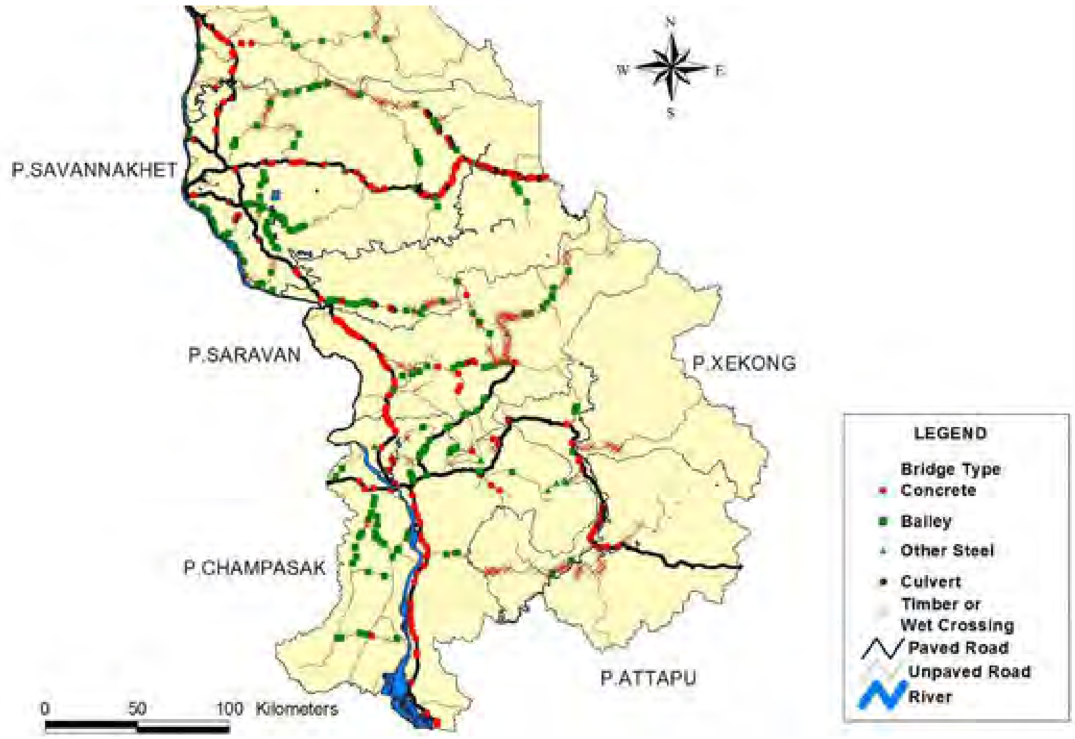


Source: JICA Study Team

Figure 2.3.5 Existing Bridges by Bridge Type

(5) Bridge Loading Capacity

Less information is available on the design condition of existing bridges, which makes difficult to understand the loading capacity. From the field study in the southern region and observatory interviews with local officials, 20 ton/axel is currently applied as a standard loading capacity of bailey type bridge in national roads. However, lower loading capacity of 12 ton/axel was applied depending on the damage to the bridges.

2.3.4 Major Findings of Bridge Condition from Field Survey

The Study Team conducted field surveys in early March and early April to understand the current bridge conditions. It also conducted a series of interviews with the local officials to update the information obtained. From the observations in the field survey, the major findings on bridge structures and facilities are described below:

Bridge structure:

- The bailey bridge was the dominant bridge type observed along the unpaved national roads. The bailey bridge was introduced due to its simple structural features, which enable it to be applied to a wide range of span lengths by composing the same truss panel and its simple construction method. However, its actual application seems not to comply with the engineering standard. The JICA Study Team observed a lack of a panel connecting double truss panels and bracing lode coupled with the use of a wooden cross beam instead of steel beam. These may lead to structural failures when the traffic volume increases in the future.

Bearing shoe and expansion joints:

- Most of concrete bridges do not have the appropriate bearing shoes underneath the girders. The bearing shoe functions as an absorption device that distributes the loads to each pier and abutment. Without the bearing shoe, the girders and the parapets of piers receive the impact of the live load directly and this causes serious structural damage on the bridge.
- Expansion joints are required to allow tolerable movement of girders by dry-shrinkage, creeping and thermal differences. Unfortunately, expansion joints are not installed in most of the existing bridges. The damage is therefore extended to not only the edge of concrete slab but also to the parapet concrete of abutment.

River protection:

- River protection around substructures is necessary to maintain roads in passable condition all year round. From the observations on site, there was little protection work for substructures except for the bridges constructed by Japan and ADB.

Traffic load control:

- Although the limit of load capacity of bridges was clearly observed at the bridge sites on major national roads, the vehicles' weights were not properly controlled at the weigh stations, located at the boundary of each province. Also, many bridge sites along provincial roads and other roads were left without sign boards of load limitation. The control of excess loading is essential to prevent the bridge structure from the damage caused by overloading vehicles.

2.3.5 Current Condition of Bridge along NR-9 and Other Roads

(1) Bridge Type at NR-9

The number of bridges along NR-9 amounts to 51 in total, and these bridges can be divided into three types of bridges: i) RC T-shaped girder bridges (RCTG) built by the former Soviet Union, ii) similar RCTG built by Vietnam and iii) Steel Girder bridges (STG) built by the former Soviet Union and other CIS countries with the exception of RC Slab or minor bridges.

Table 2.3.7 Bridge Type at NR-9

Type	Length (m)	Ratio
RCTG (i)	969.8	43%
RCTG (ii)	561.0	25%
STG(ii)	407.7	18%
STG(ii)	249.0	11%
Others	51.1	2%
	2238.6	

Table 2.3.8 Bridges at NR-9

No.	Location (km)	Bridge Name	Bridge Type	Bridge Length (m)	Bridge width (m)	Effective Width (m)	Year Completion	Donor	Remarks
1	36+000	Houay Lay	RC T-Girder	24.0	10.9	8.0	1984	Russia	Japan Grant Aid (Phase -1)
2	48+400	Houay Ka Sae	RC T-Girder	54.0	10.9	8.0	1986	Russia	
3	50+000	Houay Long Kong	RC T-Girder	39.0	11.0	8.0	1985	Russia	
4	54+900	Houay Moung	RC T-Girder	39.0	11.0	8.0	1985	Russia	
5	66+340	Houay Ta Bong Phet	RC T-Girder	42.0	11.0	8.0	1988	Russia	
6	68+185	Xe Cham Phone	Steel and RC	100.0	9.7	7.1	1984	Bulgaria	
7	103+000	Xe Xam Xoy	Steel I-Girder	100.0	9.9	7.0	1984	Hungary	
8	103+197	Houay Koa	RC Slab	18.0	10.9	8.0	1987	Russia	Japan Grant Aid (Phase -2)
9	109+775	Houay Ya Phuid	RC T-Girder	39.0	11.0	8.0	1986	Russia	
10	114+670	Houay Ngoa	RC T-Girder	36.0	10.9	8.0	1986	Russia	
11	120+795	Houay Sa Loung	RC T-Girder	36.0	10.9	8.0	1986	Russia	
12	121+790	Houay Sa Leang	RC T-Girder	54.0	10.9	8.0	1987	Russia	
13	123+040	Xe Kum Kam	Steel I-Girder	90.0	8.6	6.9	1985	Czecho	
14	125+093	Houay Jon	RC T-Girder	24.0	10.9	8.0	1987	Russia	
15	130+680	Houay Tho	RC T-Girder	36.0	11.0	8.0	1987	Russia	
16	141+110	Houay La Kouay	RC T-Girder	42.0	11.0	8.0	1987	Russia	
17	146+000	Xe Tha Mouak	Steel I-Girder	159.0	10.0	7.0	1984	Czecho	
18	152+800	Houay Ta Sap	RC T-Girder	18.0	10.0	8.0	1986	Russia	
19	154+000	Houay Po Lo	RC T-Girder	30.0	11.0	8.0	1986	Russia	
20	154+700	Houay Ta Yeung	RC T-Girder	48.0	10.9	8.0	1986	Russia	
21	163+938	Houay Pa Khi	RC T-Girder	12.0	10.9	8.0	1986	Russia	ADB Loan
22	166+246	Houay A Lang	RC T-Girder	42.0	11.0	8.0	1986	Russia	
23	171+121	Houay A Kai	RC T-Girder	51.3	10.9	8.0	1986	Russia	
24	173+700	Houay Xe Chon 1	RC T-Girder	39.2	10.9	8.0	1986	Russia	
25	175+082	Houay Koy	RC T-Girder	12.0	10.9	8.0	1986	Russia	
26	176+210	Houay Xe Chon 2	RC T-Girder	36.1	11.0	8.0	1986	Russia	
27	178+016	Houay Xe Chon 3	RC T-Girder	12.0	11.0	8.0	1986	Russia	
28	182+250	Houay La Vi	RC Beam	9.1	9.0	7.2	1986	Russia	
29	183+400	Houay Ki	RC T-Girder	36.1	11.0	8.0	1986	Russia	
30	184+400	Houay Yone	RC T-Girder	30.1	10.9	8.0	1986	Russia	
31	185+240	Houay Xay	RC T-Girder	24.0	10.9	8.0	1986	Russia	
32	188+400	Houay Kok 2	RC T-Girder	24.0	11.0	8.0	1986	Russia	
33	194+214	Houay Kok 1	RC T-Girder	90.0	11.0	8.0	1987	Russia	
34	196+020	Xe Bang Hiang	Steel and RC	207.7	11.0	8.0	1986	Russia	
35	199+101	Houay Cheng	PC I-Girder	18.0	9.5	7.0	2010	Laos	
36	199+650	Houay Sa Niam	RC T-Girder	18.0	9.5	7.0	1984	Vietnam	
37	202+400	Houay Ma Houn	RC T-Girder	21.0	9.5	7.0	1984	Vietnam	
38	204+083	Houay Sa Mang	RC T-Girder	15.0	9.5	7.0	1984	Vietnam	
39	206+400	Houay None	RC T-Girder	21.0	9.5	7.0	1984	Vietnam	
40	210+322	Houay Ta Pouan	RC T-Girder	72.0	9.6	7.8	1984	Vietnam	
41	216+000	Houay Luang	RC T-Girder	15.0	9.5	7.0	1984	Vietnam	
42	218+500	Houay Ma Heng	RC T-Girder	36.0	9.5	7.0	1984	Vietnam	
43	219+300	Houay Pa Xuoan	RC T-Girder	42.0	9.6	7.0	1984	Vietnam	
44	222+700	Houay Pa Lin	RC T-Girder	36.0	9.5	7.0	1984	Vietnam	
45	224+037	Houay Ta Khoan	RC Slab	6.0	10.0	7.0	2010	Vietnam	
46	229+141	Houay Sa Ki	RC T-Girder	54.0	9.5	7.0	1984	Vietnam	
47	229+860	Houay Sa Moun	RC T-Girder	30.0	9.2	7.0	1984	Vietnam	
48	231+246	Houay Lua	RC T-Girder	42.0	9.5	7.0	1984	Vietnam	
49	234+870	Houay Ka Hanh	RC T-Girder	42.0	9.5	7.0	1984	Vietnam	
50	236+730	Houay Pa Lath	RC T-Girder	63.0	9.5	7.0	1984	Vietnam	
51	239+400	Houay A Lone	RC T-Girder	54.0	9.7	7.0	1984	Vietnam	

