CHAPTER III

UNIT ROAD USER COST

In order to calculate the savings to road user resulting from an improvement or development in the quality of a road and changes the journey distance, increase in speeds and safety. It is necessary to develop unit travel cost for road users and the vehicles they employ.

There have been some works done on the unit road user cost in Thailand including that of TPO' Sullivan & Partners and some consulting engineering firms. But those works were limited only for specific project and conditions which are not fully justified to be used in this research. Therefore, a complete revision of unit road user cost were carried out under suitable prevailing conditions.

Before proceeding to the discussion in the determination of the different cost components, a number of terms and concepts used throughout this study will first be clearified.

Basic Cost

The basic cost is the cost associated with vehicles travelling on class 1 roads at benchmark speeds or at average lifetime speeds. The determination of the basic costs is described in the following pages for each of the cost components. For purposes of developing road user cost savings, cost increases on account of sub-optimal

conditions with respect to the road surface and the traffic volume are added to these basic costs.

Bench Mark Speeds

Bench mark speeds refer to average running speeds on roads in good condition and for low volume of traffic. The different road classes are defined primarily in terms of bench mark speeds. In this study, bench mark speeds for cars are 80 kph, and 72 kph for commercial vehicles.

Average Lifetime Speeds

Average lifetime speeds refer to the average speeds of vehicles travelling over their lifetime on roads with differing surface condition and with differing traffic volume. For the purposes of this study, the average lifetime speed has been estimated at 56 kph for both cars and commercial vehicles.

Classification of Road

In this study, roads are classified into three categories as:

1. Class I road paved: A class I road is a road where the surface allows a bench mark speed for cars of 80 kph, and 72 kph for for commercial vehicles. Speeds may be lowered on certain sections due to gradients or to traffic congestion, but the benchmark speed is that average speed which is possible on level sections without traffic congestion.

2. Class II road: A class II road is a road on which the

benchmark speed for cars is 64 kph, and 56 kph for commercial vehicles. Higher average speeds may be possible, but this would be at the expense of the vehicle and the comfort of the passengers. The surface and the average speeds on these roads will not be affected significantly during the rainy season, this road is therefore an all weather road.

3. Class III road: The typical benchmark speed on a class III road is 48 kph for cars and 40 kph for commercial vehicles. Class III roads are basically earth roads, but will include many inferior laterite roads which are poorly drained and made of inferior materials. The main factor determining speed on these roads will not be traffic volume, but the condition of the surface, and this may be highly variable over the year.

The Classification of Vehicles

In Thailand, vehicles can for most purposes be divided into six classes as: motorcycles, passenger cars, light buses and trucks, heavy trucks (2-axles and 3-axles or more) and heavy buses.

The Component of the Road User Cost

The road user cost components will be discussed in the following orders:

- depreciation
- interest
- fuel
- tyres

- parts
- labour
- lubricants
- overheads
- occupants time costs
- accident costs*

Determination of Road User Cost Component

For each of the cost components, it will be shown how the basic cost per kilometer has been derived. In general, the economic costs and technical assumptions will be representative for conditions on primary and secondary roads. Before determination of the various cost components it is necessary to know the economic cost, annual milage, service life of each vehicle class:

Car: Accroding to the result from origin and destination surveys on Bang Pa In-Nakhonsawan Highway as compiled in Appendix C, Table C1, the Japanese cars were the most popular brands used. The 1,600 cc model vehicle is considered as being representative of the passenger cars. The price of popular 1,600 cc cars quoted during the second half of 1975 are given in Table 31.

Table 31 Costs of the Typical Passenger Vehicle

Make and Model	Retail Price ฿	Economic Price ฿ ฿	Share of Make %
Toyota Corona 1,600cc	130,000	65,000	41
Toyota Carina 1,600cc	130,000	69,000	
Ford Cortina 1,600cc	145,000	72,500	16
Datsun 160J 1,600cc	150,000	75,000	26
Mazda 808 1,600cc	136,000	68,000	17

*not included because of lack of data.

