Chapter 5

Modelling Road Accidents Related Factors

5.1 Research Design

Based on the theoretical framework discussed in chapter 3, the analysis of road accidents will involve modelling approaches. The data of road accidents related factors will be collected by a time - series study design. Data to be used in the models are overall country based. It is annual data from the year 1962 to 1996.

5.2 Related Factors Influencing Road Accidents.

This section will focus on selecting the specific factors that could contribute effect to the number of deaths due to road accidents in Thailand. There are two kinds of factors: quantitative factors and qualitative factors.

5.2.1 Quantitative Factors

The quantitative factors or independent quantitative variables influence the number of deaths from road accidents are as follows:

1. Budgets for Road Transportation

This budget is the investment of the government for road transportation such as the construction of roads, maintenance of roads and road transportation administration. They may influence the numbers of deaths from road accidents overall the country. The Japan International Cooperation Agency (1985), studied the traffic safety plan from the engineering point of view for reducing road traffic accidents in Thailand. They estimated the benefit and cost ratio of the investment on traffic engineering measured by the safety devices applicable to each type of road classified among the selected hazardous locations such as correct hazardous locations on the road, construction of the roads, maintenance of the roads etc. as shown in table 5.1

Table 5.1 Summary of Economic Evaluation of Standardized Safety Measure

(Unit : Baht in Million)

Type of Evaluation	Investment Amount			Gross Benefits	Net Benefits	B/C
	Installation/ Construction	Maintenance	Total			
1. 20 Year Period (1985 - 2004)	961.3	1,610.04	2,571.34	6,657.57	4,086.23	2.59
2. 10 Year Period (1985 -1994)	961.3	342.13	1,303.43	2,164.27	860.84	1.66
3. 1st Year Rate of Return	961.3	0	961.3	451.73	-509.57	0.47

Source : Japan International Cooperation Agency Team, 1985

From the table, there are three different calculations attempted in the effectiveness evaluation of the long term plan; namely, the 20 year period evaluation, the 10 year period evaluation and the 1st year rate of return, applying all the same evaluation components. The benefits of the safety plan with all the results of calculations as described above, by summing up all the years within the evaluation period total numbers of persons saved from fatality and injury and their benefits, and the benefits for the property damage are to be obtained. All the result, the long term plan for the road safety improvement worked out in this case study can be clearly said that the plan can yield quite a high rate of return in monetary terms, and can be justified for implementation.

This research will analyze the investment of government for road safety to many organizations(see table 5.2, 5.3 and 5.4) by dividing into four categories as follows:

1.1 Total budgets of road transportation
1.2 Budgets of road transportation for direct road safety
1.3 Budgets of road transportation for indirect road safety
1.4 Budgets of road transportation neither for direct nor indirect road safety.

Table 5.2 Budgets of Road Transportation for Direct Road Safety

Year	Department of Highway	Police Department	Department of Land Transpor	Ministries of Interior	Office Control Management Land Traffic	Others
1962	5,000,000	0	3,235,000	0	0	0
1963	5,300,000	0	2,801,000	0	0	0
1964	4,171,000	0	8,272,000	0	0	0
1965	7,540,000	0	14,921,400	0	0	0
1966	8,445,000	0	15,310,600	6,000,000	0	0
1967	16,944,000	0	11,997,200	0	0	0
1968	14,890,400	0	11,714,100	0	0	0
1969	25,234,200	2,000,000	11,981,500	0	0	0
1970	27,374,900	2,000,000	12,477,800	0	0	0
1971	28,916,600	2,000,000	13,966,800	0	0	0
1972	37,108,050	2,000,000	12,240,500	12,250	0	0
1973	33,196,700	2,000,000	13,427,000	256,500	0	0
1974	36,382,400	2,000,000	14,788,300	0	0	0
1975	51,681,400	3,000,000	19,357,700	508,000	0	0
1976	69,575,900	3,000,000	35,194,600	0	0	0
1977	119,659,500	3,643,000	47,616,700	0	0	0
1978	92,436,200	0	51,444,900	0	0	0
1979	89,526,700	0	51,113,000	0	0	0
1980	232,242,800	0	81,701,700	105,039,300	0	0
1981	159,273,200	0	67,560,500	46,798,700	0	0
1982	202,402,700	0	84,060,000	31,928,700	0	0
1983	224,379,500	0	91,393,000	62,629,500	0	0
1984	267,617,705	0	102,872,000	20,101,000	0	0
1985	326,634,000	0	118,592,000	68,196,000	0	0
1986	258,160,900	0	116,742,500	6,989,100	0	0
1987	270,334,000	0	152,793,100	7,029,000	0	0
1988	339,134,700	0	164,343,100	7,043,700	0	0
1989	340,036,200	0	341,599,500	6,556,200	0	0
1990	416,979,300	0	448,491,900	7,751,800	0	0
1991	524,858,400	0	455,896,000	8,831,500	0	0
1992	674,440,500	0	363,293,600	9,846,200	0	0