(2) Bridge Condition at NR-9

The Study Team examined bridge condition, surveying all the bridges along NR-9 in early April. From this bridge condition survey, major findings on bridge structures and facilities are described below:

RC T simple girder bridge built by the former Soviet Union:

- Six standard T-shaped girders in combination with girder lengths of 12m, 15m and 18m.
- Structural cracks caused by shearing force and bending moments were observed on most girders. The widths of cracks varied from 0.1 to 0.5mm.
- The severity of the damage differed slightly by span length rather than by the bridge length. Damage on 12m long girders was more severe than for other girders.

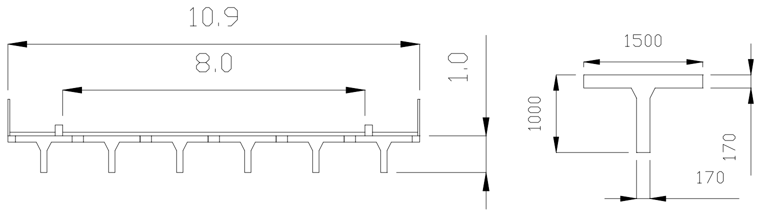
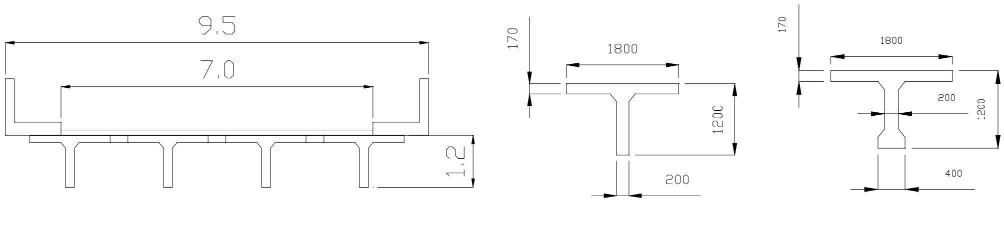
RC T simple girder bridge built by Vietnam:

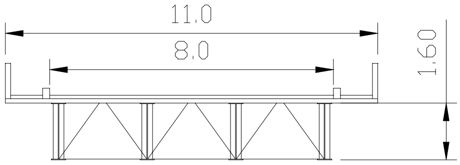
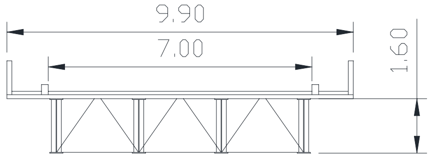
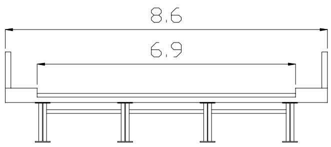
- Four standard T-shaped girders in combination with two types of girders by changing the span length at 18m.
- Structural cracks, similar to RCTG (ii) built by former Soviet Union, were observed.
- Narrow bridge width does not have lateral clearance which poses a concern for traffic safety.

Steel I-girder bridge:

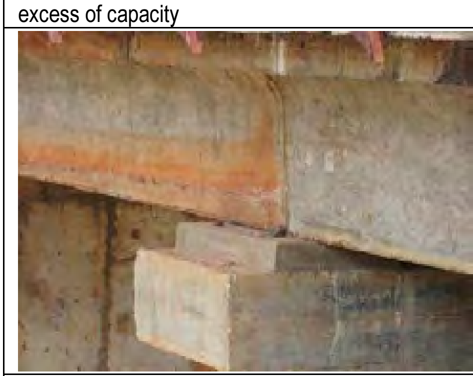
- Strengthening of bridge by incorporating additional steel truss might disturb the river flow at the flood level of 50-100 year return period. It might also result in compromising the entire bridge structure.

Table 2.3.9 Conditions of Bridges at NR-9

Structure	Bridge Feature		
Concrete	RC T simple girder bridge	RCTG(i)	Russia
			
	- Six (6) standard T-shaped girders in combination with girder lengths of 12m, 15m and 18m. - Structural cracks caused by shearing force and bending moment were observed on most girders with the widths of cracks varying from 0.1to 0.5mm - The severity in the damage differed slightly by span length rather than by the bridge length. Girders of length of 12m span had more severe damage than others.		
	RC T simple girder bridge	RCTG(ii)	Vietnam
			
	- Four (4) standard T-shaped girders in combination with two types of girders by changing the span length at 18m.		

Structure	Bridge Feature		
	- Structural cracks were observed similarly in RCTG (ii) built by Russia - Narrow bridge width with no lateral clearance poses a concern for traffic safety		
Steel	Steel I-girder bridge	STG (i)	CIS (Soviet Union)
	 No.6 and No.17	 No.7	
	- Steel I girder with RC slab - Strengthening by adding a steel truss might disturb river flow at the flood level of 50-100 year return period. It might also affect the whole bridge structure.		
	Steel I-girder bridge	STG (ii)	Czech (Soviet Union)
	 No.13 & 17		
	- Steel I girder bridges with pin-roller hinges with RC Slab - Strengthening by adding a steel truss might disturb river flow at the flood level of 50-100 year return period. It might also affect the whole bridge structure.		

Route	Bridge Type	Typical Observations of Bridges	
NR-9	RC-T simple girder bridge RCTG(i)	 Simple girder bridge constructed by Soviet Union countries in 1980s	 Standard six (6) main girders in combination of 3 span type of girder (L=12, 15 and 18m)
	RCTG(i)	 Cracks at the girders due to over stress by	 Girder web broken by shearing force

Route	Bridge Type	Typical Observations of Bridges	
		excessive bending moments	
	RCTG(i)		
		Inadequate concrete filling during fabrication	Ditto to left
	RCTG(i)		
		Many cracks observed at web of girder probably caused by shear forces and bending moments in excess of capacity	Expansion joint damaged probably by heavy traffic
NR-9	RCTG(i)		
		Absence of bearing shoe damages the bridge parapet concrete	Absence of bearing shoe damages the bridge parapet concrete
	RCTG(ii)		
		Over gap caused by misplacement of girder at the pier head	Narrow bridge width hinders traffic flows which leads to accidents

Route	Bridge Type	Typical Observations of Bridges	
NR-9	Steel I Girder Bridge STG(i)		
		Steel bridge constructed by Hungary in 1982-83 limits the maximum load to 30t.	Reinforcement support disturbs the current of river water
			
		Reinforcement by Xepon Mining Company to increase capacity so as to ensure adequacy for mining transport	No allowable gap at the expansion joint between abutment parapet and steel girder
			
		Reinforcement post has been damaged by current of water	Ditto to left
NR-9	Pin-roller hinged bridge STG (ii)		
		Abrupt profile of steel bridge using pin pin- roller hinge at joints poses a concern for traffic safety	Ditto to left

Route	Bridge Type	Typical Observations of Bridges	
			
		Residual deflection observed at the longest span of steel bridge	Ditto to left

(3) History of Repairing Bridges at NR-9

According to site survey and an interview with DPWT Savannakhet, the information on bridge construction and repairing history is obtained and summarized below:

Table 2.3.10 History of Repairing Bridges at NR-9

Time	Background of Bridges on NR-9	Remarks
1984-1987	Construction time of bridges	Russia, CIS, Vietnam
Jan, 2004	Several RCTG bridges located in Japanese Section were repaired by Japanese Contractor	
Mar., 2004	Bridge damage investigation by MCTPC (MPWT)	
Sep. 2004	Some RCTG bridges were repaired and several STG bridges were strengthened by the Xepone Mining Company	RCTG: No.3, No.5, No.18 STG: No.6, No.7, No.13, No.17
Feb. 2010	Replace the RC bridge broken with PC girder bridge by DPWT Savannakhet	No.45

(4) Observations for Other Bridges of the Roads in the Study Area

1) Bridges on NR-1G

Tathai Bridge crossing over Se Ban Hiang River was destroyed in 1964 by a bomb during Indochina War. The bridge site is located 37 km from NR-9. The original bridge was 6m wide and 270m long RC trussed bridge which was designed and constructed by Prince Soupanouvong (Red Prince) in 1942. Se Ban Hiang River has a length of 3,442 km. The total catchment area at the confluence with the Mekong is 21,516 km², and annual discharge is 15,673 million m³. The bridge should be planned taking into account the latest flood level in 2009 and the span length should be determined as per the discharged volume of river at the specified return period.

