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RURAL TRANSPORTERS: A SURVEY OF TRANSPORT BUSINESS IN RURAL CAMBODIA

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Rural Transporters

A Survey of Transport Businesses in Rural Cambodia

By

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Executive Summary

From March until May 2001, 333 transporters businesses were surveyed in and around rural markets in Siem Reap and Kampot Provinces in Cambodia. The survey was a joint research effort between the Benefit Monitoring and Evaluation (BME) Unit of the Ministry of Rural Development (MRD) and International Labour Organisation (ILO) Upstream Project's Socio-Economic Team.

Most of the rural transporters interviewed stated that the transport business was only a part time business. In Siem Reap Province only 11 per cent were full time transporters, while in Kampot this was higher, at 26 per cent of the total sample. Most transporters in both provinces were farmers, market traders or government officials. In most cases, the income earned through transporting and other activities was about equal.

The vehicles on average travelled 22,350 kilometres per year. Handcarts covered the shortest average distance (2,280 kilometres annually) and pickups the longest (61,452 kilometres annually). Bicycle trailers in Kampot made the most trips (4,140 trips annually). Oxcarts made the fewest trips, averaging 24 trips per year mainly in the wet season.

An important aim of the survey was to examine the direct expenses incurred by the vehicle operators due to their transport activities. Fuel was the major direct operating expense for the motorised vehicles in the survey. Purchasing fuel accounted for 77.2 per cent of the total direct expenses. Expenses for spare parts added up to 11.6 per cent of the total expenses. Tyres were 7.7 per cent and oil was 3.5 per cent of the transporters total expenses. The Vehicle Operating Costs (VOCs) per 1,000 kilometres was highest for trucks at US$251.90. By comparison, operating a bicycle or handcart for 1,000 kilometres cost only US$3.30. For the most common transport vehicles, motorcycles and remorques, the VOCs per 1,000 kilometres were US$29.40 and US$58.80 respectively.

The direct operating expenses for fuel, oil, spare parts and tyres differed considerably between the two survey provinces. The costs per 1,000 kilometres were higher for all vehicles in Siem Reap. This was probably caused by significantly higher unit prices for fuel, oil, spare parts and tyres in Siem Reap Province. Another reason might be the better infrastructure in Kampot Province. This difference in expenses is reflected in the fares charged by the transporters. Trip prices in Kampot were considerably lower than in Siem Reap. A comparison of trip prices in each province for last year indicates this gap has narrowed.

These price changes could also be due to road improvements. Survey respondents indicated that improved road conditions could result in 17 per cent lower trip prices. Improved roads could also increase trip numbers. Respondents indicated road improvements would result in a 24 per cent increase in trips in the dry season and 13 per cent increase in the wet season.

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Acronyms

ADB	Asian Development Bank
BME	Benefit Monitoring and Evaluation
CREAM	Cambodian Rural Economic Access Model
EIRR	Economic Internal Rate of Return
FAO	Food and Agriculture Organisation of the United Nations
HDM III	Highway Development and Management 3
ILO	International Labour Organisation
IRI	International Roughness Index
MAFF	Ministry of Agriculture, Forestry and Fisheries
MRD	Ministry of Rural Development
RIIP	Rural Infrastructure Investment Project
RTRRMS	Response Type Road Roughness Measuring Systems
TRL	Transport Road Laboratory
VOC	Vehicle Operating Cost

Introduction

The International Labour Organisation (ILO) Upstream Project has been conducting socio-economic studies on rural transport infrastructure planning and investment in Cambodia since 1999. These studies aim to measure the potential socio-economic impact of interventions in rural transport infrastructure. The series includes research on market traffic patterns, employment impact, water transport and household travel and transport patterns. Recently, a survey of small-scale road construction companies was also conducted.

This study examines rural transport services in Siem Reap and Kampot Provinces. Interviews were conducted with 333 transport providers to examine various aspects of their day-to-day business. Respondents were asked about travel patterns, seasonal differences in transport activities, the type of transport and the economic aspects of their enterprise including, income and expenses.

The survey was carried out in the North West and the South East of Cambodia, as a joint research effort between the Benefit Monitoring and Evaluation (BME) Unit of the Ministry of Rural Development (MRD) and the ILO Upstream Socio-Economic Team. After the survey was developed it was piloted around Seva Market, Prey Kbas District, Takeo Province, before being used in Siem Reap and Kampot. In March 2001, 164 vehicle operators were interviewed in and around Puok Market in Puok District, Siem Reap Province.[1] In May 2001, another 169 vehicle operators were surveyed in and around Kampot Market, Kampong Bay District, Kampot Province.

This report analyses the operation of rural transport businesses in these two Cambodian provinces. There were 13 vehicle types, both motorised and non-motorised, involved in the survey, varying from handcarts to trucks. The report describes the daily operations of the transporters and the implications for their businesses. The report also estimates the costs of operating these vehicles. These cost estimates are based on a calibration of VOCs in Cambodia. The VOC calibration is included as Appendix 1.

[1] Puok District has been the focus for several studies commissioned by the ILO Upstream Project. See for example ILO Upstream S.E. Series No 1 (2000) and ILO Upstream S.E. Series No 3 (2000).

The Rural Transport Sector

Rural transporters were interviewed around rural markets in Siem Reap and Kampot Provinces. In total 333 transporters were interviewed in a period of about two weeks. In Siem Reap, 164 transport businesses were surveyed on the parking lots around Puok Market, Puok District. In Kampot Province, 169 transporters were interviewed in and around Kampot Market, Kampong Bay District. The questionnaire used for the survey is included as Appendix 2.

Vehicle Classification

Based on earlier rural transport surveys [2], the transport providers in Puok District, Siem Reap Province were subdivided into 10 vehicle types. The following table shows these different vehicle types.

No	Vehicle Type
1	Bicycle
2	Motorcycle
3	*Remorque*[3]
4	Oxcart
5	Car
6	Pickup
7	*Koyun* [4]
8	Light Truck[5]
9	Truck
10	Handcart

Table 1: Vehicle Classification for Siem Reap Province[6]

The rural transport scene in Kampot Province was rather different. The teams did not encounter any *koyun* around Kampot market and bicycles and oxcarts seemed to be less common, at least for commercial transport purposes. A pilot study was conducted to determine the vehicle classification for the survey. Consequently, bicycle trailers, horse carts and minibuses replaced bicycles, oxcarts and *koyun*. Table 2 shows the vehicle categories used for the Kampot transporter survey.

[2] ILO Upstream S.E. Series No 1 (2000) and ILO Upstream S.E. Series No 8 (2001).
[3] A *remorque* is a motorcycle with a trailer attached.
[4] A *koyun* is a truck powered by an irrigation pump engine - *ko* is Khmer for ox and *yun* means machine.
[5] The category light truck also includes the *laan koree* - a Korean light truck.
[6] There is only one difference with earlier vehicle categories used in Siem Reap Province: trucks are subdivided into light trucks and trucks.

No	Vehicle Type
1	Bicycle Trailer
2	Motorcycle
3	*Remorque*
4	Horse Cart
5	Car
6	Pickup
7	Minibus
8	Light Truck
9	Truck
10	Handcart

Table 2: Vehicle Classification for Kampot Province

As three vehicle categories were replaced in Kampot there were 13 vehicle types involved in the two surveys. For the remainder of the report, all 13 categories will be used in tables.

Given the prevalence of motorcycle transport in Cambodia it is not surprising that most of the transporters interviewed were motorcycle drivers (34.0%) and *remorque* drivers (18.3%). The lowest sample rates were for animal-drawn carts (oxcarts and horse carts 0.3%) and handcarts (0.6%). Table 3 shows the vehicle types for the 333 survey respondents.

No	Vehicles Type	Vehicles in Siem Reap Province		Vehicles in Kampot Province		Sample Total	
		Number	%	Number	%	Number	%
1	Bicycle	29	17.7	0	0	29	8.7
2	Bicycle Trailer	0	0	29	17.2	29	8.7
3	Motorcycle	56	34.2	57	33.7	113	34.0
4	*Remorque*	30	18.3	31	18.3	61	18.3
5	Oxcart	1	0.6	0	0	1	0.3
6	Horse Cart	0	0	1	0.6	1	0.3
7	Car	2	1.2	10	5.9	12	3.6
8	Pickup	10	6.1	10	5.9	20	6.0
9	*Koyun*	7	4.3	0	0	7	2.1
10	Minibus	0	0	10	5.9	10	3.0
11	Light Truck	25	15.2	14	8.3	39	11.7
12	Truck	3	1.8	6	3.6	9	2.7
13	Handcart	1	0.6	1	0.6	2	0.6
	Total	**164**	**100**	**169**	**100**	**333**	**100**

Table 3: Number of Respondents per Vehicle Type

The Transporters

The vehicles listed in Table 3 are those operated by the respondents at the time of the survey. Most of the transport businesses surveyed owned and operated one vehicle. This was the case for all of the Kampot respondents. However, three Siem Reap transporters reported that they operated more than one vehicle. One business ran a *remorque* and two light trucks, one had a *koyun* and a light truck and a third operated two light trucks.

In some cases, more than one driver used the vehicle. In the Siem Reap sample, this was the case for 26.2 per cent of the total (see Table 4). Siem Reap respondents reported that they often shared the operation of their vehicle with a family member leaving them more time for other activities. In Kampot Province, the sharing of vehicles was less apparent, indicating perhaps a more professional attitude.

Province	Operating Vehicle Alone		Sharing Vehicle Operation		Total
	Number of Respondents	%	Number of Respondents	%	
Siem Reap	121	73.8	43	26.2	164
Kampot	151	89.3	18	10.7	169
Total	**272**	**81.7**	**61**	**18.3**	**333**

Table 4: Type of Vehicle Operation

Transportation was not the only source of income for the transporters surveyed. In Siem Reap Province only 18 (11%) of the 164 respondents were involved full time in transport activities (see Table 5). In Kampot, this number was significantly higher, as 44 respondents (26%) stated that transportation was their only business. Again, this is a sign of a more developed and professional transport scene.

Province	Full Time Transport Business		Part Time Transport Business		Total
	Number of Respondents	%	Number of Respondents	%	
Siem Reap	18	11.0	146	89.0	164
Kampot	44	26.0	125	74.0	169
Total	**62**	**18.6**	**271**	**81.4**	**333**

Table 5: Involvement in Transport Business

The majority of respondents were only involved in transport part time. Their other main source of income was farming at 67.8 per cent for Siem Reap Province and 55.2 per cent for Kampot Province. Trading was another important activity as Figure 1 shows.

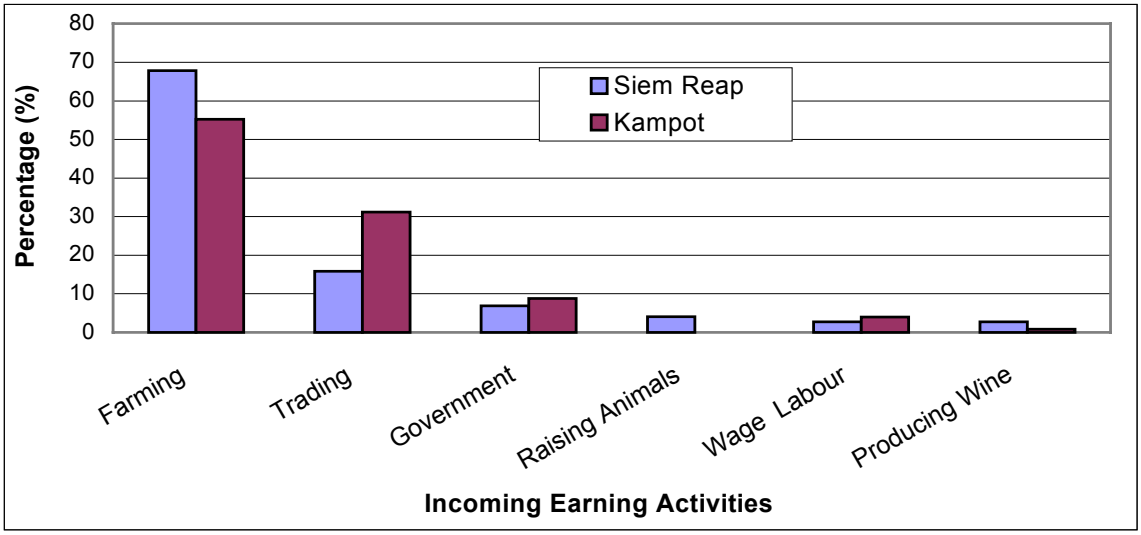

Figure 1: Other Income Earning Activities (Appendix 2, Table A)

Table 6 shows the income generated from non-transport related business activities. In both provinces, other income generating activities make up about half of the respondent's income. It is interesting to note that the 21 government officials from the two provinces almost doubled their income by providing transport services.