The economic cost of car was determined by the retail prices less than the transfer payments (tax and duty). The retail price was estimated to be 200 percent of economic cost. Therefore, the average economic cost was calculated to ฿ 70,130. In order to arrive at the economic cost excluding the tyres, the cost of tyres has to be deducted from ฿ 70,130. The cost of tyres is estimated to be about ฿ 2,200 (including taxes). Therefore, the economic cost of car excluding tyres is ฿ 67,930.

The lifetime milage of cars in Thailand has been estimated to be about 200,000 kms for 10 years life by GECO. However, the Berger study in the South shows annual milage of 14,000 kms for passenger cars and 28,000 kms for taxis. For this study, the figure of 18,000 kms per year will be chosed for 9 years service life.

Light Buses and Light Trucks: Light bus and light truck are very similar in Thailand, with the same engines and chassis, but different bodies. Light bus is usually a light truck which has been converted into a light bus by installing benches or seats. In view of this, the economic cost can first be calculated for the light truck, the cost for light bus can then be derived by adding the cost of conversions. The light commercial vehicle category comprises the 2 to 2.5 tons vehicle and the 1 ton vehicle. Some vehicle models are locally assembled while others are imported fully built. Details share of locally assembled and fully imported commercial vehicle are shown in Table 32.

Table 32 The Cost of the Light Commercial Vehicle

Make and Model	Share of Make in Total Light Commercial Category	Retail Price ฿	Economic Cost ฿
2.0-2.5 ton			
Locally Assembled:	25%		
Isuzu ELF		114,000	65,140
Imported:	25%		
Toyota Dyna		120,000	68,570
Nissan Caball Q.C. 240C		140,000	80,000
0.8-1.0 ton			
Imported:	50%		
Toyota Hilux		84,500	48,280
Datsun 1300		75,000	42,850
Mazda 1200		75,000	42,850
Toyata Hiace		120,000	68,570

The determination of economic cost of light commercial vehicles is similar to cars. The retail prices were estimated to be 175 percent of economic cost, therefore the average economic cost of light commercial vehicle calculated to be ฿ 60,170. From this figure the cost of the tyres has to be deducted. The cost of the tyres is estimated to be at ฿ 2,200 and the economic cost of the representative light truck excluding tyres is at ฿ 57,970.

The cost of the light bus is slightly more than the light truck for the added bodies; it was found to be about ฿ 5,000 more. Thus, the economic cost of the representative light bus is at ฿ 62,970. The annual milage and the service life of the light trucks and buses are the same according to TPO' Sullivan Technical Report No.42 "Road User Costs in Thailand".

Heavy Buses: The most heavy buses in Thailand comprises of three makes: Isuzu, Mercedes and Hino. These vehicles are sold with engine and chassis only, the body being locally built.

From the survey on the Bang Pa In-Nakhonsawan Highway, it was found that the Hino RF 320 model was the most popular one. Percentage share of make in total heavy bus category and retail prices are shown in Table 33.

Table 33 The Cost of Heavy Bus

Make and Model	Share of Make in Total Heavy Bus %	Retail Price ฿	Economic Cost ฿
Hino Rf.320	50	380,000	253,000
Mercedes 185 HP.	30	430,000	280,600
Isuzu BD 60	20	353,300	235,500

The retail prices were at 150 percent of the economic cost, therefore the weighted average economic cost of heavy bus was ฿ 259,580 excluding bodies. The information from the local body-

building workshop showed that the cost of bodies were about ฿ 125,000. Therefore the economic cost was ฿ 384,580 (including tyres cost). The cost of tyres must be deducted and estimated at ฿ 13,000. Thus, the economic cost excluding tyres was ฿ 371,580.

Heavy Truck (2-axles and 3-axles): In the case of heavy truck, it was dominated exclusively by Isuzu. Again, the vehicle is sold with engine and chassis and cab only, the body is added from the local body-building workshop.