Another large span bridge is located at a crossing point over Sedone River. Sedone River, a total length of 1,475 km, has its origin in the northeastern side of Bolaven Plateau near Thateng District. The catchment area is 6,170 km², and annual discharge is 5,064 million m³. The original bridge was destroyed during the Indochina War. One span of concrete truss bridge still remains. The bedrock is observed in the riverbed at the crossing point and there is a little risk of scouring of the riverbed. Furthermore, north of Sedone River, the existing road was designed and constructed with a high embankment at 3-5m in height, in consideration of the flood.

For other bridges along NR-1G, small to medium sized bridges can be replaced by simple PC girder bridges.

2) Sedone Bridge (NR-15A)

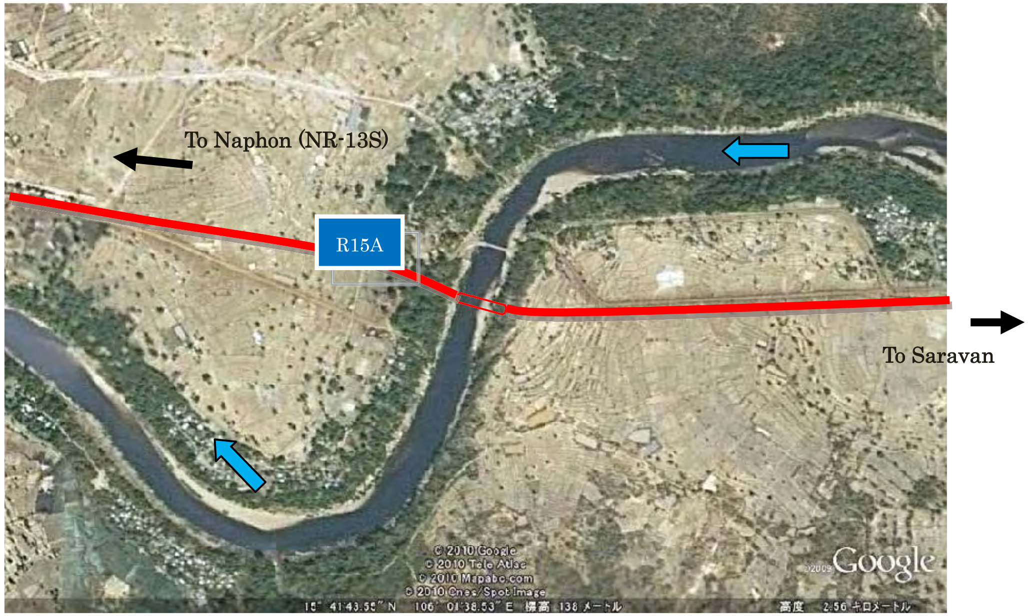
At the crossing point of Sedone River along NR-15A, a ferry operates during the rainy season despite the presence of a submerged bridge. The riverbank was observed as being unstable because the change in water level exceeds 12m while the banks with steep slopes are composed of sandy soils; hence are very prone erosion.

The river channel looks stable and it has a single cross section. Despite the fact that there are five tributaries with 50-70 m width cutting across the road, there are less technical issues pertaining to the bridge design. Much attention should be paid to the change of the water level at the points close to Sedone River. The detailed observation from field survey is summarized in following table.

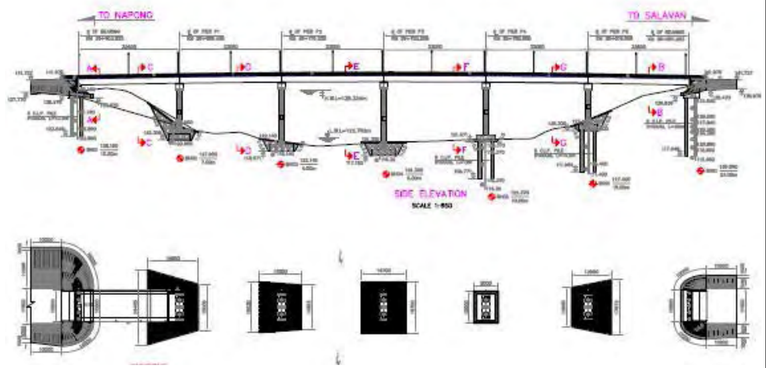
3) Sekong Bridge (NR-16B)

The source of the Sekong River is near the Lao-Vietnam borders at an elevation of 1,800 meters. The length of the mainstream to Attapeu is 170 km. The total catchment area is 10,500 km² and annual discharge reaches 16,146 million m³. The present bridge design by local consultant is 230m. However, it is suggested that the bridge length is revised to more than 280m in consideration of the high flood water level in 2009. Accordingly, the design review should be conducted taking into account the hydrological analysis to determine the alignment and bridge length. Other observations are summarized in the following table:

Sedone Bridge	NR-15A Km	L=220 (200)m, W=10.0m	Project Description



Bridge Completion Image (Proposed by JICA Study Team)



The existing design prepared by local consultant (2009) is applied to the six span PC Post tension continuous girder bridge

60m length, 6.0m width of submerged bridge (Irish crossing) is a current crossing for Sedone River during low water season

Ferry service is instead available during the high water season.

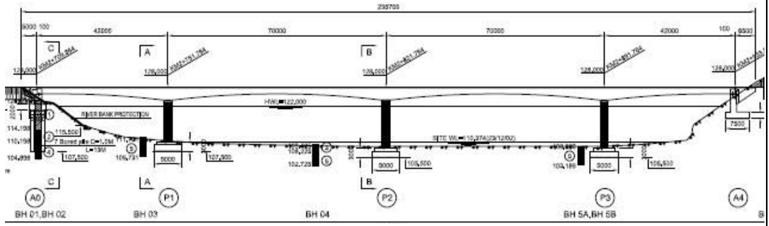
Some residences exist on the right bank along the proposed alignment for bridge approach

No residences exist on the left bank

Sekong Bridge	NR-16B Km	L=280 (230)m, W=10.0m	Drawing and Photo

Proposed location of bridge at river bending section ~~is subject to certain measures against~~

River bed and left bank slope embedded with exposed rock. However right bank is rife with sandy loose soil. Hence attention needs to paid to necessary bank protection



Four (4) span PC continuous box girder bridge (L= 230m) The existing design was prepared by local consultant collaborating with a Vietnamese consultant.

Historical flood in 2009 caused the right riverbank (lower than lef bank) to be submerged by a few meters.

Current road construction by private finance completes the road bed up to bridge site

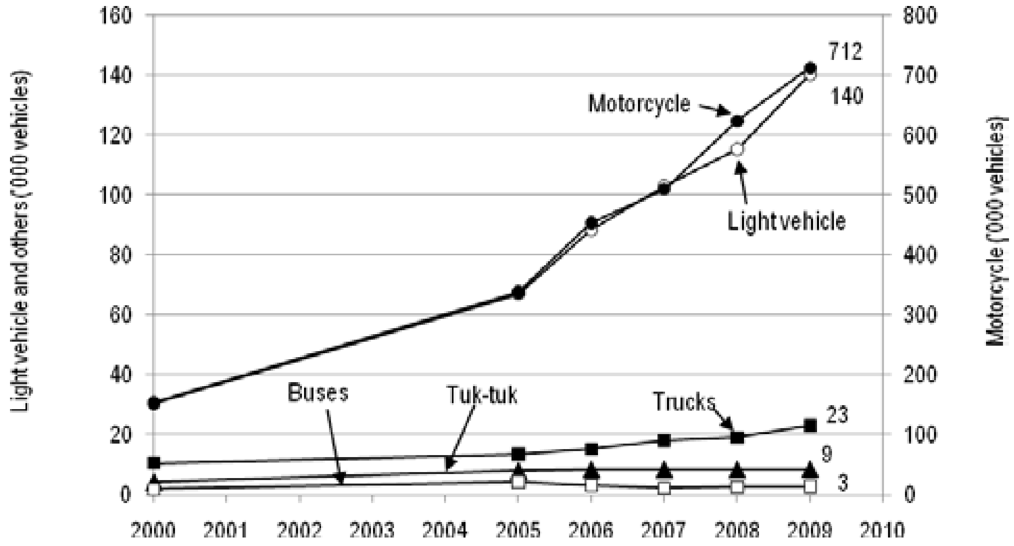
Certain number of residences exists behind right bank. Attention needs to be paid to resettlement