Table 5.2 Budgets of Road Transportation Neither for Direct Road Safety (continued)

Year	Department of Highway	Police Department	Department of Land Transpor	Ministries of Interior	Office Control Management Land Traffic	Others
1993	866,169,700	0	458,416,000	0	49,122,300	283,500
1994	1,122,458,100	160,986,000	506,388,600	0	63,591,100	0
1995	1,313,547,200	96,383,000	548,110,000	0	82,148,900	15,000,000
1996	1,958,256,400	85,392,000	649,218,900	0	118,909,900	42,265,000

Remarks : Ministries of Interior = 1. Department of Public Administration, 2. Bureaus of Interoir Policy and Plan Office

other = 1. Ministries of Public Health (MOPH), 2. National Safety Council

Source : Bureau of The Budgets, 1962 - 1996

Table 5.3 Budgets of Road Transportation for Indirect Road Safety

Year	DOH	DOI	DOP	DOPA	OARD	OEA	DOL	BMA
1962	409,999,000	1,509,000	31,490,000	N/A	N/A	N/A	749,000	N/A
1963	537,991,000	2,500,000	51,176,200	N/A	N/A	N/A	774,000	N/A
1964	698,222,000	13,933,400	799,000	N/A	N/A	N/A	781,000	N/A
1965	804,675,000	15,780,000	929,600	15,000,000	N/A	N/A	1,101,800	N/A
1966	1,187,520,000	33,499,000	1,456,400	52,083,500	N/A	N/A	6,851,900	N/A
1967	1,857,982,000	55,261,000	2,910,400	50,379,250	N/A	N/A	3,038,400	N/A
1968	1,957,202,000	52,917,500	41,303,300	72,035,300	N/A	N/A	3,698,500	N/A
1969	2,108,855,500	48,049,400	32,558,100	74,311,150	N/A	N/A	4,638,400	N/A
1970	2,327,566,800	52,757,000	57,815,100	66,683,000	200,630,000	N/A	3,517,500	N/A
1971	2,494,922,900	16,771,200	22,286,400	57,438,890	191,900,000	N/A	3,600,000	N/A
1972	2,176,759,400	13,979,400	14,044,100	63,299,500	220,000,000	N/A	2,719,700	N/A
1973	2,159,550,100	61,850,000	57,733,300	77,708,500	256,037,000	N/A	3,290,000	N/A
1974	2,342,074,600	84,240,000	49,345,306	65,749,275	320,459,100	N/A	4,024,800	N/A
1975	2,877,638,200	186,847,300	62,459,300	67,449,500	484,133,900	22,500,000	4,227,200	N/A
1976	3,721,627,600	267,414,100	46,860,300	N/A	523,883,700	34,264,600	514,427,800	N/A
1977	3,872,021,000	267,359,700	43,595,100	N/A	419,135,700	N/A	14,479,900	49,503,600
1978	4,387,945,100	206,421,500	183,024,600	108,414,000	494,551,300	N/A	20,014,200	87,219,600
1979	4,839,242,900	204,482,000	181,835,700	154,960,000	660,114,500	N/A	5,311,500	188,556,000
1980	6,015,799,500	249,515,500	364,691,200	190,166,000	816,849,300	N/A	6,221,000	227,600,000
1981	7,299,847,000	254,352,600	401,756,300	185,150,000	1,044,767,000	N/A	7,927,300	203,677,900
1982	6,862,420,000	179,555,000	390,282,000	185,150,000	1,057,223,000	226,367,000	N/A	271,420,000
1983	6,936,783,000	191,916,900	444,035,900	207,667,000	1,084,923,100	N/A	N/A	200,000,000
1984	7,672,222,600	N/A	262,896,700	228,380,000	1,089,936,200	N/A	N/A	408,752,000
1985	7,857,787,000	N/A	631,931,700	245,000,000	875,294,000	N/A	N/A	393,569,000
1986	7,353,351,000	N/A	262,837,000	237,115,000	771,811,900	N/A	N/A	307,959,000
1987	6,799,230,000	N/A	261,531,700	237,115,000	889,818,700	N/A	N/A	272,365,000
1988	7,949,790,000	N/A	406,071,400	329,056,000	907,127,700	N/A	N/A	255,485,000
1989	10,226,551,200	N/A	427,414,500	476,833,000	1,527,846,000	N/A	N/A	225,275,000
1990	14,014,813,000	N/A	979,852,700	619,060,000	3,892,717,000	N/A	N/A	310,808,000