In accordance with the Technical Report No,36 by TPO' Sullivan and Partners, the Isuzu 10-wheel truck was chosen to be representative heavy truck. In fact 10-wheel truck predominates long hauler on the major national highways linking Bangkok to the provincial towns. In case of 6-wheel truck, it is more common on the secondary roads. The study showed that a ratio of 62/38 percent split between 10-wheel and 6-wheel trucks. The cost of heavy truck and share of make of total truck are shown in Table 34.

Table 34 The Cost of Heavy Truck

Make and Model	Share of Make in Total H.T. %	Retail Price ฿	Economic Cost ฿
10-wheel Isuzu TWD 80 HJ	62	260,000	185,700
6-wheel Isuzu TXD 50 HJ	38	210,000	150,000

The average economic cost of the heavy truck is ฿ 172,100. The economic cost of body is obtained from the local bodybuilding

workshop at ₿ 55,000; the total average cost therefore is ₿ 227,100 including tyres. The cost of tyres has been estimated at ₿ 13,700 so that the average economic cost excluding tyres is ₿ 213,400.

Depreciation Costs

The basic depreciation cost per km is established for the life time speed of 56 kph on the basic of the following parameters as shown in Table 35.

Table 35 Basic Average Depreciation Cost

Vehicle Type	Economic Cost of Vehicle ₿	Annual Milage km	Year of Service	Average Life Time Milage km	Basic Depreciation Cost ₿/km
Car	67,930	18,000	9	162,000	0.419
L.B.	62,970	35,000	7	235,000	0.268
L.T.	57,970	25,000	8	200,000	0.290
H.B.	370,580	70,000	7	490,000	0.756
H.T.	213,400	70,000	7	490,000	0.435

Interest Costs

The basic interest cost is determined by the economic cost of the vehicle and is calculated for average lifetime speeds (56 kph) as was the case for the depreciation cost.

Interest costs are assessed here on 55% of the economic cost of the vehicles, on account of the fact that the vehicle population

is still growing so that the average age of vehicle park is less than half its average expected life.

The parameters which lie at the basic of the determination of the basic interest cost are summarized in Table 36. A 12 % rate of interest has been used and the annual milage assumption is the same as for the calculation of the depreciation cost.

Table 36 Basic Average Interest Cost

Veh. Type	55% of Economic Cost of Vehicle	Interest Cost ฿/Year	Annual Milage km/Year	Interest Cost ฿/km
Car	37,361	4,483	18,000	0.249
L.B.	34,633	4,156	35,000	0.119
L.T.	31,883	3,826	25,000	0.153
H.B.	203,819	24,458	70,000	0.349
H.T.	117,370	14,084	70,000	0.201

Fuel Cost

Fuel costs are composed of a performance component, kilometers per litre, and a real cost component, the tax free price per litre.

The economic cost of fuel were determined by the control retail price less the excise duty, business and municipal taxes. To establish the cost by vehicle type, it was assumed that all cars run on gasoline, and percent split of using premium and regular were 40 and 60 respectively. Heavy buses and heavy trucks, on the other hand, were assumed to run on diesel. Finally, the fuel cost

for the light commercial vehicle was based on a 65/35 split between gasoline and diesel.

The economic cost of fuel for each vehicle type has been based on the following cost by fuel products.

- premium gasoline ฿ 2.55
- regular gasoline ฿ 2.37
- diesel oil ฿ 1.29

The parameters which determine the fuel cost per kilometer at benchmark speeds are summarized in Table 37.

Table 37 Basic Fuel Cost

Vehicle Type	Performance km/Litre	Economic Cost ฿/Litre	Fuel Cost ฿/km
Car	10.9	2.44	0.224
L.B	9.5	1.99	0.209
L.T	9.5	1.99	0.209
H.B	4.2	1.29	0.307
H.T	3.6	1.29	0.358

Tyre Cost

Tyre costs have not been updated, as it was found that the economic cost of tyres in the second half of 1975 was about the same of that in 1970 and 1973 studies.