No	Other Income	Percentage of Total Income		
		Siem Reap (%)	Kampot (%)	Average (%)
1	Farming	56	53	55
2	Trading	44	49	47
3	Government	46	34	40
4	Raising Animals	58	0	58
5	Wage Labour	45	50	48
6	Producing Wine [7]	50	50	50
	Weighted Average	**53**	**50**	**52**

Table 6: Income Generated from Non-transport Business Activities

Features of the Vehicles

One of the survey questions asked how long the transporter had operated the vehicle. Operators in the two provinces had bought their vehicles 3.7 years ago on average. Non-motorised vehicles (animal drawn carts, handcarts, bicycles and bicycle trailers) were generally owned longer by the operator, while cars, pickups and heavier vehicles had been bought more recently. Vehicles had generally been owned longer in Kampot Province (3.9 years) than in Siem Reap (3.5 years), as Table 7 below shows.

[7] Producing rice wine is an important source of income in rural Cambodia.

No	Vehicle Type	Years of Possessions of Vehicle		
		Siem Reap	Kampot	Average
1	Bicycle	5.4	-	5.4
2	Bicycle Trailer	-	6.9	6.9
3	Motorcycle	3.3	2.8	3.0
4	*Remorque*	3.7	4.2	4.0
5	Oxcart	8.0	-	8.0
6	Horse Cart	-	16.0	16.0
7	Car	2.5	1.6	1.8
8	Pickup	2.2	4.8	3.5
9	*Koyun*	2.4	-	2.4
10	Minibus	-	2.3	2.3
11	Light Truck	2.5	3.5	2.9
12	Truck	2.7	3.3	3.1
13	Handcart	4.0	3.0	4.0
	Weighted Average[8]	**3.5**	**3.9**	**3.7**

Table 7: Years of Vehicle Ownership

Examining the period that the operator has used the vehicle does not reveal much about the age of the vehicle, as most of Cambodia's transportation is bought second hand. Therefore, a question was added about the vehicle's age. Table 8 shows the ages of the vehicles used and gives a rather different picture.

No	Vehicle Type	Age of Vehicle (Years)		
		Siem Reap	Kampot	Average
1	Bicycle	7.9	-	7.9
2	Bicycle Trailer	-	15.7	15.7
3	Motorcycle	9.6	8.3	8.9
4	*Remorque*[9]	11.2	8.2	9.7
5	Oxcart	8.0	-	8.0
6	Horse Cart	-	21.0	21.0
7	Car	7.5	15.7	14.3
8	Pickup	5.3	10.6	8.0
9	*Koyun*	4.7	-	4.7
10	Minibus	-	8.0	8.0
11	Light Truck	7.4	11.8	8.9
12	Truck	14.7	11.7	12.7
13	Handcart	4.0	4.0	4.0
	Weighted Average	**8.8**	**10.6**	**9.7**

Table 8: Age of Vehicles

[8] The weighted average is the total average of the years of possessions which is derived by the sum of the years of possession of each vehicle multiplied by the number of each vehicle types and divided by the total sample of vehicle
(e.g.: For Siem Reap province: { (5.4 x 29)+(3.3 x 56)+(3.7 x 30)+(8X1)+(2.5 x 2)+(2.2 x 10)+(2.4 x 7)+ (2.5 x 25)+(2.7 x 3)+(4.0 x 1)} **/164 =3.5**

[9] The age in the case of the *remorque* reflects the age of the motorcycle.

The average age of the vehicles surveyed was about 10 years, indicating that most vehicles were around six years old when purchased by their present owners. Interestingly, vehicles in Kampot Province were, on average, two years older than the ones in the Siem Reap sample. The age of the surveyed vehicles varied from 21 years for horse carts to four years for handcarts in both provinces. Motorcycles, the most common mode of transport, were nine years old on average. *Remorques* were slightly older, averaging 9.7 years. Non-motorised vehicles, except handcarts, were in use longer and were also older.

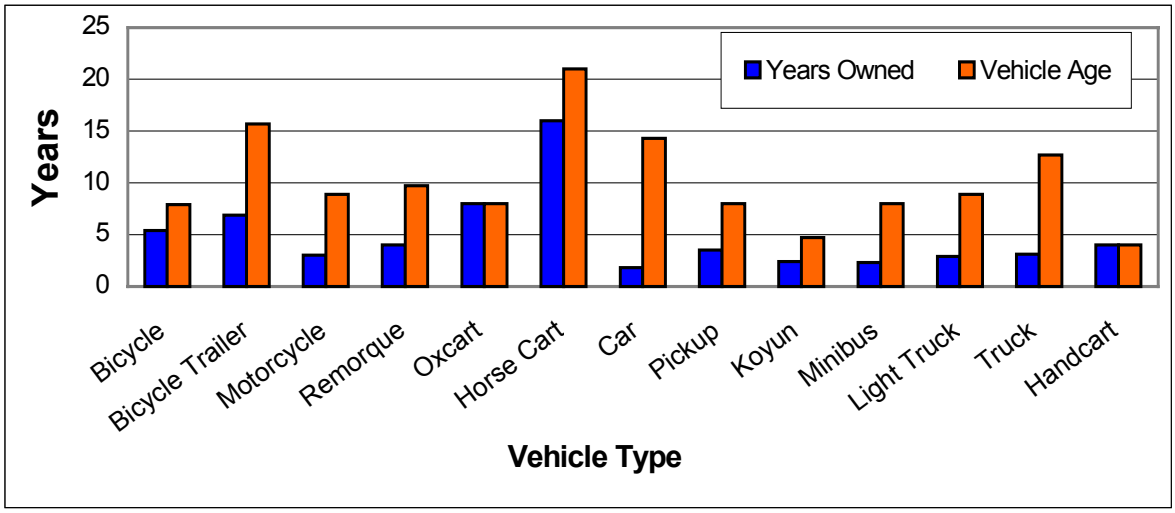

Figure 2: Vehicle Age and Years Owned for Total Sample

No	Vehicle Type	Price of Vehicle (US$)		
		Siem Reap	Kampot	Average
1	Bicycle	35	-	35
2	Bicycle Trailer	-	49	49
3	Motorcycle	577	409	492
4	*Remorque*	498	563	531
5	Oxcart	350	-	350
6	Horse Cart	-	250	250
7	Car[10]	3,850	1,390	1,800
8	Pickup	3,755	4,590	4,173
9	*Koyun*	3,191	-	3,191
10	Minibus	-	3,300	3,300
11	Light Truck	3,308	3,057	3,218
12	Truck	7,133	7,292	7,239
13	Handcart	51	21	36

Table 9: Purchase Price of Vehicles

[10] This high price might be explained by the low sample size: only two car drivers were interviewed.

The prices paid for vehicles varied from an average US$35 for a bicycle to US$7,239 for a truck. When comparing the purchase prices between the two provinces, it seems that the average prices for the same modes of transport are slightly lower in Kampot than in Siem Reap Province. This may be due to the differences in age of the vehicles in the two provinces.

Seasonal Vehicle Use

According to all respondents, vehicles were not used to the same extent in the wet and the dry seasons. Use of vehicles in the wet season is considerably lower because of seasonal influences on work and the transport infrastructure. Table 10 shows vehicle use by season.

No	Vehicle Type	Siem Reap		Kampot	
		Dry Season (days)	Wet Season (days)	Dry Season (days)	Wet Season (days)
1	Bicycle	148	75	-	-
2	Bicycle Trailer	-	-	166	139
3	Motorcycle	146	96	146	124
4	*Remorque*	145	78	142	114
5	Oxcart	24	48	-	-
6	Horse Cart	-	-	168	120
7	Car	168	144	130	125
8	Pickup	120	46	132	110
9	*Koyun*	147	79	-	-
10	Minibus	-	-	113	98
11	Light Truck	136	54	135	123
12	Truck	104	48	112	104
13	Handcart	168	72	168	168
	Weighted Average[11]	**142**	**78**	**143**	**122**

Table 10: Vehicle Use by Season

The oxcart is the only vehicle that is used more frequently in the wet season. As explained in earlier studies[12], the oxcart is better equipped to travel on roads in poor condition or affected by floods. Other vehicles all travel less in the wet season, most notably pickups in Siem Reap Province.

[11] The total average of vehicle used by season calculated by the sum of each vehicle use multiplied by number of each vehicle sample divided by the total samples of vehicles.
[12] Upstream Project S.E. Series No 3: *Household Travel and Transport Analysis,* September 2000.

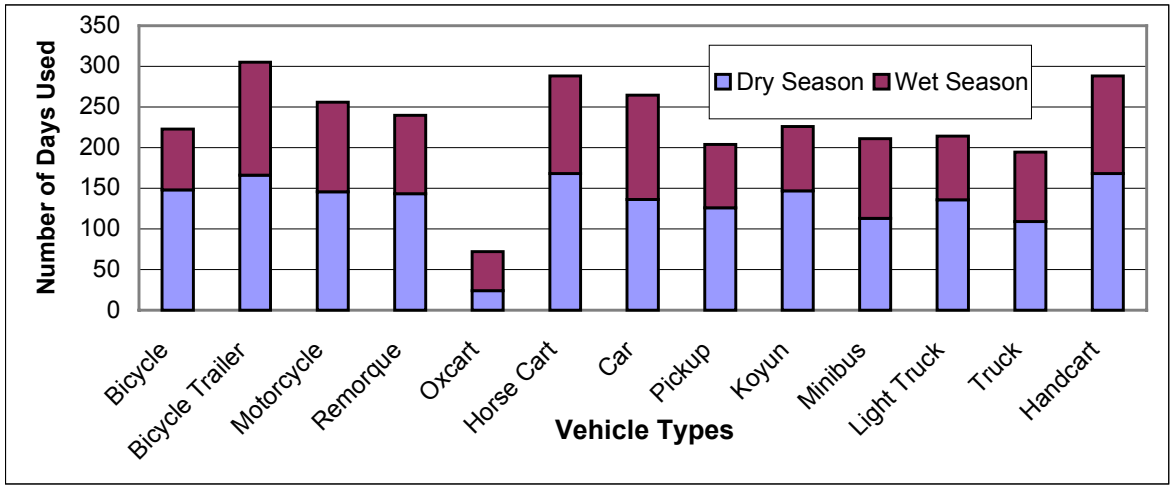

Figure 3: Vehicle Use by Season for Total Sample (Appendix 2, Table B)

It is interesting to note that the ratio between wet and dry season travel is significantly lower in Siem Reap Province than in Kampot (0.55 compared to 0.85)[13]. This may be another indication that the transport infrastructure is more developed in Kampot. More transporters are involved full time in transport in Kampot and therefore do not lose days in the wet season working, for example, in the rice fields. This is also reflected in Table 11, which shows that the number of operating days lost per year[14] due to poor infrastructure conditions is higher on average in Siem Reap than in Kampot Province.

No	Vehicle Type	Days Lost		
		Siem Reap	Kampot	Average
1	Bicycle	106	0	106
2	Bicycle Trailer	0	35	35
3	Motorcycle	68	55	61
4	*Remorque*	75	66	70
5	Oxcart	0	0	0
6	Horse Cart	0	48	48
7	Car	23	57	51
8	Pickup	139	97	118
9	*Koyun*	84	0	84
10	Minibus	0	89	89
11	Light Truck	141	60	112
12	Truck	157	153	154
13	Handcart	50	65	58
	Weighted Average[15]	**93**	**62**	**77**

Table 11: Days Lost per Year by Season

[13] Table B in Appendix 2 shows details of the dry/wet season ratios for each vehicle type.
[14] This is not a calendar year, but the total days a transporter would normally operate each year.
[15] The average number of days lost calculated by taking the number of days lost for each vehicle multiplied by the samples of each type of vehicle and divided by the total vehicle sample.

Type of Transport

The majority of the respondents reported that they transported both passengers and products (64% in both provinces). Focusing on carrying passengers seemed to be more common in Kampot Province (28.8%) while solely transporting products occurred more often in Siem Reap Province (26.9%).