Table 5.3 Budgets of Road Transportation for Indirect Road Safety (continued)

Year	DOH	MOD	DOP	DOPA	OARD	OEA	DOL	BMA
1991	17,123,636,000	N/A	1,096,274,100	869,933,440	4,966,644,500	N/A	N/A	286,276,000
1992	19,171,722,900	N/A	1,828,322,900	967,649,700	4,882,457,100	822,000,000	N/A	339,340,000
1993	26,143,750,000	N/A	4,146,843,300	1,467,316,500	6,124,272,300	4,650,000,000	N/A	650,722,000
1994	31,518,993,100	89,283,400	4,077,346,200	2,251,848,170	10,575,599,000	N/A	300,000,000	1,677,191,500
1995	34,692,995,700	126,239,900	6,131,483,600	3,062,301,100	13,602,297,200	N/A	240,000,000	1,423,870,700
1996	43,575,640,000	214,316,900	6,566,261,600	3,062,090,500	20,805,087,600	600,000,000	1,028,000,000	5,617,422,300

Source: Bureau of The Budget, 1962 - 1996

Remark : DOH = Department of Highway

DOI = Department of Irrigation

DOP = Department of Public Works

DOPA = Department of Public Administration

OARD = Office of the Accerelated Rural Development

OEA = Organization Expressway and Rapid Transit Authorities of Thailand

DOL = Department of Land Transportation

BMA = Bangkok Metropolitant Authorities

MOD = Ministry Of Defence

Table 5.4 Budgets of Road Transportation Neither for Direct Nor Indirect Road Safety

Year	Department of Highway	Department of Land Transport	Transport Company	Organization Expressway and Rapid Transit Authorities
1962	83,386,000	1,136,000	N/A	N/A
1963	116,138,000	973,000	N/A	N/A
1964	207,686,000	984,000	N/A	N/A
1965	193,540,000	1,057,100	N/A	N/A
1966	317,201,200	1,026,600	20,500,000	N/A
1967	342,717,600	1,009,000	13,000,000	N/A
1968	436,866,800	1,219,000	N/A	N/A
1969	487,800,700	4,304,500	N/A	N/A
1970	527,955,900	1,392,000	N/A	N/A
1971	519,596,600	7,143,300	N/A	N/A
1972	540,957,200	1,464,900	N/A	N/A
1973	636,416,700	1,460,000	N/A	5,000,000
1974	637,054,800	2,241,100	N/A	1,200,000
1975	809,259,800	2,860,900	N/A	21,028,900
1976	925,556,900	3,729,000	N/A	111,269,500
1977	968,737,700	4,668,500	N/A	131,796,000
1978	999,398,400	3,798,300	N/A	161,770,250
1979	1,110,404,300	5,055,000	N/A	565,044,200
1980	1,235,401,600	6,399,800	150,000,000	617,284,100
1981	1,323,386,000	11,713,900	N/A	292,302,000
1982	1,862,390,000	10,108,600	N/A	N/A
1983	2,281,429,500	13,731,000	N/A	N/A
1984	1,516,537,500	14,717,600	N/A	N/A
1985	1,548,188,000	13,081,000	N/A	N/A
1986	1,566,634,500	15,810,000	N/A	N/A
1987	1,617,465,100	46,842,200	N/A	57,331,000
1988	1,736,585,800	35,731,100	N/A	67,321,000
1989	1,808,974,300	32,030,300	N/A	78,432,100
1990	2,110,188,100	29,185,500	N/A	N/A
1991	2,500,854,600	166,628,000	N/A	N/A
1992	2,726,983,400	534,867,500	N/A	N/A
1993	5,850,265,700	586,955,900	199,204,600	1,533,820,000
1994	6,969,001,800	826,705,400	N/A	2,580,690,000
1995	14,022,037,700	1,951,455,600	N/A	2,387,888,000
1996	17,014,502,300	879,935,400	N/A	7,984,843,000