The parameters on which the basic tyre costs have been

calculated are given in Table 38.

Table 38 Basic Tyres Cost

Veh. Type	Life Milage of Tyre. Km	Economic Cost of 1-tyre ฿	Tyre Wear Cost ฿/km	No. of Tyres	Tyre Cost ฿/km
Car	40,000	350	0.009	4	0.036
L.B	60,000	550	0.009	4	0.036
L.T	60,000	550	0.009	4	0.036
H.B	55,000	1,370	0.025	6	0.150
H.T	55,000	1,370	0.025	10	0.250

The life milages for tyres quoted here are for class I road conditions at average lifetime speed of 56 kph.

Parts Cost

The cost of parts has been expressed as a certain percentage of the economic cost of the vehicle per 1,000 km. This percentage of economic cost of the vehicle per 1,000 km has been derived from the percentage given by J de Weille in his study "Quantification of Road User Saving" and from the results of other studies on parts cost. The parameters which determine the parts cost at benchmark speeds are given in Table 39.

A basic parts cost for this study are higher than that of Technical Report No.42. For the same percentage of economic cost of vehicle per 1,000 km, the parts cost is higher than in the

1973 due to increase in cost of living in the last few years and higher economic cost of vehicles.

Table 39 Basic Parts Cost

Vehicle Type	% of Economic Cost of Vehicle per 1,000km	Economic Cost of Vehicle ฿	Basic Parts Cost ฿/km
Car	0.126	67,930	0.085
L.B	0.138	62.970	0.086
L.T	0.138	57,970	0.079
H.B	0.080	370,580	0.296
H.T	0.080	213,400	0.171

Labour Cost

Labour costs are calculated using a time parameter (number of hours of labour per 1,000 km) and a hourly labour cost. The basic cost is determined at benchmark speeds. The actual values of the parameters are given in Table 40.

Table 40 Basic Labour Cost

Vehicle Type	Hrs.of Labour per 1,000 km	Average Labour Cost per hr. ฿	Labour Cost per km ฿
Car	1.650	27.50	0.045
L.B	1.900	27.50	0.052
L.T	1.900	27.50	0.052
H.B	4.363	27.50	0.119
H.T	4.363	27.50	0.119

The parameters, hours of labour per 1,000 km, are based on J. de Weille's paper, and on the results of other studies. In the Technical Report No.36 studied in 1970, the labour cost was given at 30 baht per hour; in 1973 it rose to 32.80 baht per hour. The 1973 figure is substantially high, although it included the material machinery, overheads and profit associated with labour in the garage business. In this study, the labour cost was estimated to be ฿ 27.50.

Lubricants Cost

The lubricants cost is too small to merit lengthly study. According to the study of the International Bank for Reconstruction and Development, engine oil costs for cars and light truck vary comparatively little with changes in speeds and surfaces, so that changes in engine oil costs are only about 0.3 % of the total changes in operating costs as road conditions change.

The lubricants cost is composed of performance component, the kilometers per litre, and a real cost component, economic cost per litre. The parameters which determine the lubricants cost per kilometer at benchmark speeds are summarized in Table 41. The retail prices of engine oil varies from ฿ 15 to ฿ 22, thus the average retail price is ฿18.50. The retail price of lubricant is about 130 percent of the economic cost, therefore the economic cost of lubricant is ฿14.23.

Table 41 Basic Lubricant Cost

Vehicle Type	Performance km/Litre	Economic Cost ฿/Litre	Lubricant Cost ฿/km
Car	1,000	14.23	0.014
L.B	770	14.23	0.018
L.T	770	14.23	0.018
H.B	450	14.23	0.032
H.T	450	14.23	0.032

Overhead Cost*

Overhead costs are calculated for heavy buses and trucks only since it is assumed that savings in overhead cost will not be relevant for operators using heavy commercial vehicles.