No	Use of Transport	Siem Reap	Kampot	Total
1	Passengers	9.1%	28.8%	19.1%
2	Products	26.9%	7.2%	16.9%
3	Passengers and Products	64.0%	64.0%	64.0%
	Total	**100%**	**100%**	**100%**

Table 12: Use of Transport

Transport businesses carried agricultural and non-agricultural products. In Siem Reap Province, 61 per cent of the transported products were agricultural and 39 per cent were non-agricultural. In Kampot Province 59 per cent were agricultural and 41 per cent non-agricultural. For the total sample, 60 per cent of the products carried were agricultural, against 40 per cent non-agricultural products. The most frequently carried products were rice or paddy, fresh vegetables and fruit. Figure 4 shows the details of the various agricultural products transported.

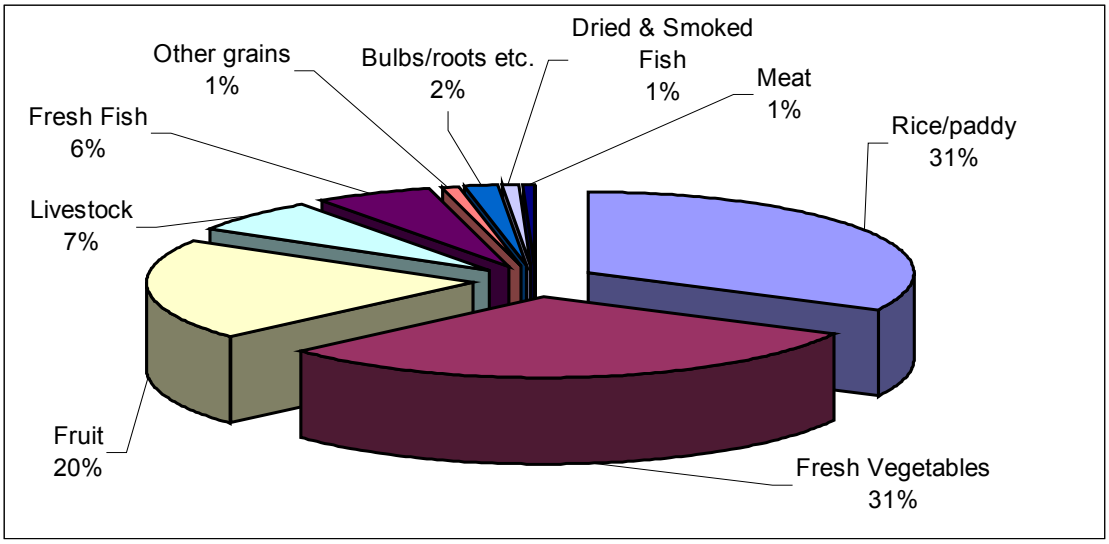

Figure 4: Agricultural Products Transported (Appendix 2, Table C)

Construction materials were the most frequently transported non-agricultural products in both provinces (45.5% of the total sample). About a quarter of the trips made by the transport businesses, involved dried or processed food products. Transporting firewood and charcoal was third in importance in both provinces.

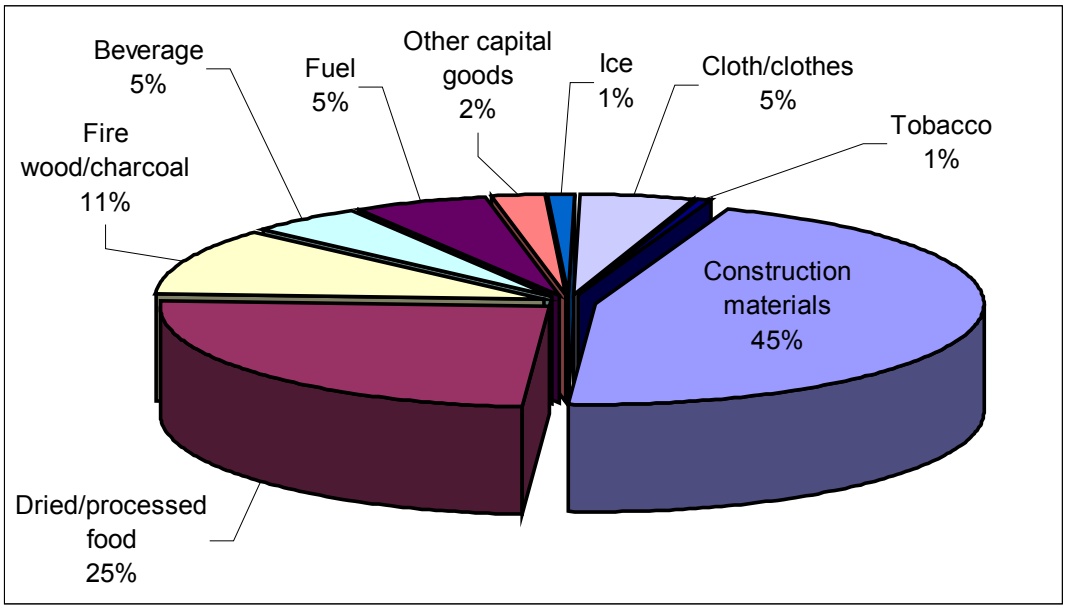

Figure 5: Non-agricultural Products Transported (Appendix 2, Table D)

The survey questionnaire also covered the transport capacity of the vehicles, both in products and in passengers. The average capacity for product transport varied from 43 kilograms for bicycles to 5,667 kilograms[16] for larger trucks. In terms of passengers, the capacity ranged from one passenger on average for bicycles to 26 passengers for light trucks.

No	Vehicle Type	Products (kg)
1	Bicycle	43
2	Bicycle Trailer	384
3	Motorcycle	114
4	*Remorque*	985
5	Oxcart	300
6	Horse Cart	300
7	Car	125
8	Pickup	1,495
9	*Koyun*	3,357
10	Minibus	275
11	Light Truck	2,251
12	Truck	3,056
13	Handcart	45

Table 13: Vehicle Load Capacity

[16] See Appendix 2 ,Table E.

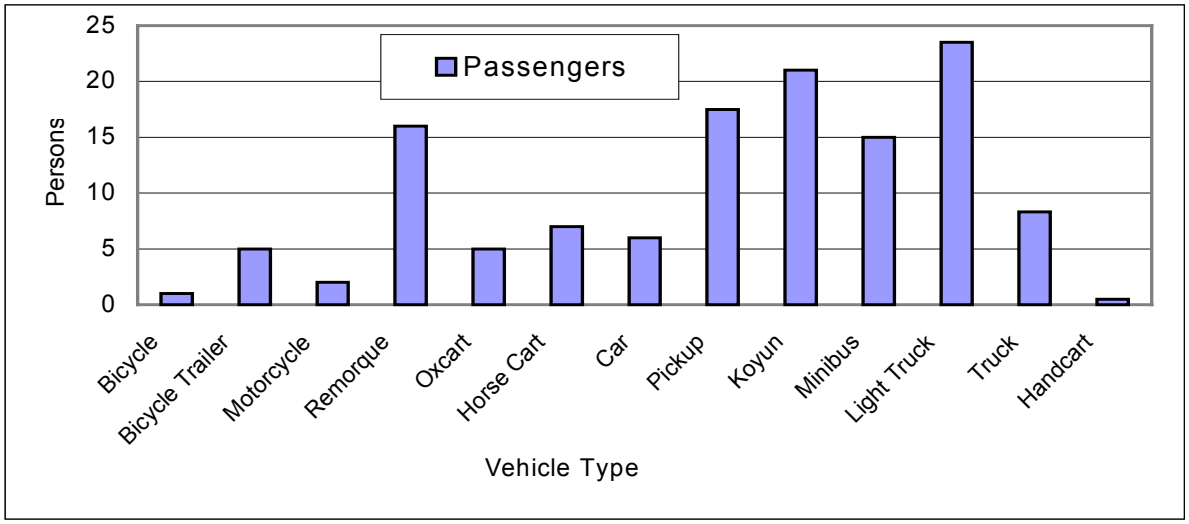

Figure 6: Vehicle Passenger Capacity (Appendix 2, Table E)

Transporters were asked whether they used their vehicles only for commercial transportation, i.e. transport on behalf of others, or whether they also used their vehicles to carry their own produce. Table 14 shows that about a quarter of the sample used their vehicles for carrying their own produce. In Siem Reap, this was around 35 per cent. This was probably due to the many part time farmers among the rural transporters in the Puok District of this province.

No	Vehicle Use	Siem Reap		Kampot		Total Sample	
		Number	%	Number	%	Number	%
1	Commercial Use Only	107	65	141	83	248	74
2	Commercial and Private Use	57	35	28	17	85	26
	Total	**164**	**100**	**169**	**100**	**333**	**100**

Table 14: Vehicle Use (private versus commercial)

Transport Costs

An important aim of the transporter survey was to understand the expenses transport businesses incur when they operate their vehicles. The expenses included here are the direct expenses, the ones that are the most visible for the transport entrepreneur. These are fuel, oil, spare parts and tyres.[17]

Travel Distance

To determine the costs of vehicle operation, the total travel distance need to be known. Figure 7 compares the annual distances travelled by the 13 modes of transport. These average distances vary from 384 kilometres per year for oxcarts to 61,452 kilometres per year for pickups.

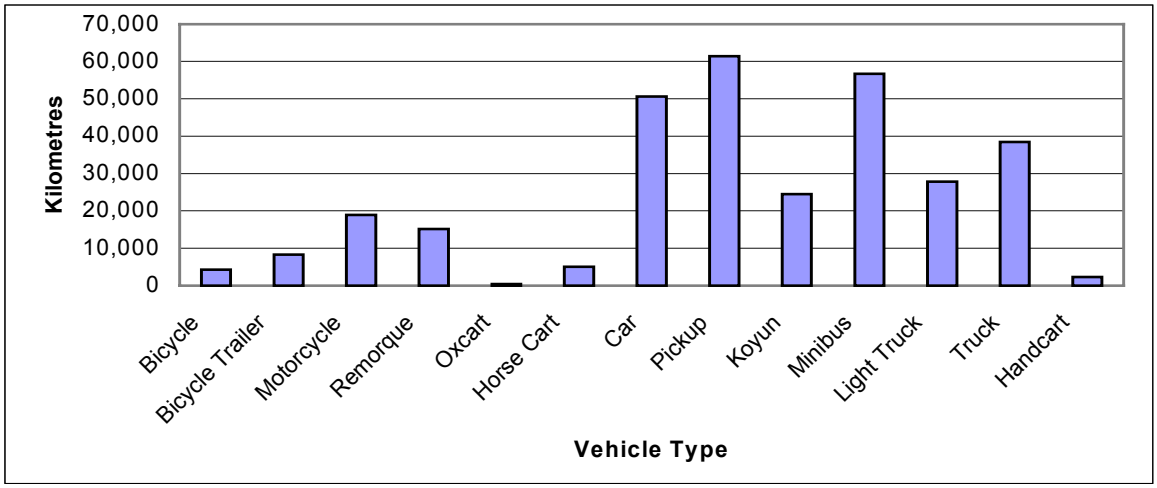

Figure 7: Average Travel Distance per Year (Appendix 2, Table F)

One of the questions of the survey dealt with the average trip distance. The survey results show that the average trip distance in Siem Reap was 33 kilometres, while in Kampot it was 44 kilometres. For the total sample, the trip average was 38 kilometres, as Table 15 shows.

[17] These four cost components are subsequently used for the calculation of *Vehicle Operating Costs* this calculation and the further use of the VOC are explained in Appendix 1.

No	Vehicle Type	Siem Reap (km)	Kampot (km)	Total average (km)
1	Bicycle	14	-	14
2	Bicycle Trailer	-	2	2
3	Motorcycle	21	22	22
4	*Remorque*	15	28	22
5	Oxcart	16	-	16
6	Horse Cart	-	7	7
7	Car	16	88	76
8	Pickup	129	127	128
9	*Koyun*	33	-	33
10	Minibus	-	129	129
11	Light Truck	66	89	74
12	Truck	65	88	80
13	Handcart	1	3	2
	Weighted Average[18]	**33**	**44**	**38**

Table 15: Average Trip Length

As expected, handcarts made the shortest trips on average. The average bicycle trailer trips in Kampot, however, were also short, at two kilometres per trip. Pickups in Siem Reap made the longest trips (129 kilometres), while in Kampot minibuses (129 kilometres) and pickups (127 kilometres) travelled the longest distances. Combining the data from Figure 7 and Table 15 gives the average trips per annum shown in Figure 8.