Source : Bureau of The Budgets, 1962 - 1996

2. Alcohol Consumption

Alcohol consumption means the consumption of alcoholic beverages of people for each year. The consumption of alcoholic beverages would decrease the physical skill to drive vehicles. Most of the studies of road accidents point out that drinking alcohol was a main cause of road accidents.

3. Economics Growth

This variable is collected from the National Economic and Social Development Board (NESDB) by using at 1972 price. Thailand' s economy has undergone rapid expansion over the past decade with an average annual growth rate of 8%. During the period of 1988-1990, the country even experienced an annual growth rates of between 11.6% and 13.3%. Even afterwards, the economic growth has continued to be approximately 8%. At the same time the traffic volume increased as shown in table 5.5

Table 5.5 Vehicle - Kilometer in Thailand 1986 - 1994

Year	Vehicle - Kilometer
1986	28,008.30
1987	31,716.80
1988	35,179.60
1989	41,593.90
1990	45,769.80
1991	52,095.59
1992	63,834.28
1993	69,953.30
1994	81,444.15

Source : Department of Highway, 1995

The economic growth might have an influence on the road accidents. The consideration type of economic growth in this study is divided into 3 categories as follows:

3.1 Economic growth of agricultural sector
3.2 Economic growth of manufacturing sector

3.3 Economic growth of service sector

4. Vehicles Registration

Data were collected between 1962 and 1996. The favorable economic expansion has led to the rapid increase in the number of vehicles registration as shown in table 5.6.

Table 5.6 Vehicle Registration in Thailand 1986 - 1994

Year	Vehicle Registration (Units)
1986	4,044,394
1987	4,957,217
1988	5,800,416
1989	6,505,020
1990	7,592,085
1991	8,481,025
1992	9,595,191
1993	11,101,758
1994	12,579,903

Source : Source : Department of Highway, 1995

The number of vehicles registration might have influenced into the number of road accidents. This variables can be divided into four types as follows:

4.1 number of car registration
4.2 number of bus registration
4.3 number of truck registration
4.4 number of motorcycle registration

5.2.2 Qualitative Factors

The qualitative factors or independent qualitative variables that can influence the road accidents is traffic law enforcement. According to Japan International Cooperation Agency(1985), there are 3 majors laws in Thailand i.e "Land Traffic Act(1979)", "Transport Act(1979)" and "Automobile Act(1979)", that ensure safe driving as well as smooth traffic flow. It

seems that the contents of these laws are adequate for their objectives. But the strict enforcement of these laws also is one of the most important factors for safety improvement.

However, the enforcement cannot be measured quantitatively. This study acts to use the legislation of the following:

1. Speed Limits law Legislation
2. Motorcycles Helmet Use Legislation
3. Seat Belt Use Legislation

5.2.3 Measurement of the variables

1. Quantitative variables measurement

Table 5.7 displays, for the dependent variable and for each of the independent quantitative variables, the units of measurement, the scales of measurement and the sources of data.

Table 5.7 : Measurement of the Quantitative Variables

Variable	Factors	Unit	Scales of measurement	Sources of data
Y	# death persons	persons	continuous	MOPH
X_1	# budgets direct	baht	continuous	Bureau of The Budgets
X_2	# budgets indirect	baht	continuous	Bureau of The Budgets
X_3	# budgets neither direct nor indirect	baht	continuous	Bureau of The Budgets
X_4	# alcohol consumption	litre	continuous	The Excise Department
X_5	agriculture growth	percentage	continuous	NESDB
X_6	manufacture growth	percentage	continuous	NESDB
X_7	services growth	percentage	continuous	NESDB
X_8	# cars registration	units	continuous	Land Transport Department
X_9	# buses registration	units	continuous	Land Transport Department
X_{10}	# trucks registration	units	continuous	Land Transport Department
X_{11}	#motorcycles registration	units	continuous	Land Transport Department

2. Qualitative Variables Measurement

Table 5.8 displays, for each of the independent qualitative variables, the units of measurement, the scales of measurement and the sources of data. All the qualitative data are primary ones and will be obtained by presence of traffic law legislation.