Ferry service is currently the only means to cross the Sekong River along NR-16B

2.3.6 Traffic Conditions

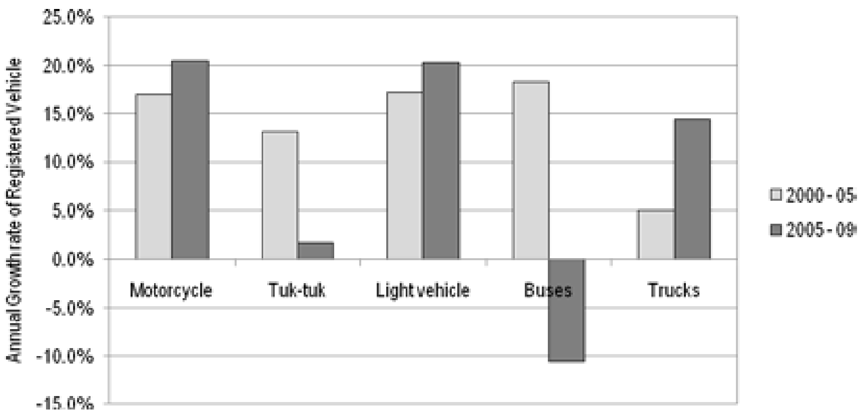
(1) Registered Vehicle

The number of registered vehicles in the whole of Lao PDR reached 887,000 vehicles in 2009: including 712,000 motorcycles, 140,000 light vehicles such as sedans, pick-ups, vans and jeeps, 23,000 trucks, 9,000 Tuk-tuks and 3,000 buses (see Figure 2.3.6). Private vehicles such as motorcycles and light vehicles have increased considerably in the last decade i.e. by more than 17% per annum as shown in Figure 2.3.7.



Source: Statistics of Vehicle for whole country, MPWT, DOT.

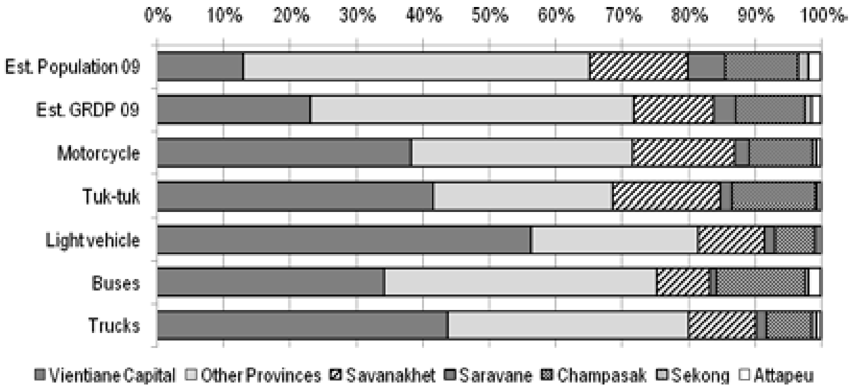
Figure 2.3.6 Registered Vehicles in Lao PDR



Source: Statistics of Vehicle for whole country, MPWT, DOT

Figure 2.3.7 Annual Growth Rate of Registered Vehicles in Lao PDR

Figure 2.3.8 shows composition of the registered vehicles by province in 2009, comparing estimated population and GRDP. The 5 provinces (Savannakhet, Saravane, Sekong, Champasak and Attapeu) account for 35% of population, 28% of GRDP, 28% of motorcycles, 31% of Tuk-tuks, 18% of light vehicles, 20% of trucks and 25% of buses in the whole Lao PDR.

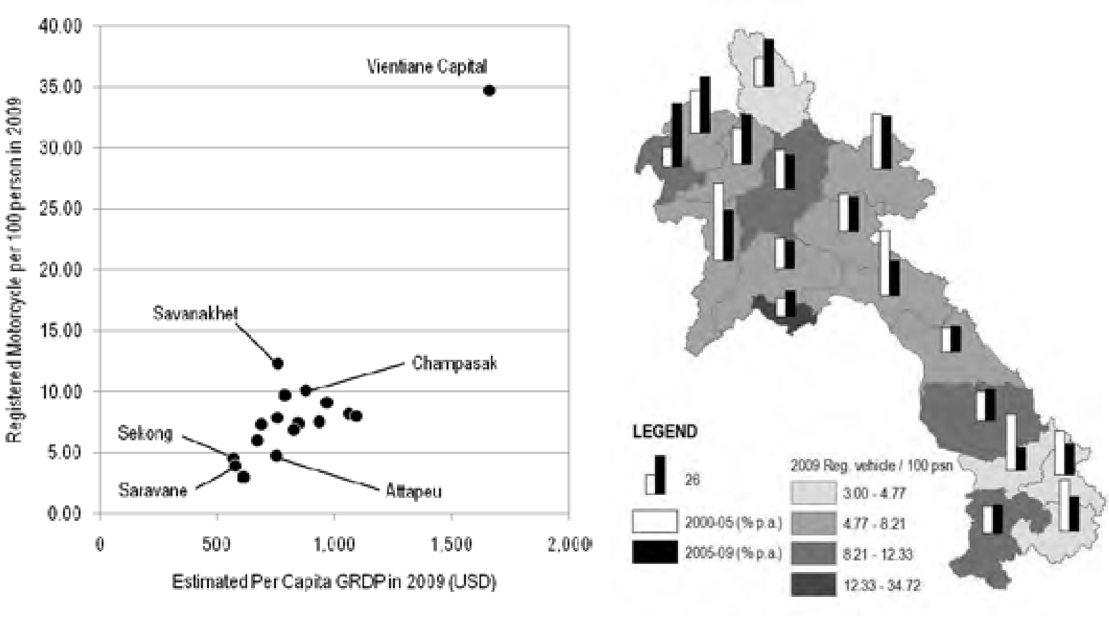


Note: Population and GRDP in 2009 are estimated by Study Team.

Source: Statistics of Vehicle for whole country, MPWT, DOT

Figure 2.3.8 Composition of Population, GRDP and Registered Vehicle in 2009

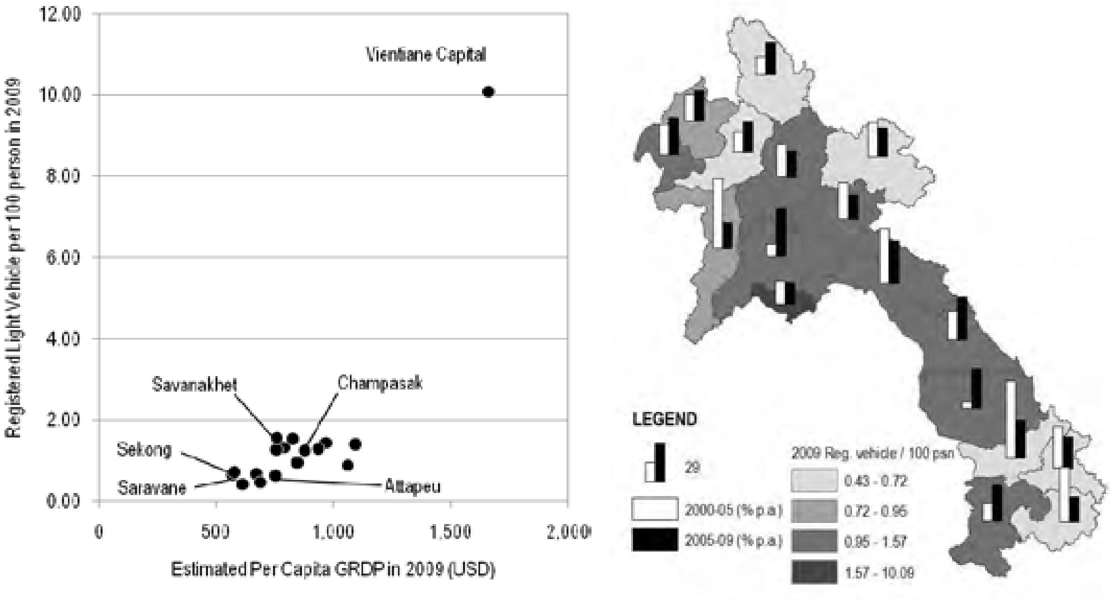
Figure 2.3.9 to 2.3.11 show the number of registered vehicles per population (100 persons); estimated per capita GRDP by province in 2009 and annual growth rate of registered vehicles per population between 2000 - 2005 and 2005 - 2009. Savannakhet and Champasak, of which per capita GRDP is relatively higher, show higher vehicle ownership ratio than other provinces in Lao PDR. Saravane and Sekong, of which GRDP per capita is relatively lower, show low vehicle ownership ratio in Laos.



Note: 2009 population and per capita GRDP are estimated by Study Team.