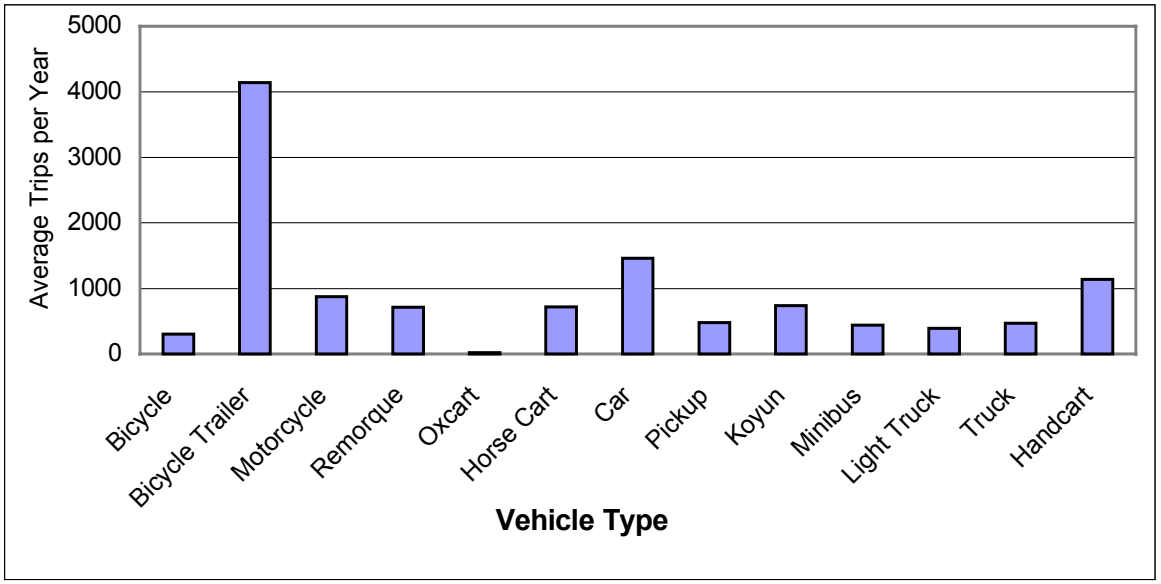

Figure 8: Average Trips per Year (Appendix 2, Table G)

[18] The total average trip length is the sum of trip length of vehicles multiplied by samples of each vehicle and divided by the total vehicle samples.

Direct Expenses Comparison

The four core direct expenses examined in both provinces were fuel, oil, spare parts and tyres. Normally tyres are considered spare parts, but for the purpose of this study, they were put in a separate cost category as they make up a considerable proportion of the spare parts category.

Table 16 compares the relative vehicle direct expenses for surveyed vehicles in Siem Reap Province. Fuel is the largest expense for all the motorised vehicles, varying from 75 to 84 per cent of the total of the direct vehicle expenses being 78% (average). For non-motorised vehicles, spare parts were the most significant direct expense. Oil was the least significant expense for vehicles in Siem Reap Province (on average 4%), while spare parts accounted for 24 per cent and tyres for 8 per cent.

No	Vehicle Type	Fuel (%)	Oil (%)	Spare Parts (%)	Tyres (%)
1	Bicycle	-	-	81	19
2	Motorcycle	84	5	9	2
3	*Remorque*	77	4	15	4
4	Oxcart	-	-	100	-
5	Car	76	2	15	7
6	Pickup	75	3	18	4
7	*Koyun*	77	5	13	5
8	Light Truck	78	4	11	7
9	Truck	80	4	3	13
10	Handcart	-	-	57	43
	Weighted Average[19]	**78**	**4**	**10**	**8**

Table 16: Direct Expenses Comparison in Siem Reap Province

The overall picture in Kampot Province was rather similar to Siem Reap. Again, the fuel costs were dominant, ranging from 74 to 79 per cent of direct expenses. Spare parts were again ranked second (27%), tyres third (7%) and oil fourth (3%). The main direct expense for non-motorised transport was clearly spare parts; the other cost being tyres. Table 17 shows the details of the direct expenses comparison in Kampot Province.

[19] The weighted average of direct expenses is calculated by taking the sum of the expenses of each vehicle multiplied by samples of each vehicle and divided by the total samples.

No	Vehicle Type	Fuel	Oil	Spare Parts	Tyres
1	Bicycle Trailer	-	-	82%	18%
2	Motorcycle	77%	6%	15%	2%
3	*Remorque*	76%	3%	16%	5%
4	Horse Cart	-	-	68%	32%
5	Car	75%	3%	14%	8%
6	Pickup	79%	4%	11%	6%
7	Minibus	74%	2%	19%	5%
8	Light Truck	78%	3%	12%	7%
9	Truck	78%	3%	9%	10%
10	Handcart	-	-	64%	36%

Table 17: Direct Expenses Comparison in Kampot Province

For all transport businesses surveyed, the main direct expense was fuel at 77.2 per cent. Spare parts were ranked second overall, contributing 11.6 per cent to the expenses. Tyres made up 7.7 per cent of the operating costs of all the surveyed transporters. Oil purchases were only a small proportion of the total operating expenses, being 3.5 per cent on average.

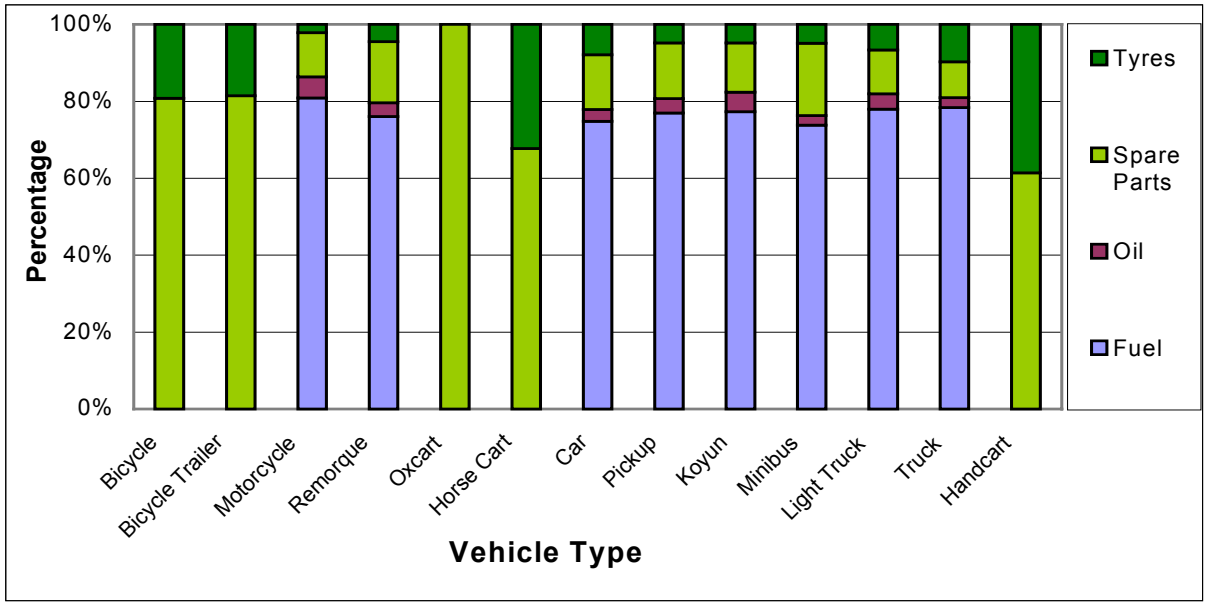

Figure 9: Direct Expenses for Total Sample (Appendix 2, Table H)

Vehicle Operating Costs

The previous section gave an overview of the proportional relationship of the different vehicle direct expenses components for transporters in the two provinces. This section examines transport expenses related to distance travelled. These expenses are calculated per 1,000 kilometres. Dividing the direct expenses for each vehicle by the distance travelled gives the vehicle operating cost per 1,000 kilometres. Table 18 shows the results for Siem Reap Province.

No	Vehicle Type	Vehicle Operating Cost (US$/1,000 km)				
		Fuel	Oil	Spare Parts	Tyres	Total
1	Bicycle	0.0	0.0	2.7	0.6	3.3
2	Motorcycle	32.2	2.0	3.3	0.7	38.2
3	*Remorque*	50.4	2.5	10.2	2.7	65.8
4	Oxcart	0.0	0.0	8.0	0.0	8.0
5	Car	49.2	1.3	9.7	4.9	65.1
6	Pickup	83.1	3.3	19.9	3.8	110.1
7	*Koyun*	92.0	6.1	15.2	5.7	119.0
8	Light Truck	141.6	8.0	20.0	11.7	181.3
9	Truck	227.1	12.1	8.3	37.7	285.2
10	Handcart	0.0	0.0	1.2	1.0	2.2

Table 18: Vehicle Operating Costs in Siem Reap Province

In Siem Reap Province, the VOCs varied from US$2.20 per 1,000 kilometres for a handcart to US$185.20 for a truck. For the most common vehicles, the motorcycle and the *remorque*, the VOCs were US$38.20 and US$65.80 respectively.

No	Vehicle Type	Vehicle Operating Cost (US$/1,000 km)				
		Fuel	Oil	Spare Parts	Tyres	Total
1	Bicycle Trailer	0.0	0.0	3.9	0.9	4.8
2	Motorcycle	16.0	1.2	3.0	0.5	20.7
3	*Remorque*	39.3	1.7	8.5	2.5	52.0
4	Horse Cart	0.0	0.0	4.3	2.0	6.3
5	Car	48.5	2.1	9.2	5.2	65.0
6	Pickup	51.0	2.8	7.1	4.0	64.9
7	Minibus	68.1	2.3	17.3	4.5	92.2
8	Light Truck	66.6	3.0	10.0	5.8	85.4
9	Truck	184.3	6.1	21.9	22.9	235.2
10	Handcart	0.0	0.0	2.8	1.7	4.5

Table 19: Vehicle Operating Costs in Kampot Province

In Kampot Province, the average VOC of the surveyed transport businesses was considerably lower than in Siem Reap. For instance, the VOC for operating a motorcycle in Kampot Province was US$20.70 per 1,000 kilometres, while in Siem Reap Province it was US$38.20. Several factors may explain this difference. Firstly, the unit price of fuel, oil, spare parts and tyres was generally lower in Kampot than in Siem Reap. For example, the price of fuel in Kampot was usually 1,900 Riel per litre and 2,100 Riel per litre in Siem Reap. The price difference was even larger for oil. In Siem Reap, one litre of oil cost 4,000 Riel, while Kampot transporters paid 3,500 Riel per litre.

The different infrastructure conditions may also have influenced expenses. In Siem Reap, most transporters used secondary, tertiary and sub-tertiary roads, which were usually in poor condition. In Kampot, vehicles mainly travelled on primary and secondary roads. Vehicles in Kampot usually made longer trips, which might also have influenced costs.