Table 5.8 : Measurement of the Qualitative Variables

Variable	Factors	Scales of Measurement	Sources of Data
D_1	limits speed legislation	discrete	Traffic Law Legislation
D_2	helmet use legislation	discrete	Traffic Law Legislation
D_3	seat belt legislation	discrete	Traffic Law Legislation

5.3 Multiple Regression Analysis of the Factors of Total Budgets for Road Transportation

Regression analysis is concerned with the study of the dependence variable (Y) on one or more other explanatory variables. With a view to investigate the impact of total budgets of road transportation on the number of deaths from road accidents, the related factors are assumed to be a function of both quantitative and qualitative as shown below:

$$Y = f(totalbud; X_4; .....x_{11}; D_1; .....D_3)$$

where

Y is the number of deaths from road accidents

The independent quantitative variables are;

totalbud represents the total budgets for road transportation

X_4 represents the alcohol consumption

X_5 represents the economics growth of agricultural sector

X_6 represents the economics growth of manufacturing sector

X_7 represents the economics growth of services sector

X_8 represents the cars registration

X_9 represents the buses registration

X_{10} represents the trucks registration

X_{11} represents the motorcycles registration

The independent qualitative variables are :

D_1 represents the speed limits legislation

D_2 represents the motorcycle helmet use legislation

In order to incorporate the qualitative independent variables in the regression model, they are be quantified in some manner through the use of dummy variables. The variable is a variable that assumes only a finite numbers of values (such as 0 or 1) for the purpose of identifying the different categories of a qualitative variable. According to Gujarati (1995, 499), by constructing artificial variables that take on values of 1 or 0, 0 indicates the absence and 1 indicates the presence.

Table 5.9 : Dummy Variables for the Measurement of Qualitative Factors.

Variables	Qualitative factors	Dummy variables
D_1	speed limits legislation	$D_1 = \{1$ for presence 0 for absence
D_2	motorcycle helmet use legislation	$D_2 = \{1$ for presence 0 for absence
D_3	seat belt legislation	$D_3 = \{1$ for presence 0 for absence

5.4 Multiple Regression Analysis of the Related Factors

Regression analysis used here is to determine the number of deaths from road accidents, the dependent variable Y, corresponding to the related factors such as budgets of road transportation for road safety, alcohol consumption, etc..... which are the independent variables X_i

The related factors of road accidents are measured by the number of deaths from road accidents between 1962 and 1996. The related factors of road accidents are assumed to be the set of both quantitative and qualitative factors as shown below.

$$Y = f(X_1; X_2; X_3; .....X_{11}; D_1;.....D_3)$$

where
y is the number of deaths from road accidents

The independent quantitative variables are ;
X_1 represents the budgets for direct road safety
X_2 represents the budgets for indirect road safety
X_3 represents the budgets of road transportation (not related road safety)

X_4;.....D_1;....D_3 represents the same as shown in section 5.3

In order to incorporate the qualitative independent variables in the regression model, they are the same the factor of total budgets for road transportation as well.

5.5 The Multiple Regression Models

Multiple regression equation of each related factors will consider all the quantitative variables and the qualitative variables.

The multiple linear regression model of total budgets for road safety is as follows :

$$Y_i = \beta_0 + \beta_1 \text{totalbud} + \beta_2 X_4 + \beta_3 X_5 + \beta_4 X_6 + \beta_5 X_7 + \beta_6 X_8 + \beta_7 X_9 + \beta_8 X_{10} + \beta_9 X_{11} + \beta_{10} D_1 + \beta_{11} D_2 + \beta_{12} D_3 + \varepsilon_i$$

The multiple linear regression model of each budgets for road safety is as follows :

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} D_1 + \beta_{13} D_2 + \beta_{14} D_3 + \varepsilon_i$$

where (i) y is a typical value from the Y values; (ii) the β_i are called the regression coefficient, X_1, X_2,.....,D_3; (iii) X_1, X_2,.....,D_3 are respectively value of the independent variables X_1, X_2,.....,D_3; (iv) the ε_i is random variable with mean equal zero. The variance σ^2 is the common variance of Y values.