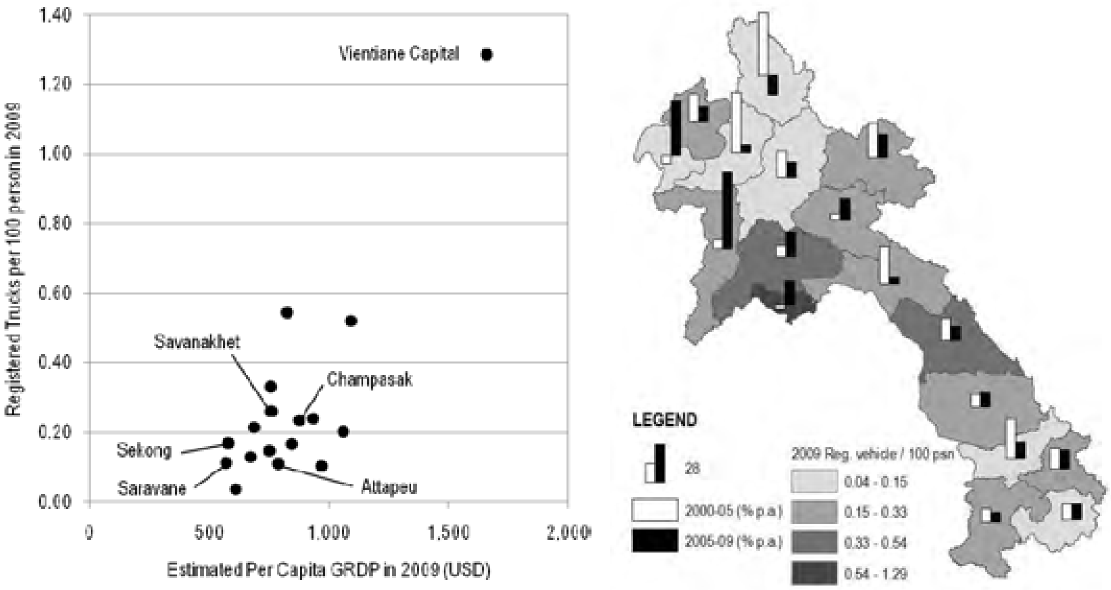
Source: Statistics of Vehicle for whole country, MPWT, DOT

Figure 2.3.9 Registered Motorcycles per population (Left) and Annual Growth Rate (Right)



Note: 2009 population and per capita GRDP are estimated by Study Team.
Source: Statistics of Vehicle for whole country, MPWT, DOT

Figure 2.3.10 Registered Light Vehicles per population (Left) and Annual Growth Rate (Right)



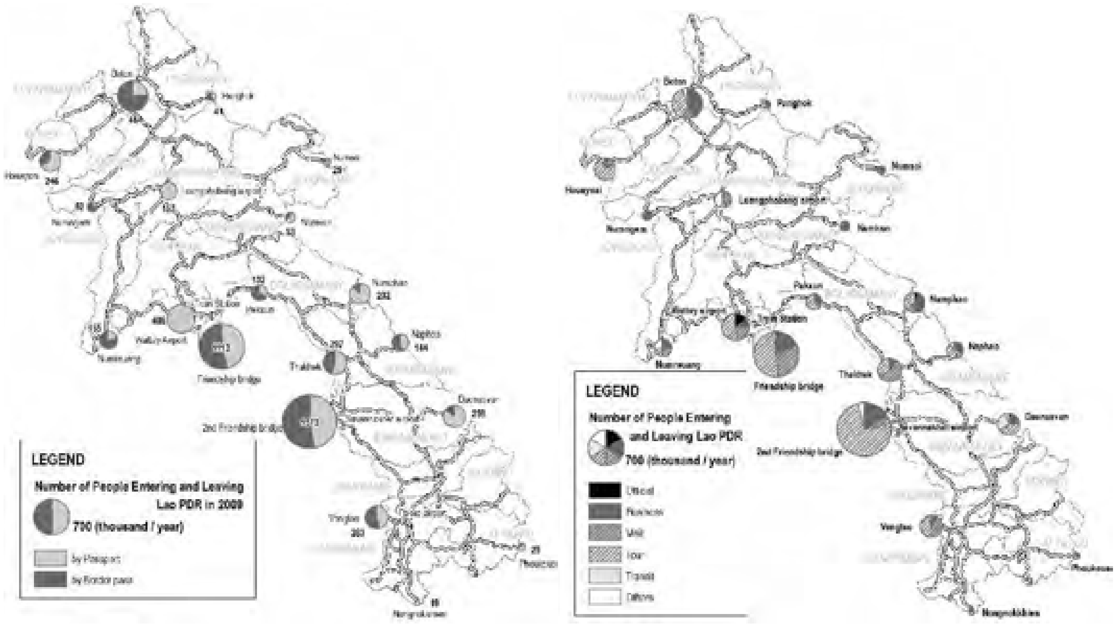
Note: 2009 population and per capita GRDP are estimated by Study Team.
Source: Statistics of Vehicle for whole country, MPWT, DOT

Figure 2.3.11 Registered Trucks per population (Left) and Annual Growth Rate (Right)

(2) Cross Border Transport

Figure 2.3.12 shows the number of people entering and leaving Lao PDR at the cross border points in 2009. The Second Friendship Bridge in Savannakhet is the busiest cross border point in Lao PDR since the Savan Vegas Hotel & Casino, which attracts numerous visitors from Thailand, opened in April 2009. On average, about 4,300 people per day come and go to/from Thailand and their trip purposes are dominated by tour trips (74%) and business trips (17%).

About 259,000 people passed through Densavan immigration in 2009. The composition of trip purpose at Densavan is as follows: business trips (17%), tour (41%) and transit (22%). Vantao immigration in Champasak is another prominent international border crossing in the study area and about 283,000 people passed through it in 2009. The major purposes of trips at Vantao immigration are touring (46%), visiting purposes (41%) and business (7%).

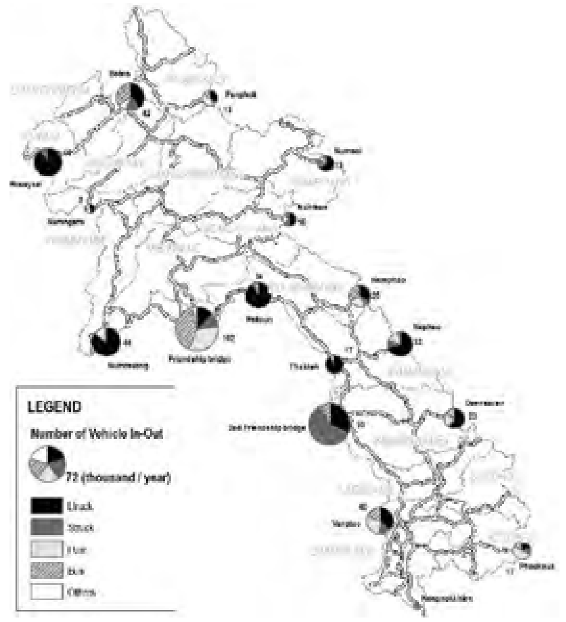


Note: The number of people shown in the left figure is identical to that to the right figure.

Source: Summary of Immigration Statistics, Immigration Police Department, Ministry of Public Security

Figure 2.3.12 Number of People Entering and Leaving Lao PDR in 2009

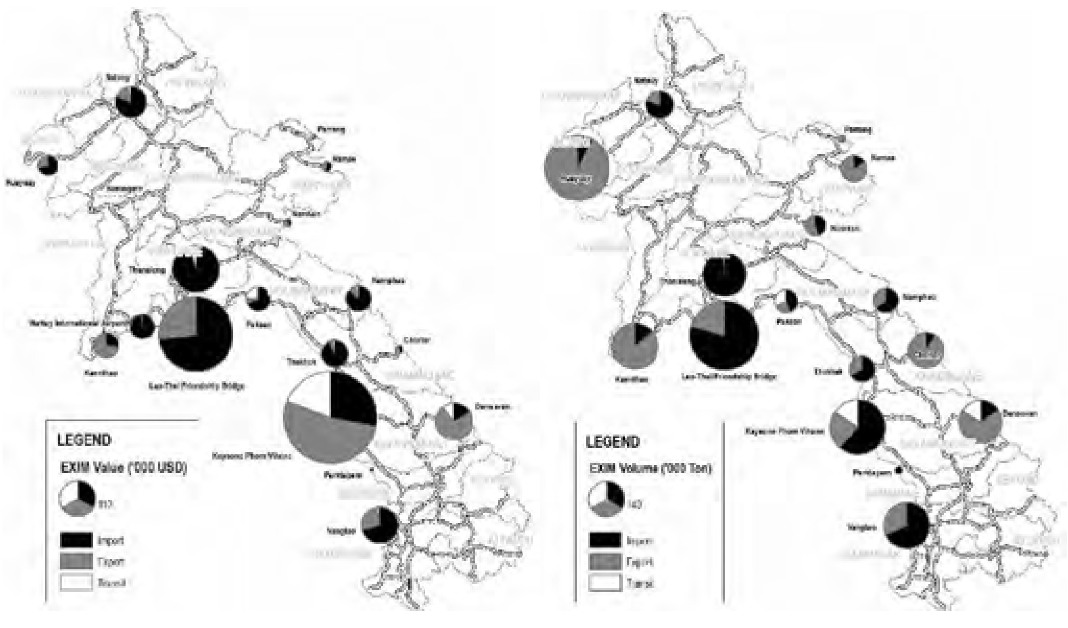
Figure 2.3.13 shows the number of vehicles passing through the cross border points in 2009. The number of vehicles through the Second Friendship Bridge was about 93,000 vehicles per year, which is a figure close to that of the Friendship Bridge in the Vientiane Capital. The vehicle composition at the Second Friendship Bridge is, however, quite different from that at the Friendship Bridge; with the trucks dominant, accounting for 91% of the vehicles. The share of trucks at other major cross border points in the study area is also high, accounting for 61% of the vehicles at Densavan and 51% at Vantao.



