ± 0.02 (the ratio is 0.6 when SF=UF=RF). A good estimate for the ratio of fatal to total accident costs is 0.6.

Table 4 summarises the above and computes the likely upper and lower values of fatal accident costs for the period 1993 to 1997. GDP for the period 1982 to 1992 has shown an average yearly increase of about 2 percent. All the above analyses have dealt with fatal accidents only, but **Table 2** also indicates the ratio of fatal casualties per fatal accident. This ratio is approximately 1.08, therefore, the average cost of a fatal road casualty is for 1993 is $385400 \div 1.08 =$ TT$356,852.

4.0 CONCLUSION

The actual number of road deaths occurring in Trinidad and Tobago in 1993 was 154. The Smeed model forecast a figure of 241, therefore, the accuracy of this prediction is 64 percent.

The 1993 lower value for the fatal accident costs in Trinidad and Tobago **(Table 4)** is approximately 10 percent of the total budgetary allocation for road development recurrent expenditure. Quite a significant cost indeed. This, from a physical point of view, means that every road safety measure, whether it be through geometric design and construction, road rehabilitation, or traffic signing and marking, saves lives and provides benefits for the country. A portion of these benefits can subsequently be invested into the road transportation industry with the consequent further safety improvement and added financial benefits.

A useful area of further work is a detailed study of the actual resource and subjective costs in Trinidad and Tobago in order to provide more accurate valuation of road deaths.

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