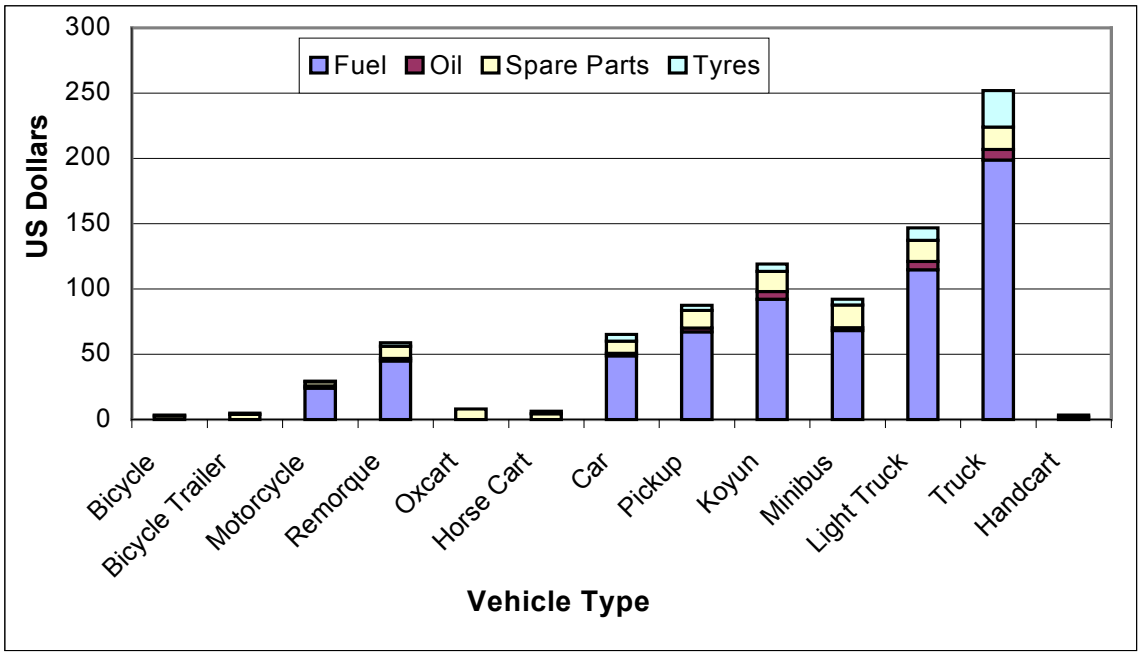

Figure 10: Vehicle Operating Costs for Total Sample (Appendix 2, Table I)

Figure 10 combines information from both provinces. On this aggregate level, the VOCs varied from US$3.30 per 1,000 kilometres for a handcart or a bicycle, to US$251.90 for a truck. For the most common transport vehicles, the motorcycle and the *remorque*, the VOCs were US$29.40 and US$58.80 respectively.

Transport Income

One part of the survey asked about the price transporters charged their customers for the trips they made. Transporters were asked about the fares for transporting people and products. The survey also looked at changes in trip fares over the last year.

Figures 11 and 12 compare the fares charged per kilometre to transport one person in both Siem Reap and Kampot Provinces. As expected, the average fares charged in Siem Reap were considerably higher than in Kampot. This reflects the higher operation costs explained in the previous section. Comparing the years shows that fare prices in Siem Reap decreased significantly, while Kampot prices stayed about the same, or increased slightly. Thus, the price gap between the two provinces became smaller during the year. Siem Reap respondents reported that increased competition and improved infrastructure caused this price decrease.

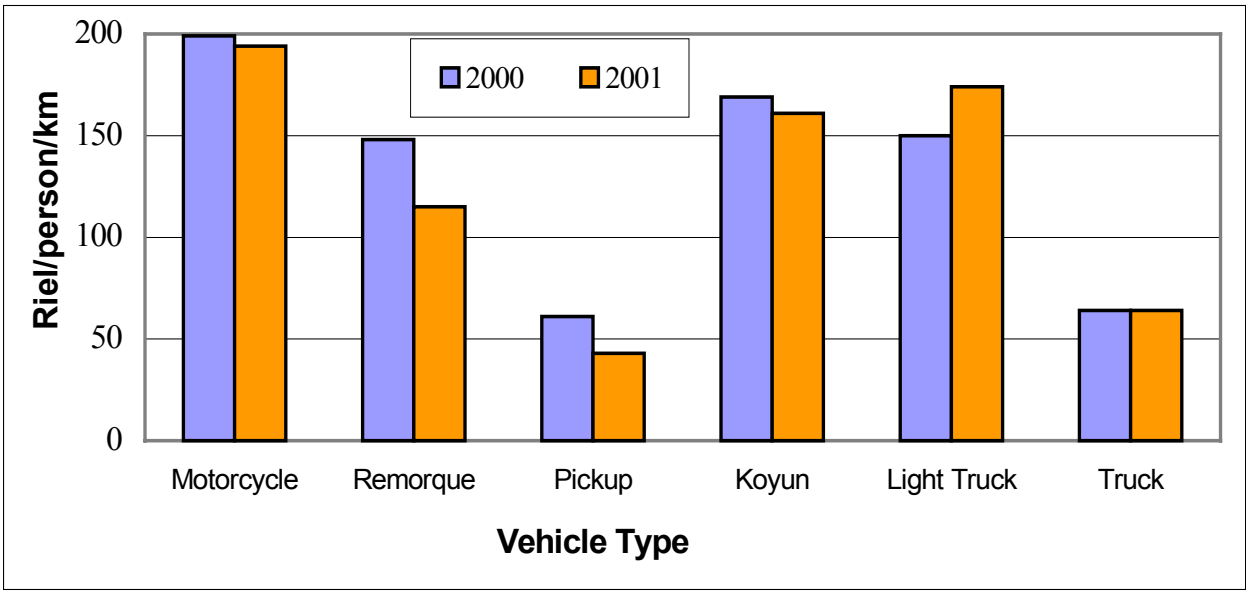

Figure 11: Passenger Transport Fares in Siem Reap Province (Appendix 2, Table J)

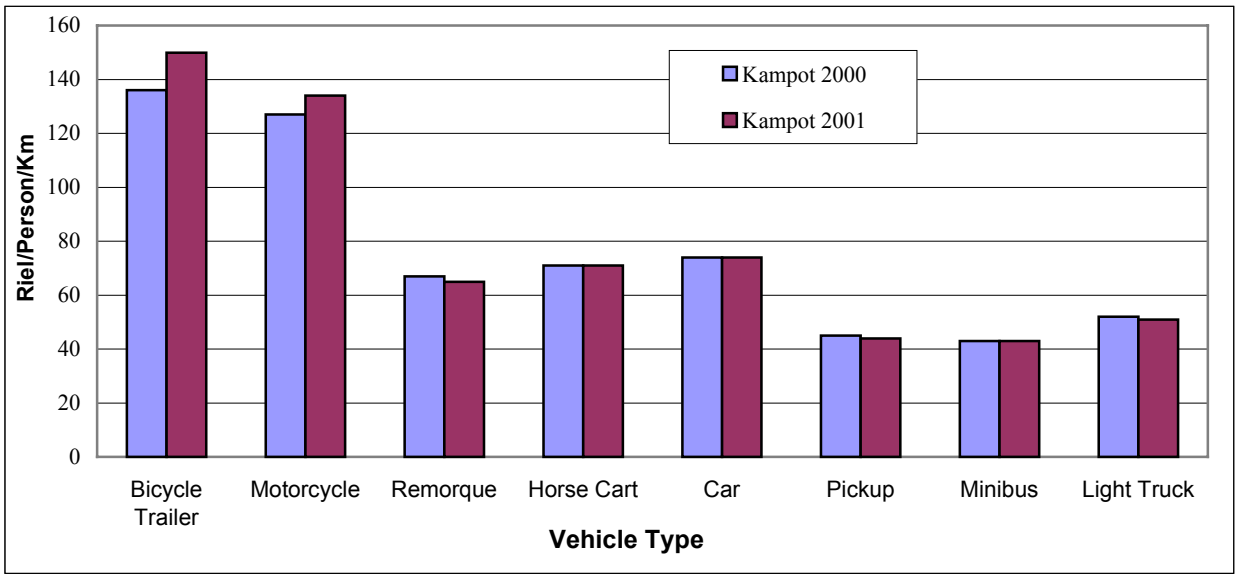

Figure 12: Passenger Transport Fares in Kampot Province (Appendix 2, Table J)

Costs for transporting products in Siem Reap were also higher than Kampot. However, the price differences between the provinces were smaller, especially comparing the 2001 figures. Table 20 shows details of this comparison.

No	Vehicle Type	Charge in Riel/kg/km			
		2000		2001	
		Siem Reap	Kampot	Siem Reap	Kampot
1	Bicycle	15.0	-	11.0	-
2	Bicycle Trailer	-	9.2	-	7.0
3	Motorcycle	6.0	6.0	9.0	8.0
4	*Remorque*	2.0	0.9	3.0	0.9
5	Oxcart	4.2	-	4.2	-
6	Horse Cart	-	2.0	-	2.0
7	Car	-	-	-	-
8	Pickup	1.4	0.7	1.0	0.8
9	*Koyun*	0.9	-	0.5	-
10	Minibus	-	-	-	-
11	Light Truck	1.2	1.3	0.7	2.0
12	Truck	0.5	0.4	0.3	0.4
13	Handcart	-	-	-	-

Table 20: Product Transport Fees for Total Sample

In 1997, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the UN Food and Agriculture Organisation (FAO) carried out a study on agricultural marketing in Siem Reap Province.[20] It focussed on marketing channels and included transport of agricultural products. Though only small numbers of transporters were interviewed, it indicated the fares charged for product transport. For instance, *remorque* operators interviewed at Psa Leu in Siem Reap town were estimated to charge between 0.83 and 4.46 Riel per kilogram per kilometre. The average was 2.7 Riel per kilogram per kilometre, which is similar to the two Riel per kilogram per kilometre found on average in this survey.

[20] *Agricultural Marketing in Siem Reap: Study results of markets and marketing channels for agricultural commodities*, Marketing Section, Department of Planning, Statistics and International Cooperation, Ministry of Agriculture, Forestry and Fisheries, in cooperation with FAO, Phnom Penh, May 1997.

Impact of Road Improvements

The last two questions of the survey asked about the potential impact of road improvement on fares and the number of trips made. Respondents indicated that improved road conditions could result in 17 per cent lower trip prices (18.2% decrease for Siem Reap respondents and 15.9% decrease for Kampot respondents). Table 21 shows details of the potential impact of road improvements.

No	Vehicle Type	Road Improvement Price Decrease		
		Siem Reap	Kampot	Average
1	Bicycle	-8%	-	-8%
2	Bicycle Trailer	-	-2%	-2%
3	Motorcycle	-20%	-19%	-20%
4	*Remorque*	-13%	-17%	-15%
5	Oxcart	0	-	0
6	Horse Cart	-	0	0
7	Car	0	-23%	-19%
8	Pickup	-33%	-23%	-28%
9	*Koyun*	-23%	-	-23%
10	Minibus	-	-17%	-17%
11	Light Truck	-26%	-17%	-23%
12	Truck	-32%	-26%	-28%
13	Handcart	0	0	0
	Weight Average	**-18%**	**-16%**	**-7%**

Table 21: Relationship between Road Improvement and Fare Decrease

Improved road conditions can lead to increased trip numbers, thus increasing the availability of rural transport services and the income generated. Table 22 compares the potential impact of road improvement in the two provinces for wet and dry season travel. For the total sample, road improvements could result in a 24 per cent increase in trips in the dry season and 13 per cent in the wet season. The potential impact of road improvement was greater in Kampot than in Siem Reap Province, probably because professional transport businesses in Kampot would be more likely to increase their trip numbers than the part time transporters in Siem Reap Province.

Increase in Trips by Season							
No	**Vehicle Type**	**Siem Reap**		**Kampot**		**Average**	
		Dry	Wet	Dry	Wet	Dry	Wet
1	Bicycle	+10%	+1%	-	-	+10%	+1%
2	Bicycle Trailer	-	-	+17%	+13%	+17%	+13%
3	Motorcycle	+22%	+3%	+27%	+20%	+25%	+12%
4	*Remorque*	+17%	+2%	+33%	+17%	+25%	+10%
5	Oxcart	0	0	-	-	0	0
6	Horse Cart	-	-	+10%	+10%	+10%	+10%
7	Car	0	+3%	+48%	+48%	+40%	+41%
8	Pickup	+28%	+3%	+22%	+20%	+25%	+12%
9	*Koyun*	+24%	+3%	-	-	+24%	+3%
10	Minibus	-	-	+45%	+43%	+45%	+43%
11	Light Truck	+22%	+2%	+44%	+42%	+30%	+16%
12	Truck	+32%	+3%	+50%	+50%	+44%	+34%
13	Handcart	0	0	0	0	0	0
	Weight Average	**+19%**	**+2%**	**+30%**	**+24%**	**+24%**	**+13%**

Table 22: Relationship between Road Improvement and Trip Increase

Main Findings

This survey of 333 transport businesses in Siem Reap and Kampot reveals some interesting characteristics of rural transporters. Most of the entrepreneurs interviewed mentioned that transport was a part time business. In Siem Reap Province, only 11 per cent were full time transporters, while in Kampot this percentage was higher, at 26 per cent. Most transporters in both provinces were also farmers, market traders or government officials. For those who were part time transporters, the income earned through transporting and other sources was about equal.