Source: Summary of Immigration Statistics, Immigration Police Department, Ministry of Public Security

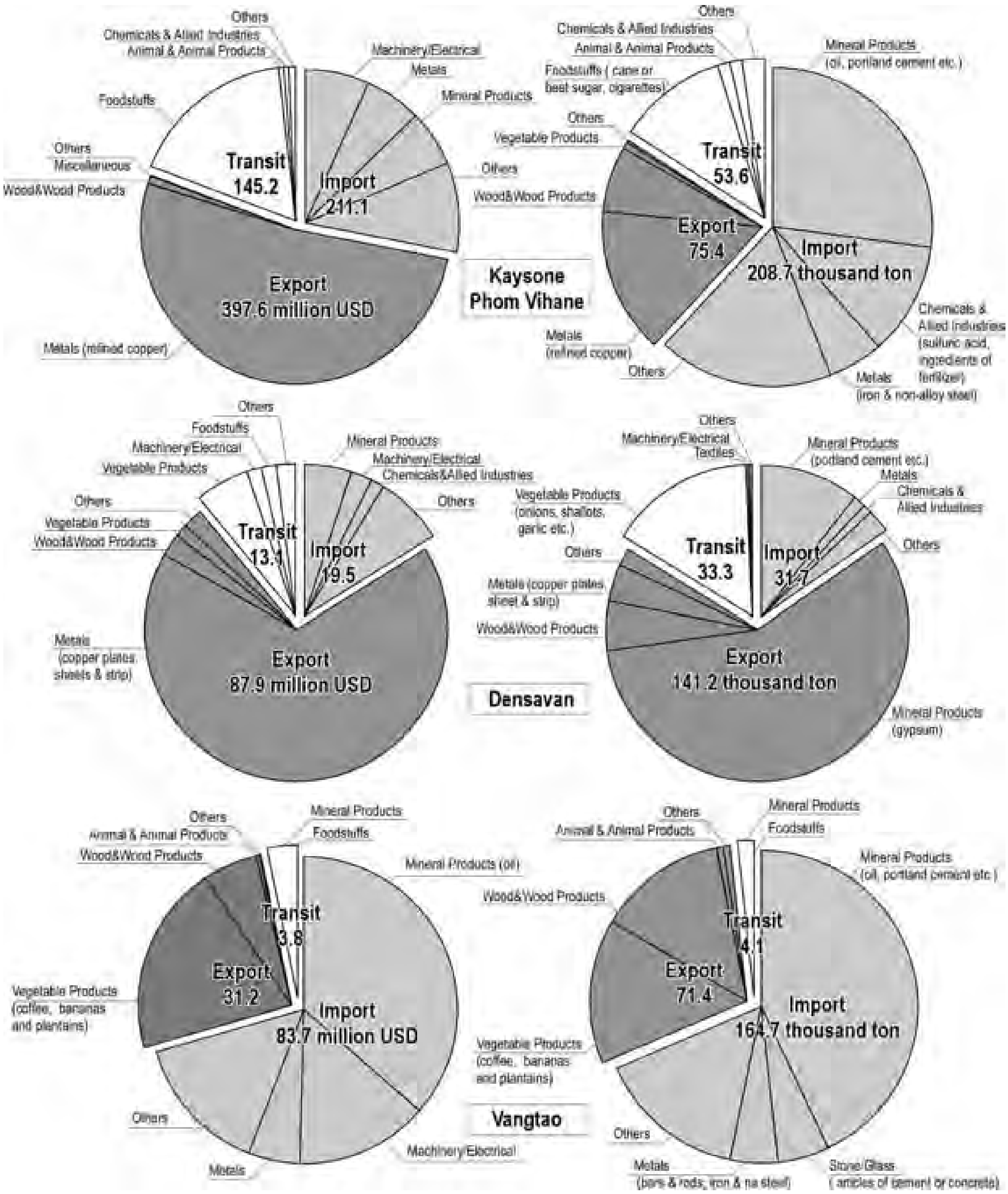
Figure 2.3.13 Number of Vehicles Entering and Leaving Lao PDR in 2009

Figure 2.3.14 shows the import, export and transit cargo volume by customs in 2007/08. There are three major customs in the southern region, namely, Khanthabury and Dansavan in Savannakhet Province, and Vantao customs in Champasak. The Khanthabury customs in particular occupies 29% in value and 10% in weight of total EXIM cargo in Lao PDR.



Source: C2000 Custom Data (Oct. 2007 - Sep. 2008), Custom Department, Ministry of Finance.

Figure 2.3.14 EXIM Volume at Major Customs in Lao PDR



Source: C2000 Custom Data (Oct. 2007 - Sep. 2008), Custom Department, Ministry of Finance.

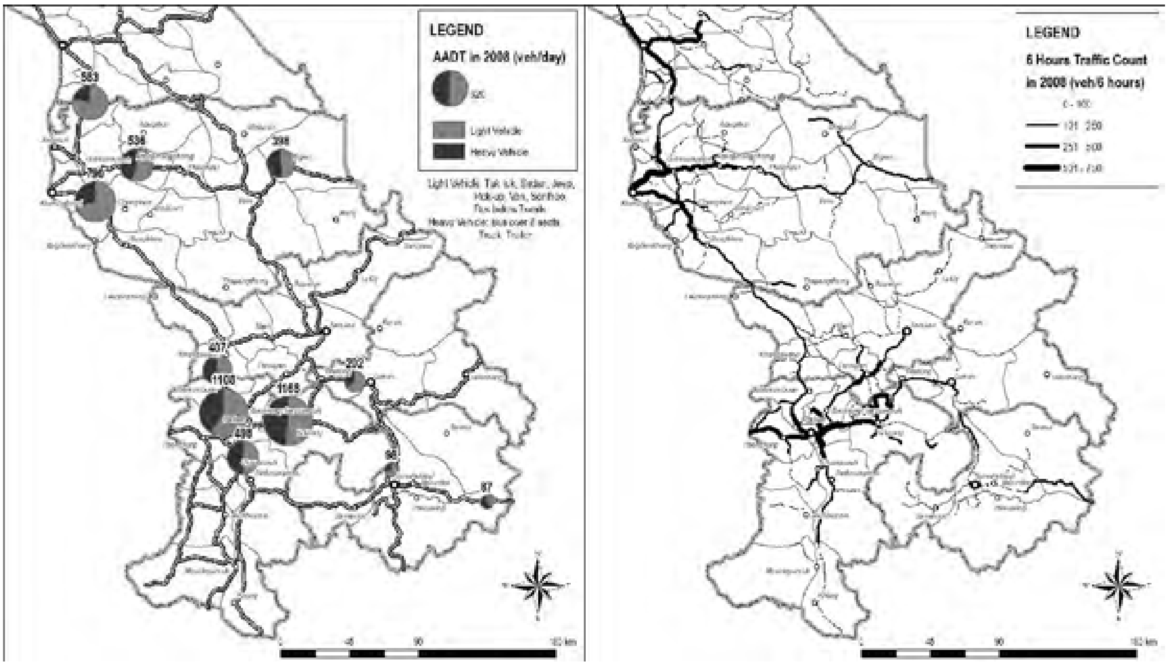
Figure 2.3.15 Composition of EXIM Commodity at Major Customs in Southern Region

Figure 2.3.15 shows the composition of EXIM commodities at three major customs in southern region by value and weight. Kaysone Phomvihane customs in Savannakhet province, also located along the East-West Economic Corridor, is the largest cross-border point in terms of handling cargo in Lao PDR. The trade volume at Kaysone Phomvihane customs reached 753.9 million USD and 337,700 tons in 2007/08. The major commodities at Kaysone Phomvihane customs are refined copper exported to and mineral products imported from Thailand. Densavan customs is also located along the East-West Economic Corridor, crossing the border with

Vietnam. The major commodities at Densavan customs are gypsum and copper exported to Vietnam. Vantao customs in Champasak handles oil, construction materials and machinery parts that are imported from Thailand and agricultural products such as coffee and vegetables that are exported to Thailand.

(3) Traffic Volume

Figure 2.3.16 shows the existing traffic volume based on the toll collection data in 2008 and 6 hours traffic volume complied into Road Management System in 2008. Both figures indicate the number of vehicles travelling in both directions, excluding motorcycles. In the southern region, large traffic volumes were observed on national roads connecting province centers such as NR-13S, NR-9, NR-16, NR-18 and NR-20. The traffic volumes in the southern region were, however, observed to be less than a maximum of 2000 pcu/day, with the exception of congested streets in the urban areas.