The parameter which determined the basic variable overhead cost at average lifetime speeds of 56 kph are shown in Table 42.

Table 42 Basic Overhead Cost

Vehicle Type	Overhead Cost in 1973 Study ฿/km	Cost Increase %	Overhead Cost ฿/km
Heavy Bus	0.051	12	0.057
Heavy Truck	0.073	12	0.082

*such as offices, terminals, supervision, administration etc.

Occupants Time Costs

The time costs of vehicle occupants has been based on income data. The cost figures are derived by combining these income data with data on vehicle occupancies and trip purposes. The assumption made on occupancies and trip purposes are summarized in Table 43.

Table 43 Vehicle Occupancies and Trip Purposes

Vehicle Type	Total Occupancy	Driver	Assistance	Working Occupant	Leisure Occupant	
					Active	Non-Active
Car						
Business	3.2	1	-	2.2	-	-
Leisure	4.0	1	-	-	1.8	1.2
L.B.	10.0	1	-	3.0	4.0	2.0
L.T.	4.0	1	-	2.0	1.0	-
H.B.	23.0	1	1	7.0	9.33	4.67
H.T.	3.0	1	-	1.33	0.67	-

The trip purposes of cars are divided into two categories, business and leisure. The study of the average total occupancies are slightly less than that of the Department of Highways survey conducted on the highways around outside Bangkok. The study also showed that the split percentage of the trip purpose for passenger cars were 70/30 between the business and leisure purpose, respectively. The assumption made for the percentage of active and non-active population were 60/40 (excluded driver)

The light buses in this study refer to the local buses and taxis. The local light buses, which run in short distance either from amphoe to amphoe or amphoe to changwat, while the taxis run a longer distance connecting changwats and Bangkok. The local light buses are relatively little volume compare to those of the taxis. The taxis in this sense are not the same as taxis in Bangkok. They are larger and have more seats, most of them are Japanese made such as Toyota Hiace for an example. The seatings capacity for these taxis are for 15 persons (including driver), although the average occupancy is found to be about 10 persons.

Heavy commercial buses connecting short distance seemed to carry more persons than those of the longer distance. The average total occupancy for heavy buses are 23 persons.

These occupancies are combined with time values (based on income data) in order to determine the total time cost of vehicle occupants. Time values are assumed as a certain percentage of income. The income data and the rate at which income are counted in the calculation of the time values are given in Table 44 and the results of time per kilometer at benchmark speed are given in Table 45.

Table 46 shows the basic road user cost by type of vehicle for road class I paved. The following Tables 47 and 48 also show the unit cost for various operating speed of 80, 72, 64 and 56 kph. Indices of conversion of the basic unit cost components of the various operating speeds are shown in Appendix C, Tables C3 to C6.

Table 44 Time Values of Vehicle Occupants

Vehicle Type	Driver ฿/hr	Assistance ฿/hr	Working Occupant ฿/hr	Leisure Occupant		Hourly Time Cost ฿/hr
				Active ฿/hr	Non-Active ฿/hr	
Car:						
Business	6.36 33%	- -	26.2 75%	- -	- -	45.3
Leisure	6.36 25%	- -	- -	5.3 25%	5.3 8%	4.5
L.B.	6.36 100%	- -	6.1 75%	6.1 25%	5.3 8%	27.0
L.T.	6.36 100%	- -	6.1 75%	6.1 25%	- -	17.0
H.B.	6.36 100%	4.24 100%	6.1 75%	6.1 25%	5.3 8%	58.8
H.T.	6.36 100%	- -	6.1 75%	6.1 25%	- -	13.5

Table 45 Time cost by Vehicle Type (at Benchmark speed)

Vehicle Type	Hourly Time Cost ฿/hr	Time Cost ฿/km
Car	33.0	0.413
L.B.	27.0	0.375
L.T.	17.0	0.236
H.B.	58.8	0.816
H.T.	13.5	0.188