Thirteen vehicle types were included in the survey. Of these, 64 per cent mainly carried a combination of passengers and products, 19.1 per cent only transported people and 16.9 per cent only carried products. In the last category, about 60 per cent were agricultural products - like rice and paddy, vegetables and fruit. The remaining 40 per cent were non-agricultural products like construction materials, dried and processed food, firewood and charcoal.

On average, the vehicles surveyed travelled 22,350 kilometres per year. Handcarts covered the shortest average distance (2,280 kilometres annually) and pickups the longest distance (61,452 kilometres annually). Bicycle trailers in Kampot made the largest number of trips (4,140 trips annually). Oxcarts made the smallest numbers of trips. On average, they made 24 trips per year, mainly in the wet season.

An important aim of the survey was to examine the direct expenses incurred by the transporters. Fuel turned out to be the major direct expense for the vehicles in the survey, 77.2 per cent of the total was for purchasing fuel. Expenses for spare parts were 11.6 per cent of the total, while tyres were 7.7 per cent and oil 3 per cent.

The VOC per 1,000 kilometres were highest for trucks at US$251.90 per kilometre. The VOC for a bicycle or a handcart was only US$3.30. For the most common transport vehicles, the motorcycle and the *remorque* the VOC was US$29.4 and US$58.8 respectively.

The direct operating expenses for fuel, oil, spare parts and tyres differed considerably between the two survey provinces. The VOC per 1,000 kilometres was higher in Siem Reap for all vehicle types. This difference was probably due to significantly higher unit prices for fuel, oil, spare parts and tyres in Siem Reap Province. The better infrastructure conditions in Kampot Province may also have contributed to this difference.

The difference in costs between the two provinces was also reflected in the fares charged by the transporters. Trip prices in Kampot were considerably lower than those charged in Siem Reap. However, when comparing the prices for last year and this year, the difference between the provinces narrows.

The survey respondents indicated that improved road conditions could result in 17 per cent lower trip prices. For Siem Reap respondents this could be an 18.2 per cent price decrease and for Kampot respondents it could be a 15.9 per cent decrease in price.

Road condition improvements could also increase the number of trips that transporters make. This would improve the availability of rural transport services and the income generated by

it. For the total sample, road improvement could result in 24 per cent increase in trips in the dry season and 13 per cent in the wet season. The potential impact of road improvement was larger in Kampot than in Siem Reap Province. This is probably because professional transport businesses in Kampot are more likely to increase their number of trips than part time transporters in Siem Reap Province.

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Appendices

Appendix 1: CREAM Calibration

By John Tracey-White

One of the main goals of undertaking the transporter survey was the calibration of the Cambodian Rural Economic Access Model (CREAM). This appendix describes the process of using the transporter survey data to undertake this calibration.

CREAM Assumptions

CREAM was developed initially for the MRD/ADB Rural Infrastructure Improvement Project.[21] It is a consumer surplus model, based around a trip generation gravity model. The model evaluates road improvements by measuring changes in vehicle operating costs (VOCs) for the existing and estimated traffic on individual rural roads. To use the model in its simplest form only three basic pieces of information are required:

- Population density in the area of influence of the road (this requires mapping for each commune detailing the average density in persons per square kilometre).
- Length of the road in kilometres (this information does not effect the results of the analysis).
- Estimated construction costs per kilometre of road.

Vehicle operating costs are standardised in the model for different transport modes. The benefits of road improvements are assumed to depend on both the initial and improved conditions of a road. This is defined by its roughness. The main method for classifying this is the International Roughness Index (IRI). There are various techniques for measuring IRIs[22]. These include:

- Precision measurement of the road profile, for example using the TRL profile beam that directly computes the IRI values (in m/km). This is only possible for short sections of road.

- Other profilometric methods, less accurate than the precision methods, but quicker to use, like high-speed profilometers.

- Correlation methods using Response Type Road Roughness Measuring Systems (RTRRMS). These are vehicle mounted instruments, like a TRL bump integrator, that measure road roughness in terms of the cumulative movement between the vehicle axle and the chassis when travelling along a road under a set of standard conditions.
- Subjective ratings, involving observing the road's rideability (the comfort level related to the vehicle speed) and making a visual assessment of the road condition (presence and severity of potholes, undulations and corrugation of the road surface). For new observers

[21] Tracey-White, J. and Vaidya. K. (1998).
[22] TRL/DFID, (1999).

these methods may produce errors as great as 40 per cent. Typical subjective ratings relating vehicle speed to IRIs for paved roads (asphaltic concrete or surface dressed finish) might be as follows:

- IRI 2: Ride comfortable over 120 km/hour.
- IRI 4: Ride comfortable up to 100-120 km/hour.
- IRI 7/8: Ride comfortable up to 70-90 km/hour.
- IRI 9/10: Ride comfortable up to 50-60 km/hour.
- IRI 11/12: Necessary to reduce velocity below 50 km/hour.

However, as no measured or subjective data was available on the IRI values for rural roads in Cambodia, the existing road condition in the CREAM are defined in terms of accessibility rather than engineering characteristics. The assumed initial road condition categories are shown with their broad relationship to IRI in Appendix Table 1.1.

Access	Description of Road Conditions	Broad IRI Equivalent
Level 0	No existing road or road/track - impassable to most traffic all the year round	IRI 18 or higher
Level 1	Impassable to most traffic in the wet season, difficult but passable all year round	IRI range 10 to 15
Level 2	Passable all year round except for structures, need for drainage or other spot improvements in places	IRI range 10 to 15
Level 3	Difficult but passable all year round	IRI range 10 to 15
Level 4	Passable all year round in comfort at acceptable average speed of about 60 km/hour	IRI 7

Appendix Table 1.1: Road Accessibility Criteria

One of the main assumptions built into the CREAM was that the purpose of road improvement should be to achieve an acceptable condition. This condition was defined as being passable all year round at an average speed of 50-60 kilometres per hour. To achieve this objective, a rural road improvement project would normally seek to bring selected routes up to Access Level 4, broadly equivalent to IRI 7. Many rural roads are passable in the dry season but are inaccessible or difficult for four-wheeled vehicles (possibly excluding four-wheel-drive vehicles) for some of the wet season. In relatively flat terrain, with a high population density and a long dry season, there will be virtually no roads or tracks of Access Level 0. Most rural roads fall in the categories 1, 2 and 3 and the distinction between them is not easy to make.

Therefore, as the model uses only a single screening test (effectively 'with' and 'without' project conditions), it assumes difficult but passable conditions in the dry season for all vehicles and no passable four-wheeled motorised vehicles in the wet season. As volumes of four-wheeled motorised traffic in relation to two-wheeled vehicles (bicycles and motorcycles) are very low, this simplification does not make a significant difference to the estimated benefits and the outcome of the exercise.

The model also assumed that traffic volume in the wet season would be 70 per cent of that in the dry season and no motorised four-wheel vehicle traffic was assumed before the road improvement. The wet season was assumed to be of three months duration. The VOC assumptions incorporated in the CREAM were based on the limited information available from feasibility studies for national roads in Cambodia, as well as some international evidence on vehicle operating costs on rural roads.

In the model, the existing cost of wet season trips was assumed to be ten per cent higher than for dry season trips. The VOC for motorised transport was assumed, in the dry season, to be reduced by 40 per cent and for non-motorised transport to be reduced by 30 per cent. For the wet season, the VOCs were reduced pro-rata in line with the existing difference in VOCs between the dry and wet seasons. These assumptions are summarised in Appendix Table 1.2.

Transport mode	Existing VOCs		Future VOCs	Future VOC	
	($ Per km)		($ Per km)	% Savings	
	Dry Season	Wet Season	Dry Season	Dry Season	Wet Season
MOTORISED					
Motorcycle	0.090	0.099	0.054	40.0	45.5
Remorque	0.220	0.242	0.132	40.0	45.5
Car	0.720	0.792	0.432	40.0	45.5
Pickup	0.410	0.451	0.246	40.0	45.5
Truck	0.650	0.715	0.390	40.0	45.5
NON-MOTORISED					
Bicycle	0.040	0.044	0.028	30.0	36.4
Animal Cart	0.220	0.264	0.154	30.0	41.7

Appendix Table 1.2: Original VOC Assumptions used in CREAM

Overall Results of the VOC Surveys and CREAM Calibration

The VOC surveys described in the main text estimated the total use of a vehicle over a year and enabled a reasonably detailed analysis of the vehicle operating costs to be made by transport mode, including fuel, oil, spare parts (including labour) and tyres.

To allow a full analysis of the VOCs to be made, the following cost components needed to be added:

- Operator costs based on the average days worked per year, by season and by mode, to estimate transporter wages and profit, assuming a daily wage level of 4,000 Riel.

- Interest, based on the average purchase price.

- Annual depreciation based on average purchase price, usually of a second-hand vehicle and an assumed remaining vehicle life.

- Miscellaneous costs and charges.

Assuming the survey results represent average travel conditions for rural roads in the provinces (say IRI 12-13) there are quite distinct differences in the VOCs for the two provinces. Those in Kampot are lower than in Siem Reap. These values are summarised in an additional spreadsheet now included in the CREAM. The only comparable VOC results for Cambodia were prepared in 1997 for the World Bank. Other data available is for Vietnam[23]. These values are summarised in Appendix Table 1.3 below.

Transport Mode	**Upstream Survey**		**World Bank Studies**			
	Siem Reap	Kampot	Cambodia		Vietnam	
Assumed IRI	IRI 12.5	IRI 12.5	IRI 12.5	IRI 7	IRI 12.5	IRI 7
MOTORISED						
Motorcycle	0.073	0.042	0.130	0.090	0.080	0.047
Remorque	0.109	0.083	0.330	0.200	0.077	0.055
Car	0.101	0.085	0.360	0.252	0.351	0.179
Pickup	0.145	0.088	0.310	0.210	0.283	0.192
Truck	0.424	0.225	0.530	0.400	0.329	0.181
NON-MOTORISED						
Bicycle	0.067	0.050	N/A	N/A	0.008	0.005
Animal Cart	0.334	0.060	N/A	N/A	0.083	0.063

Appendix Table 1.3: Comparison of Surveyed VOCs (US$ per kilometre)

The measured VOCs for most transport modes are generally lower than those assumed in the CREAM. For example, the model assumed a value of nine cents per kilometre for motorcycles, whilst the survey gave values of four to seven cents. Some costs were higher. Bicycle costs were significantly higher; four cents in the model compared to five to seven cents. In calibration of the model, the question is whether to use one province as the indicator of the extremes in road conditions (generally ranging between IRI 10-15, with some improved roads at IRI 7) or to combine the survey results to produce general figures. The more conservative assumption would be to combine the results of the two surveys. This approach has been used in the calibration, as shown in Appendix Table 1.4.

Transport Mode	**Fuel**	**Oil**	**Spare Parts**	**Tyres**	**Operator**	**Other***	**Total**
MOTORISED							
Motorcycle	0.0244	0.0016	0.0032	0.0006	0.014	0.011	0.056
Remorque	0.0455	0.0021	0.0094	0.0026	0.017	0.018	0.095
Cars	0.0494	0.0020	0.0094	0.0052	0.005	0.016	0.087
Pickup	0.0681	0.0031	0.0137	0.0040	0.003	0.024	0.116
Truck	0.2274	0.0111	0.0126	0.0356	0.006	0.057	0.350
NON-MOTORISED							
Bicycle	-	-	0.0033	0.0008	0.044	0.008	0.056
Animal Cart	-	-	0.0169	0.0010	0.058		0.094

* Interest payments, depreciation and miscellaneous charges

Appendix Table 1.4: VOCs used to Calibrate CREAM (US$ per kilometre)

[23] IT Transport Ltd. (1999).

However, before finishing the calibration, some further analysis of the factors was required and these are discussed below and summarised in Appendix Table 1.5:

- ***The ratio between wet and dry season trips:*** The overall weighted ratio between seasons found in the VOC survey was 65 per cent (i.e. road users under existing road conditions made 35% less trips in the wet season). This compared very well with the 70 per cent ratio used in original model. However, there are significant differences between transport modes so the calibration uses a mode-specific ratio (differences include the decreased use of bicycles and increased use of oxcarts in the wet season).