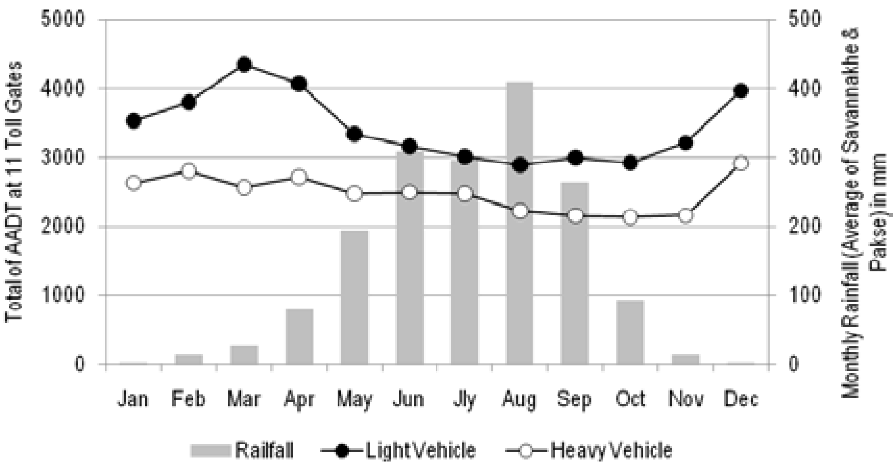


Note: 6 hours Traffic Volume is based on the Traffic Count in Road Management System (RMS)

Source: Annual Average Daily Traffic Volume at Toll Gate is based on the Toll Fee Collection Data in 2008

Figure 2.3.16 AADT at Toll Gate in 2008 (left) and 6 Hours Traffic Volume in 2008 (right)

Figure 2.3.17 shows the annual average daily traffic volume (AADT) at 11 tollgates in the southern region together with the average rainfall of Savannakhet and Pakse. During the rainy season, the number of both light vehicles and heavy vehicles is observed to be relatively smaller, compared to the number in dry season.



Source: Toll Fee Collection Data in 2008 and Statistical Year Book

Figure 2.3.17 Monthly Traffic Volume Dispersion by Toll Gate

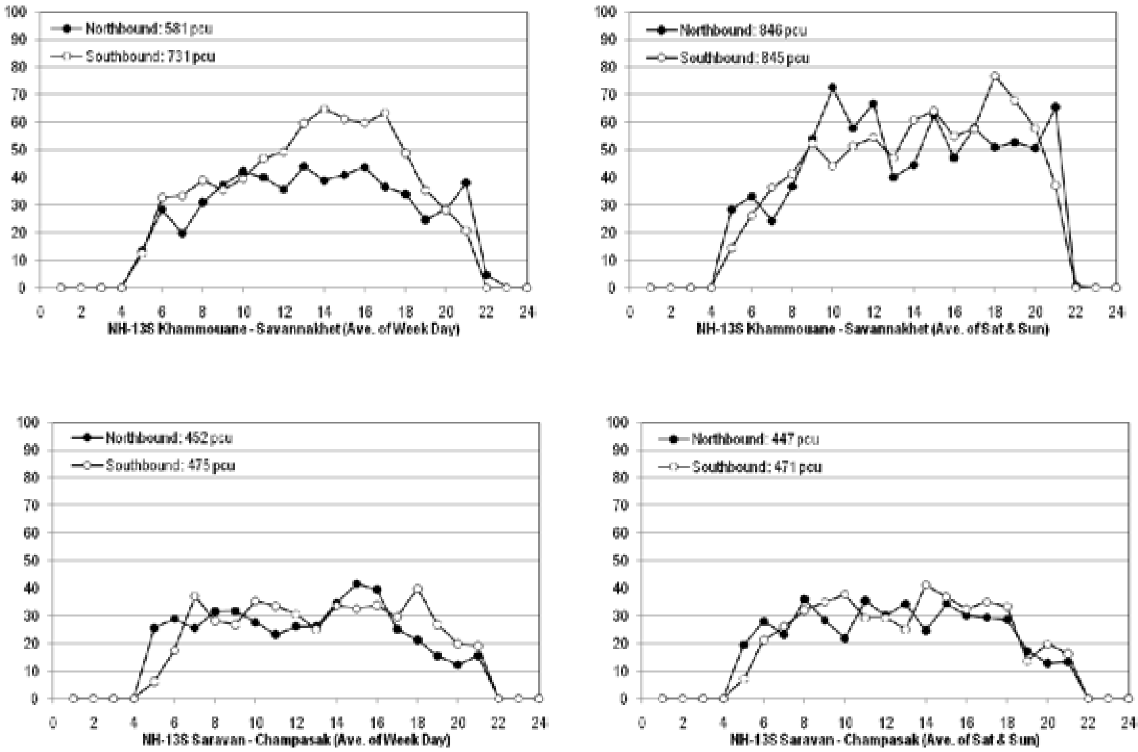
Based on the 2008 toll collection data in the study area, adjustment factor for monthly fluctuations to annual average is calculated as shown in Table 2.3.11.

Table 2.3.11 Adjustment Factors for Monthly Fluctuations

Vehicle Type	Adjustment Factor (Mar)	Adjustment Factor (May)
Tuk-tuk	1.000	0.929
Sedan, Jeep, Pick-up, Van	0.978	1.029
Sonteo, Bus (below 7 seats)	0.884	0.912
Bus (8-15 seats), Light Truck (below 7 tons)	0.938	1.041
Bus (over 36 seats), Heavy Truck (over 7 tons)	1.011	0.996
Heavy Truck 18-22 Wheels	1.171	0.858

Source: Toll Fee Collection Data in 2008

Figure 2.3.18 shows the hourly fluctuation by the traffic count survey conducted in May 2009 on NR-13S at Khammouane - Savannakhet boundary and Saravane - Champasak boundary. At the provincial boundaries at NR-13S, morning peak and evening peak were not observed. Besides, the difference in traffic volume on weekdays and weekends is not significant.



Source: The Comprehensive Study on Logistics System in Lao PDR, JICA (ongoing)

Figure 2.3.18 Hourly Fluctuation on NR-13S

An expansion factor for the estimation of daily traffic volume based on the results of 12 hours or 16 hours traffic count surveys were calculated in the on-going JICA Study (the Comprehensive Study on Logistics System in Lao PDR) as shown in Table 2.3.12.

Table 2.3.12 Expansion Factor for Daily Volume

Vehicle Type	Expansion Factor (12 hours to 24 hours)	Expansion Factor (16 hours to 24 hours)
Motorcycle	1.160	1.051
Tuk-tuk, Sonteo	1.113	1.078
Passenger Car	1.335	1.066
Medium Bus	1.000	1.000
Large Bus	1.426	1.108
2 Axles Rigid Truck	1.472	1.125
3 Axles and more Rigid Truck	1.436	1.113
Trailer (semi and full)	1.771	1.214

Source: The Comprehensive Study on Logistics System in Lao PDR, JICA (ongoing)

(4) Traffic Survey

For calibration and updating of the existing Origin - Destination matrix prepared in the on-going JICA Study (the Comprehensive Study on Logistics System in Lao PDR), traffic count and roadside OD interview surveys were conducted on 30 and 31 of March 2010. The traffic count survey was performed in 12 hours (6:00 - 18:00) at 9 locations while the roadside OD interviews were conducted at location No.9 during the same period as shown in Figure 2.3.19.