Table 46 Summary of the Basic Cost Components by Type of Vehicle

Basic Cost	Type of Vehicle					Remark
	Car	LB	LT	HB	HT	
Depreciation	0.419	0.268	0.290	0.756	0.435	L.T. speed[1]
Interest	0.249	0.119	0.153	0.349	0.201	L.T. speed[1]
Fuel	0.224	0.209	0.209	0.307	0.358	B.M. speed[2]
Tyres	0.036	0.036	0.036	0.150	0.250	L.T. speed[1]
Parts	0.085	0.086	0.079	0.296	0.171	B.M. speed[2]
Labour	0.045	0.052	0.052	0.119	0.119	B.M. speed[2]
Lubricant	0.014	0.018	0.018	0.032	0.032	B.M. speed[2]
Overhead	-	-	-	0.057	0.082	L.T. speed[1]
Time Cost	0.413	0.375	0.236	0.816	0.188	B.M. speed[2]

[1] L.T. speed = Average lifetime speed 56 kph

[2] B.M. speed = Benchmark speed, 80kph for cars and 72 kph for commercial vehicles.

Table 47 Road User Cost (Baht/km) by Type of Vehicle For Road Class I Paved

Items	Type of Vehicle (64 kph)					Type of Vehicle (56 kph)				
	Car	Light Bus	Light Truck	Heavy Bus	Heavy Truck	Car	Light Bus	Light Truck	Heavy Bus	Heavy Truck
Depreciation	0.419	0.241	0.258	0.701	0.400	0.419	0.268	0.290	0.756	0.435
Interest	0.249	0.105	0.132	0.306	0.176	0.249	0.119	0.153	0.349	0.201
Fuel	0.199	0.192	0.192	0.282	0.329	0.193	0.181	0.181	0.273	0.318
Tyres	0.041	0.041	0.041	0.171	0.285	0.036	0.036	0.036	0.150	0.250
Parts	0.076	0.081	0.075	0.265	0.153	0.072	0.077	0.071	0.252	0.145
Labour	0.040	0.049	0.049	0.106	0.106	0.038	0.047	0.047	0.101	0.101
Lubricant	0.014	0.018	0.018	0.032	0.032	0.014	0.018	0.018	0.032	0.032
Overhead	-	-	-	0.050	0.073	-	-	-	0.057	0.082
Time Cost	0.515	0.422	0.265	0.918	0.211	0.589	0.482	0.304	1.050	0.241
Total Road User	1.553	1.149	1.030	2.831	1.765	1.610	1.291	1.100	3.020	1.805

Table 48 Road User Cost (Baht/km) by Type of Vehicle for Road Class I Paved

Items	Type of Vehicle (80 kph)					Type of Vehicle (72 kph)				
	Car	Light Bus	Light Truck	Heavy Bus	Heavy Truck	Car	Light Bus	Light Truck	Heavy Bus	Heavy Truck
Depreciation	0.419	0.206	0.221	0.586	0.336	0.419	0.223	0.238	0.648	0.372
Interest	0.249	0.084	0.106	0.243	0.139	0.249	0.093	0.118	0.271	0.156
Fuel	0.224	0.229	0.229	0.340	0.397	0.210	0.209	0.209	0.307	0.358
Tyres	0.054	0.054	0.054	0.223	0.372	0.046	0.046	0.046	0.193	0.322
Parts	0.085	0.090	0.083	0.330	0.190	0.081	0.086	0.079	0.296	0.171
Labour	0.045	0.054	0.054	0.132	0.133	0.043	0.052	0.052	0.119	0.119
Lubricant	0.014	0.018	0.018	0.032	0.032	0.014	0.018	0,018	0.032	0.032
Overhead	-	-	-	0.040	0.057	-	-	-	0.045	0.062
Time Cost	0.413	0.337	0.212	0.735	0.169	0.458	0.375	0.236	0.816	0.188
Total Road User	1.503	1.072	0.977	2.661	1.825	1.520	1.102	0.996	2.727	1.780