- ***Changes in the number of trips made due to road improvements:*** This was automatically estimated in the original model assuming that traffic generated from the improvements would result in a 50 per cent increase in traffic levels. This was based on an assumed elasticity of transport demand of 0.5 for goods and persons, using data from studies of higher level roads in Cambodia[24]. This appears to be an over estimate as the increased use of vehicles for some transport modes is not that great (particularly the non-motorised forms of transport). Although the difference is more significant for motorised transport, the maximum is around 40 per cent for cars. There is also a seasonal difference with fewer generated trips in the wet season than was originally envisaged in the model (the generated traffic in the dry season was 24%, compared to 12% in the dry season).

- ***Changes in fares due to road improvements:*** Estimated changes in fares charged by the vehicle operators can be used as a proxy for changes in vehicle operating costs. This is not a perfect method, but does link VOCs and fares together in a reasonably consistent way. The alternative to this approach would be to use the method used in the Vietnam study, which modelled the changes using the VOC module of the HDM III Model. The HDM III predicts the VOCs for each category of IRI using correlation coefficients for the axle loading and pavement strength. These values are derived from countries with completely different transport conditions. On balance, therefore, this was not thought to be appropriate, as it would not properly reflect the actual transport conditions in Cambodia.

Transport Mode	**Wet/Dry Ratio**	**Seasonal Trip Increase (%) - Generated Traffic**		**Fare Decrease**
	(%)	Wet	Dry	(%)
MOTORISED				
Motorcycle	75	12	25	19
Remorque	67	10	25	15
Cars	94	41	40	19
Pickup	62	12	25	28
Truck	78	34	44	23
NON-MOTORISED				
Bicycle	51	1	10	8
Oxcart	200	0	0	0

Appendix Table 1.5: Survey Factors Used to Calibrate CREAM

[24] SMEC International PTY Ltd., (1997) and Scott, Wilson, Kirkpatrick & Partners and BCEOM, (1997).

CREAM assumes standard values for vehicle occupancy and the load carried. These values are used to adjust the modal split (of different vehicle types) so that the number of vehicles on a road can be converted from vehicles into persons travelling or load carried. Surveys of traffic characteristics around Puok market in Siem Reap Province by the Upstream Project provide a good comparison with the assumptions used in the model.[25] These values are compared in Appendix Table 1.6. In general, the survey results are higher for occupancy and loads and these values have been adjusted in the CREAM.

Transport Mode	**Original Model**		**Puok Survey**	
	Occupancy (persons)	Load (tons)	Occupancy (persons)	Load (tons)
MOTORISED				
Motorcycle	1.7	0.07	1.7	0.0587
Remorque	6.0	0.20	9.9	0.2989
Cars	3.5	0.20	5.5	0.8202
Pickup	4.0	0.50	8.5	1.0563
Truck	5.0	4.00	7.2	2.5489
NON-MOTORISED				
Bicycle	1.3	0.02	1.2	0.0293
Oxcart	2.0	0.20	2.6	0.2668

Appendix Table 1.6: Vehicle Occupancy and Load

Other assumptions were also re-examined. In the original model, a ten per cent difference in VOCs was assumed between the wet and dry seasons (10% more in the wet season). This seasonal difference was confirmed by the survey. However, there was insufficient data to quantify the difference, so the original assumption was not altered. As the users of vehicles in rural Cambodia are invariably carrying their own loads, the CREAM also assumed an average load per person of 25 kilograms. A better estimate was not available from the VOC survey. However, rural transport demand studies in Bangladesh have found ratios of goods to persons as high as 50 kg of goods to one person-km and 28 kg in India. This would suggest that a more realistic figure might be around 30 kilograms per person-km and this value has been inserted into the model.

Another factor to reconsider was the trip generation rates derived from the gravity model. The original assumption was that the main trip outside the settlement area was to the market and on average this was 7.2 kilometres. This was an average derived for the six ADB RIIP provinces, collected by the Ministry of Planning[26]. Comparable market access data for other rural areas in Cambodia was 13.22 kilometres. For primary schools and pharmacies, there is not such a wide divergence:

- Primary schools: RIIP provinces 7.91 km. Other rural areas 8.92 km.
- Pharmacies: RIIP provinces 6.27 km. Other rural areas 7.22 km.

Given the closeness of these figures there would not seem to be any need to alter the original assumption in the model.

[25] Rozemuller, B. et al, (2000).
[26] Knowles, J., Ministry of Planning, (1997).

Another factor to consider was whether the assumption that was used in the model for converting financial costs to economic costs was valid. An argument could be made for using different conversion factors for new works compared to maintenance (to reflect different labour and equipment components). Complex approaches can also be adopted to reflect border pricing and subsidy arrangements. The World Bank's second rural transport project in Vietnam uses figures of 0.8 and 0.75 respectively for capital and maintenance works. However, for simplicity, the World Bank's standard conversion factor of 0.85 used in Cambodia for project preparation in the rural sector has been used in the model (in the original version 0.85 was also used).

Traffic growth levels also influence the model. Originally, an annual increase of five per cent per annum was assumed. A re-examination of Upstream Project records of traffic growth on roads improved by the project suggest that this might be an under estimate. The World Bank has used an initial rate of eight per cent for the first five years after improvement, reduced to six per cent for the next five years and five per cent thereafter. The model has been adjusted to use these rates.

The modal split assumptions in the model are based on traffic counts on ILO roads before and after improvement. These values are still valid and no change is needed in the model. However, further analysis of the ILO data is now needed. The circumstances under which road improvements in Siem Reap Province were undertaken have changed. As the ILO programme was the main programme in these areas, there was substantial switching to their routes because the higher level alternative routes were in such poor condition.

Comparing Results after Calibration

The obvious way to gain an overview of the results of calibrating the CREAM is to compare the output of the model before and after calibration. For the original model, devised for use in the six RIIP provinces, a minimum Economic Internal Rate of Return (EIRR) of 15 per cent was specified in the project document. The model has been adjusted to allow a "pass" EIRR of 12 per cent, more realistic for lower grade rural roads. Appendix Table 1.7 shows the generated outputs, the Economic Internal Rates of Return, before and after. The model now only allows economic viability at higher densities and lower construction costs.

Density	**Original Model**			**Calibrated Model**		
Road Cost:	Low	Medium	High	Low	Medium	High
Per km	$10,500	$14,500	$19,500	$10,500	$14,500	$19,500
50 persons km2	10.7	4.5	-0.8	4.8	-1.1	-
70 persons km2	18.1	10.9	5.2	11.5	5.1	-0.4
100 persons km2	28.3	19.0	12.2	19.8	12.2	6.2
120 persons km2	34.8	23.9	16.2	24.9	16.3	9.8
150 persons km2	44.4	31.1	21.9	32.3	22.0	14.6
170 persons km2	50.8	35.8	25.5	37.1	25.7	17.6
200 persons km2	60.4	42.8	30.8	44.2	31.0	21.8

Appendix Table 1.7: CREAM Comparison of Economic Rates of Return (%)

The model is highly sensitive to population density, as this is the basis for the trip generation sub-model prediction of basic traffic levels. Careful calculation of the actual population within the catchment zone of the road (taken as a maximum of 3 kilometres either side) is

essential to obtain reliable results. Road improvement costs also need to be carefully calculated, but these do not seem to have changed significantly from when the model was originally prepared.

Appendix 2: Additional Tables

No	Type of Business	Siem Reap		Kampot		Total	
		Number	%	Number	%	Number	%
1	Farming	99	67. 8	69	55.2	168	62.0
2	Trading	23	15.8	39	31.2	62	22.9
3	Government	10	6.9	11	8.8	21	7.8
4	Raising Animals	6	4.1	0	0	6	2.2
5	Wage Labour	4	2.7	5	4.0	9	3.3
6	Producing Wine[27]	4	2.7	1	0.8	5	1.8
	Total	**146**	**100**	**125**	**100**	**271**	**100**

Table A: Other Income Earning Activities

No	Vehicle Type	Siem Reap			Kampot			Average		
		Dry Season (days)	Wet Season (days)	Ratio Wet/ Dry	Dry Season (days)	Wet Season (days)	Ratio Wet/ Dry	Dry Season (days)	Wet Season (days)	Ratio Wet/ Dry
1	Bicycle	148	75	0.51	-	-	-	148.0	75.0	0.51
2	Bicycle Trailer	-	-	-	166	139	0.84	166.0	139.0	0.84
3	Motorcycle	146	96	0.66	146	124	0.85	146.0	110.1	0.75
4	*Remorque*	145	78	0.54	142	114	0.80	143.5	96.3	0.67
5	Oxcart	24	48	2.00	-	-	-	24.0	48.0	2.00
6	Horse Cart	-	-	-	168	120	0.71	168.0	120.0	0.71
7	Car	168	144	0.86	130	125	0.96	136.3	128.2	0.94
8	Pickup	120	46	0.38	132	110	0.83	126.0	78.0	0.62
9	*Koyun*	147	79	0.54	-	-	-	147.0	79.0	0.54
10	Minibus	-	-	-	113	98	0.87	113.0	98.0	0.87
11	Light Truck	136	54	0.40	135	123	0.91	135.6	78.8	0.58
12	Truck	104	48	0.46	112	104	0.93	109.3	85.3	0.78
13	Handcart	168	72	0.43	168	168	1.00	168.0	120.0	0.71
	Weighted Average	**142**	**78**	**0.55**	**143**	**122**	**0.85**	**143**	**100**	**0.67**

Table B: Vehicle Use by Season

[27] Producing rice wine is an important income generating activity in rural Cambodia.

No	Type of Product	Siem Reap (%)	Kampot (%)	Average (%)
1	Rice/paddy	39.1	25.9	32.4
2	Fresh Vegetables	34.1	27.7	30.9
3	Fruit	11.9	28.8	20.5
4	Livestock	6.9	6.4	6.6
5	Fresh Fish	4.9	6.4	5.7
6	Other Grains	1.9	0	0.9
7	Bulbs/roots etc.	0.4	2.6	1.5
8	Dried & Smoked Fish	0.4	1.5	0.9
9	Meat	0.4	0.7	0.6
	Total	**100**	**100**	**100**

Table C: Ranking of Agricultural Products Transported

No	Type of Product	Siem Reap (%)	Kampot (%)	Average (%)
1	Construction Materials	44.0	47.0	45.5
2	Dried/processed Food	24.7	25.1	24.9
3	Firewood/charcoal	14.5	7.1	10.6
4	Beverage	6.6	3.3	4.9
5	Fuel	5.4	5.5	5.4
6	Other Capital Goods	1.8	2.7	2.3
7	Ice	1.8	0.5	1.2
8	Cloth/clothes	1.2	7.7	4.6
9	Tobacco	0.0	1.1	0.6
	Total	**100.0**	**100.0**	**100.0**

Table D: Ranking of Non-agricultural Products Transported

No	Vehicle Type	Siem Reap		Kampot		Average	
		Products (kg)	Passengers	Products (kg)	Passengers	Products (kg)	Passengers
1	Bicycle	43	1	-	-	43	1
2	Bicycle Trailer	-	-	384	5	384	5
3	Motorcycle	129	2	99	2	114	2
4	*Remorque*	809	15	1,155	17	985	16
5	Oxcart	300	5	-	-	300	5
6	Horse Cart	-	-	300	7	300	7
7	Car	250	6	100	6	125	6
8	Pickup	1,500	18	1,490	17	1,495	18
9	*Koyun*	3,357	21	-	-	3,357	21
10	Minibus	-	-	275	15	275	15
11	Light Truck	2,896	26	1,100	19	2,251	24
12	Truck	5,667	25	1,750	-	3,056	8
13	Handcart	10	1	80	-	45	1

Table E: Vehicle Load Capacity

No	Vehicle Type	Siem Reap (Km)	Kampot (Km)	Average (Km)
1	Bicycle	4,296	-	4,296
2	Bicycle Trailer	-	8,280	8,280
3	Motorcycle	14,556	23,256	18,944
4	*Remorque*	11,400	18,684	15,102
5	Oxcart	384	-	384
6	Horse Cart	-	5,040	5,040
7	Car	37,080	53,340	50,630
8	Pickup	45,792	77,112	61,452
9	*Koyun*	24,516	-	24,516
10	Minibus	-	56,676	56,676
11	Light Truck	18,036	45,264	27,810
12	Truck	29,124	43,140	38,468
13	Handcart	2,400	2,160	2,280
	Weight Average	**15,405**	**29,088**	**22,350**

Table F: Average Travel Distance per Year

No	Vehicle Type	Trips per Annum		
		Siem Reap	Kampot	Average
1	Bicycle	306	-	306
2	Bicycle Trailer	-	4,140	4,140
3	Motorcycle	693	1,057	875
4	*Remorque*	760	667	713
5	Oxcart	24	-	24
6	Horse Cart	-	720	720
7	Car	2,317	606	1,461
8	Pickup	354	607	480
9	*Koyun*	742	-	742
10	Minibus	-	439	439
11	Light Truck	273	508	390
12	Truck	448	490	469
13	Handcart	2,400	720	1,140
	Weight Average	**576**	**1,355**	**971**

Table G: Average Annual Trips

No	Vehicle Type	Fuel (%)	Oil (%)	Spare Parts (%)	Tyres (%)
1	Bicycle	-	-	80.8	19.2
2	Bicycle Trailer	-	-	81.5	18.5
3	Motorcycle	80.9	5.5	11.5	2.1
4	*Remorque*	76.1	3.5	15.9	4.5
5	Oxcart	-	-	100.0	-
6	Horse Cart	-	-	67.7	32.3
7	Car	74.8	3.1	14.2	7.9
8	Pickup	77.0	3.7	14.5	4.8
9	*Koyun*	77.3	5.1	12.8	4.8
10	Minibus	73.8	2.5	18.8	4.9
11	Light Truck	78.0	4.0	11.4	6.6
12	Truck	78.4	2.6	9.3	9.7
13	Handcart	-	-	61.4	38.6
	Weight Average	**77.2**	**3.5**	**11.6**	**7.7**

Table H: Operating Cost Comparison by Vehicle Type for Total Sample

No	Vehicle Type	Direct Transport Expenses (US$/1,000 km)				
		Fuel	Oil	Spare Parts	Tyres	Total
1	Bicycle	0.0	0.0	2.7	0.6	3.3
2	Bicycle Trailer	0.0	0.0	3.9	0.9	4.8
3	Motorcycle	24.0	1.6	3.2	0.6	29.4
4	*Remorque*	44.8	2.1	9.3	2.6	58.8
5	Oxcart	0.0	0.0	8.0	0.0	8.0
6	Horse Cart	0.0	0.0	4.3	2.0	6.3
7	Car	48.7	2.0	9.3	5.1	65.1
8	Pickup	67.0	3.1	13.5	3.9	87.5
9	*Koyun*	92.0	6.1	15.2	5.7	119.0
10	Minibus	68.1	2.3	17.3	4.5	92.2
11	Light Truck	114.7	6.2	16.4	9.6	146.9
12	Truck	198.6	8.1	17.4	27.8	251.9
13	Handcart	0.0	0.0	2.0	1.3	3.3

Table I: Direct Transport Expenses per Vehicle for Total Sample

No	Vehicle Type	Charge in Riel/person/km			
		2000		2001	
		Siem Reap	Kampot	Siem Reap	Kampot
1	Bicycle	-	-	-	-
2	Bicycle Trailer	-	136	-	150
3	Motorcycle	199	127	194	134
4	*Remorque*	148	67	115	65
5	Oxcart	-	-	-	-
6	Horse Cart	-	71	-	71
7	Car		74	-	74
8	Pickup	61	45	43	44
9	*Koyun*	169	-	161	-
10	Minibus	-	43	-	43
11	Light Truck	150	52	174	51
12	Truck	64	-	64	-
13	Handcart	-	-	-	-

Table J: Transport Fees Charged (Riel/person/kilometre)

Appendix 3: Survey Questionnaire

TRANSPORTERS SURVEY QUESTIONNAIRE

Transporter's Name :

Sex : ☐ **Male** ☐ **Female**

Age : **……Years**

Address :

Date/Month/Year :

Interviewer's name :

Form Number :

Interview Location:

Questions:

1. What *type* of vehicles do you use?

1. .....
2. ...…….....
3. …….

2. How many of these vehicles do you *own*?

1.	(Type & No. of Vehicle)
2.	(Type & No. of Vehicle)
3.	(Type & No. of Vehicle)

3.How many *drivers* do you have?

1. Full-time (number):	Part-time (number): ...
2. Full-time (number):	Part-time (number): ...
3. Full-time (number):	Part-time (number): ...

4.*When* did you buy the vehicles?

1. ..... Year.....
2. ..... Year.....
3. ..... Year.....

5. How much did you *pay* for the vehicles?

1. ..... USD
2. ..... USD
3. ..... USD

6. *How old* are the vehicles now?

1 .....Years
2 .....Years
3 .....Years

7. How many days *a week* do you use the vehicle(s)

1. No of days (dry season)	No of days (wet season) .....
2. No of days (dry season)	No of days (wet season) .....
3. No of days (dry season)	No of days (wet season) .....

8. How many days a year do you *lose* because of rain or bad road conditions?

1. Number of days.....
2. Number of days.....
3. Number of days.....

9. What *sort of trip* do your vehicles make?
(to/from which villages/communes/district centres and if possible, approx.)

Please, write the name of origin and destination (village, commune, district and province) and then add the relative percentage.

1.....Percentage .....%
.....Percentage .....%
.....Percentage .....%
.....Percentage .....%
2.....Percentage .....%
.....Percentage .....%
.....Percentage .....%
.....Percentage .....%
3.....Percentage ....%
.....Percentage .....%
.....Percentage ....%
.....Percentage ....%

10. What are the vehicles used for - transporting *goods and/or people*?
(specify percentage of people and/or weight of goods)

100% people 0 % goods	1	percentage of people..... percentage of goods.....
to	2	percentage of people.....
0 % people		percentage of goods.....
100% goods	3	percentage of people.....
		percentage of goods.....

11. What types of *agricultural products* do you carry?
(rank in order of importance)

1.....
2.....
3.....
4.....
5.....

12. What *other types* of product do you carry?

1.....
2.....
3.....
4.....
5.....

13. What is the *total load* your vehicle can carry?

1. Product (kg) ..... Number of people .....
2. Product (kg) ..... Number of people .....
3. Product (kg) ..... Number of people .....

14. Do you operate any *other types of business*?

☐ Yes ☐ No

If yes, specify (incl. % of total income) .....

15. Do you also use the vehicle (s) for *marketing your own produce*?

☐ Yes ☐ No

16. How much *fuel* do you use per day?

1. Number of liters..... Price per liter (Riel) .....
2. Number of liters..... Price per liter (Riel) .....
3. Number of liters..... Price per liter (Riel) .....

17. How much *oil* do you use per month?

1. Number of liters..... Price per liter (Riel) .....
2. Number of liters..... Price per liter (Riel) .....
3. Number of liters..... Price per liter (Riel) .....

18. How much do you spend in total on *repairs* per month?
(excluding costs of tyres, but including spare parts)

1. ..... (Riel)
2. .....(Riel)
3. .....(Riel)

19. How often do you replace your *tyres*?

1. Number of tyres per year..... Price per tyre (Riel) .....
2. Number of tyres per year..... Price per tyre (Riel) .....
3. Number of tyres per year..... Price per tyre (Riel) .....

20. What is the average *length of trip*?
(if not average then a range of distances)

Type of Vehicles	Average distance (km)
1.	
2.	
3.	

21. What do you *charge* per one way trip for persons transported?
(try to extract information to calculate cost per person per km)

Year	Type of vehicles	From *(Village, Commune)*	To (*Village,Commune*)	Distance *(Km)*	Time (min)	Fare for one person (Riel)
Last year	**1.....**	.....	.....	.....	.....	.....
	2.....	.....	.....	.....	.....	.....
	3.....	.....	.....	.....	.....	.....
This year	**1.....**	.....	.....	.....	.....	.....
	2.....	.....	.....	.....	.....	.....
	3.....	.....	.....	.....	.....	.....

22. What do you *charge* per one way trip for goods carried?
(try to extract information to calculate cost per kg/km)

Year	**Type of vehicles**	From *(Village, Commune*)	To (*Village,Commune*)	Distance *(km)*	Time (min)	Weight (kg)	Price (Riel)
Last year	**1.....** **2.....** **3.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**
This year	**1.....** **2.....** **3.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**	**.....** **.....** **.....**

23.What is the *approximate distance* travelled by your vehicles in one day/month?

1. Distance in Km per day: …….. month: .....
2. Distance in Km per day: …….. month: .....
3. Distance in Km per day: …….. month: .....

24. If roads were *improved*, would this affect the fares you charge?
(try to get transporter to specify this as a decrease)

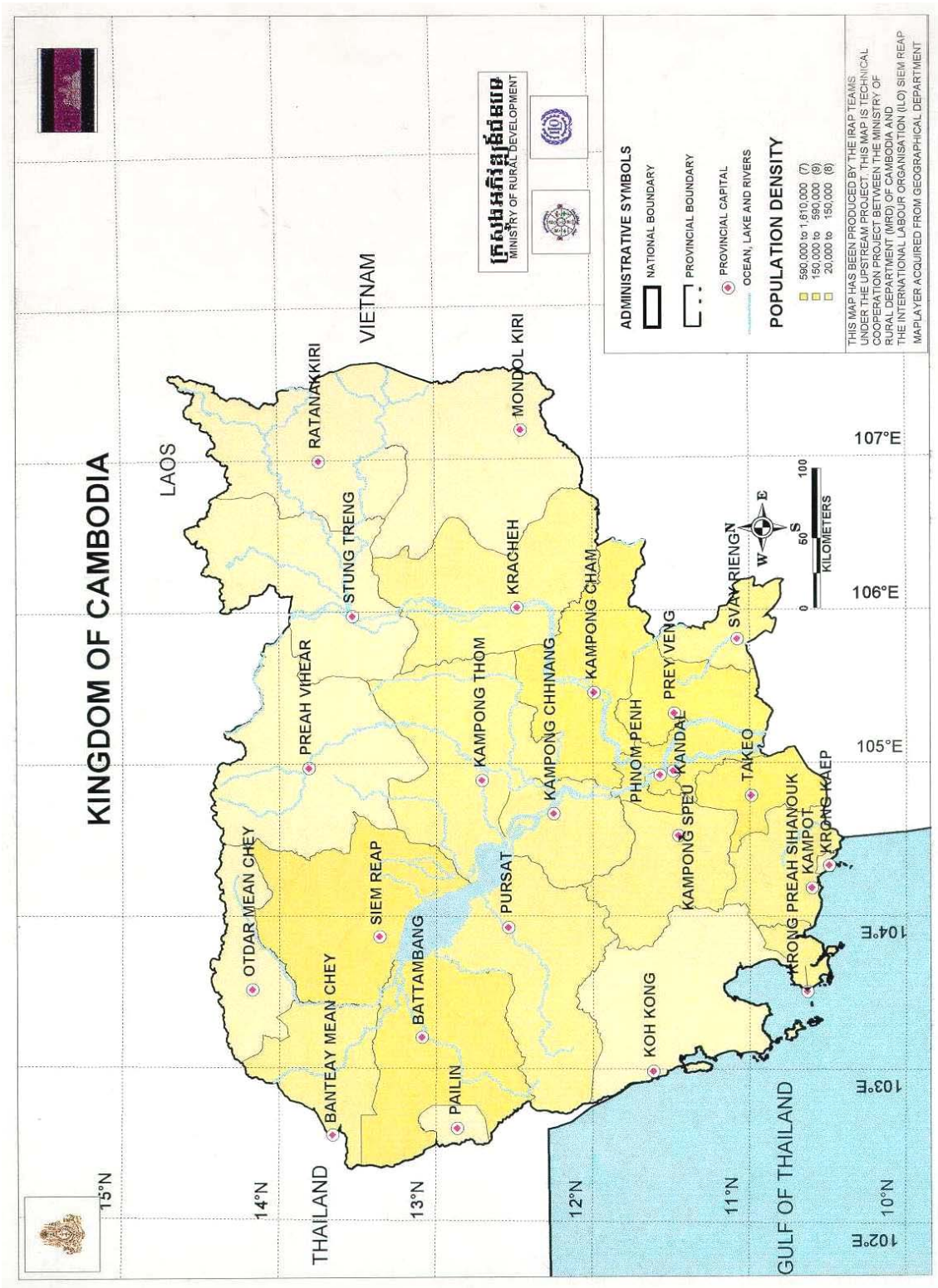
Percentage decrease: .....%

25. If road were *improved*, would this affect the number of trips/distance you make?
(try to get transporter to specify this as an increase)

% increase in wet season: trips: ……. distance: ….....
% increase in dry season: trips: …….. distance: ….....

Thanks

Appendix 4:
Map of Cambodia



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