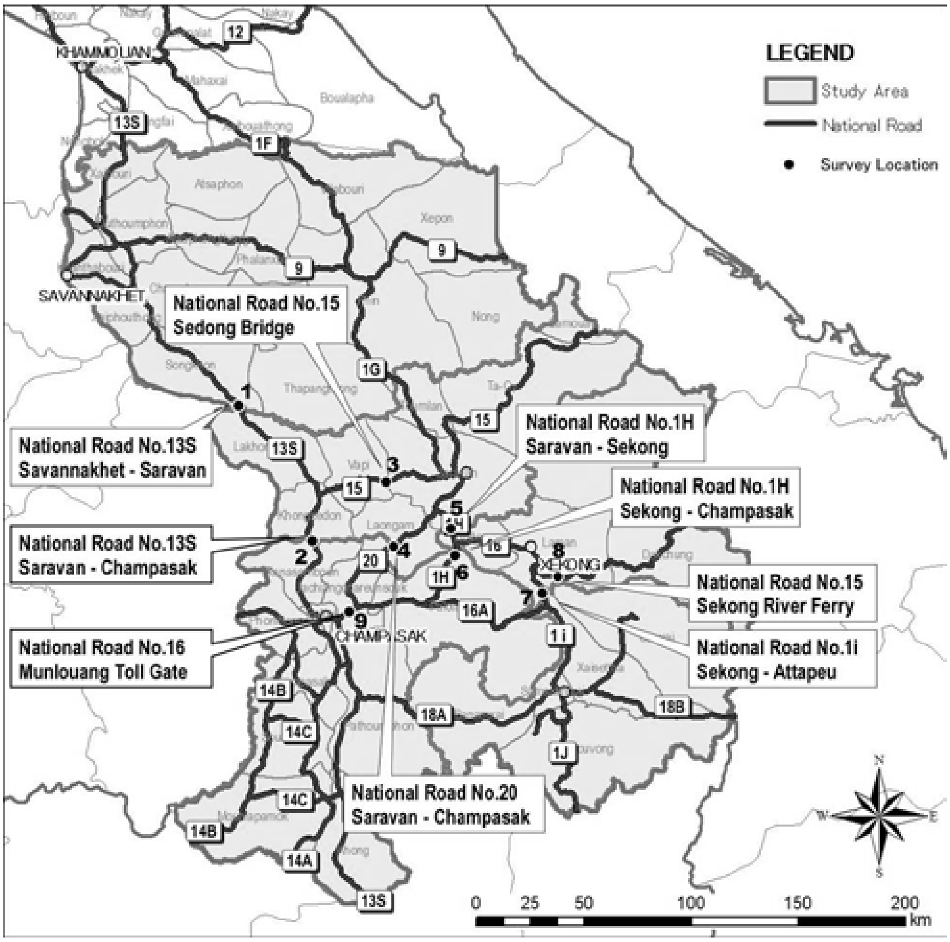
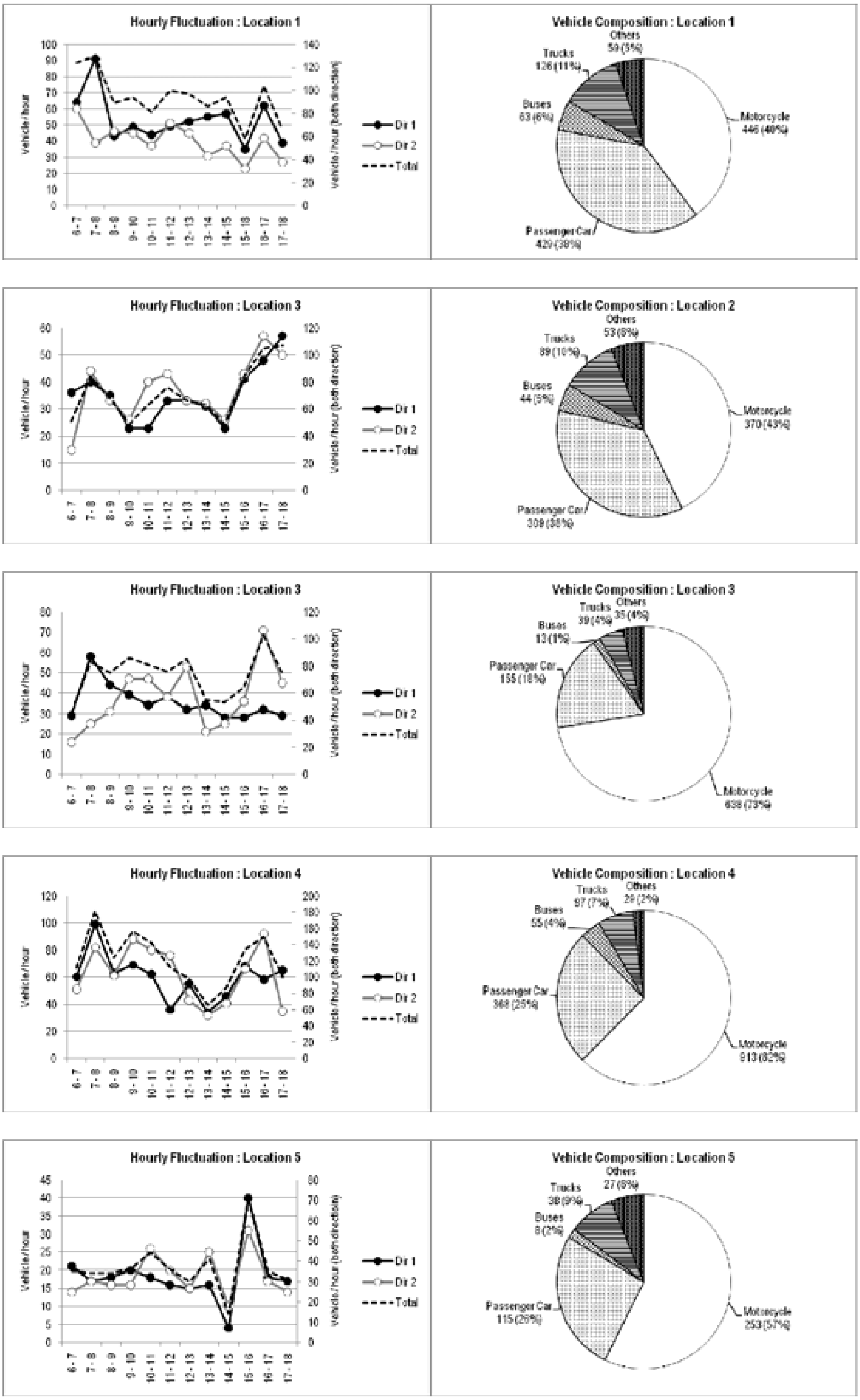


Figure 2.3.19 Traffic Survey Locations

Table 2.3.13 shows the total number of vehicles in 12 hours by location while Figure 2.3.20 shows hourly fluctuation.

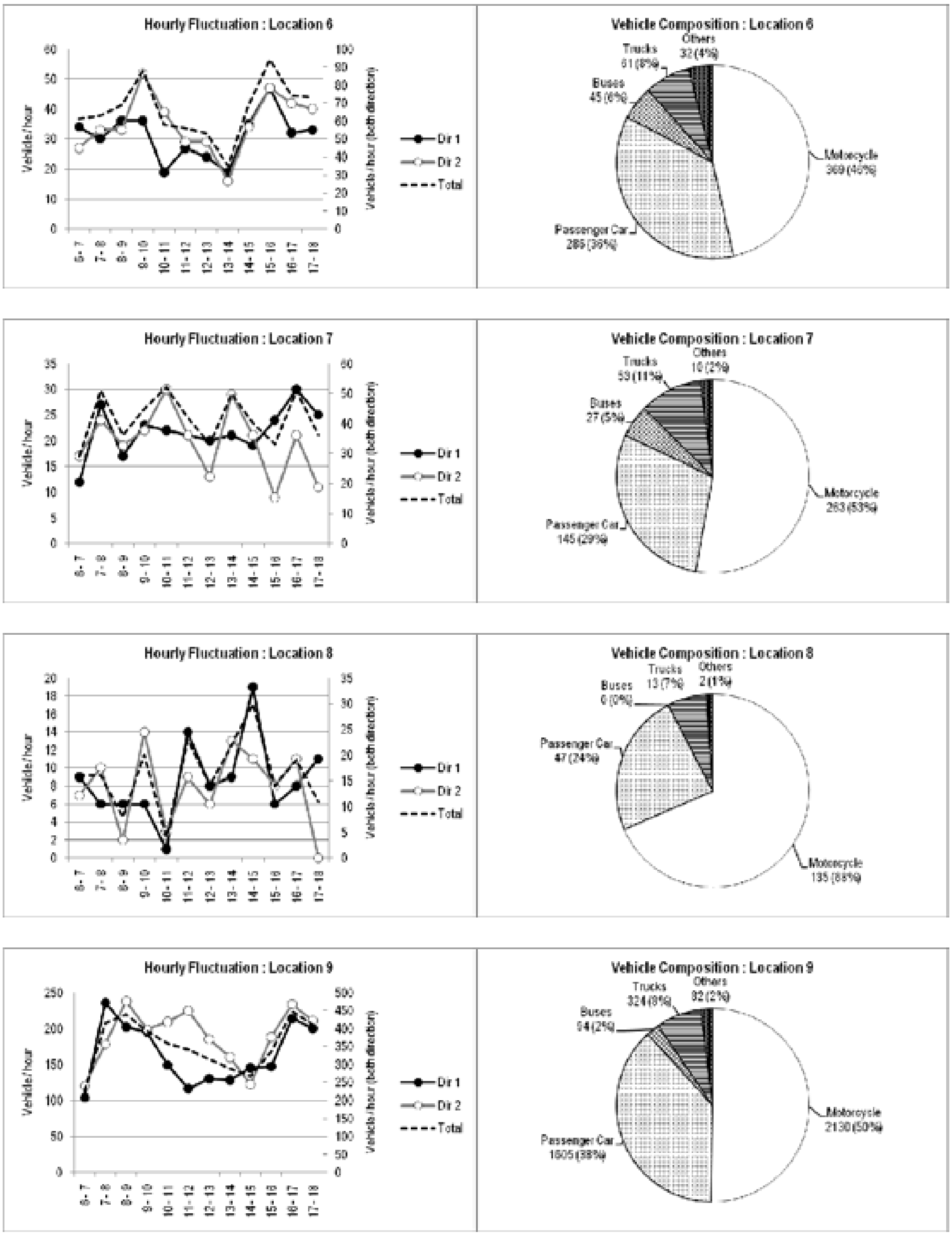
Table 2.3.13 12 hours Traffic Count Result

Location	Motor-cycle	Tuk-tuk	Passenger Car	Sonteo	Medium Bus	Large Bus	2 Axles Truck	3 Axles And more	Trailer	Tractor	Total (veh/12h)
1	446	5	429	31	1	31	54	32	40	54	1123
2	370	8	309	2	4	38	34	30	25	45	865
3	638	0	155	6	6	1	20	12	7	35	880
4	913	5	368	11	26	18	42	40	15	24	1462
5	253	0	115	8	0	0	14	19	5	27	441
6	369	8	286	7	6	32	34	17	10	24	793
7	263	1	145	10	0	17	18	9	26	9	498
8	135	0	47	0	0	0	3	10	0	2	197
9	2130	44	1605	27	9	58	179	84	61	38	4235



Source: JICA Study Team

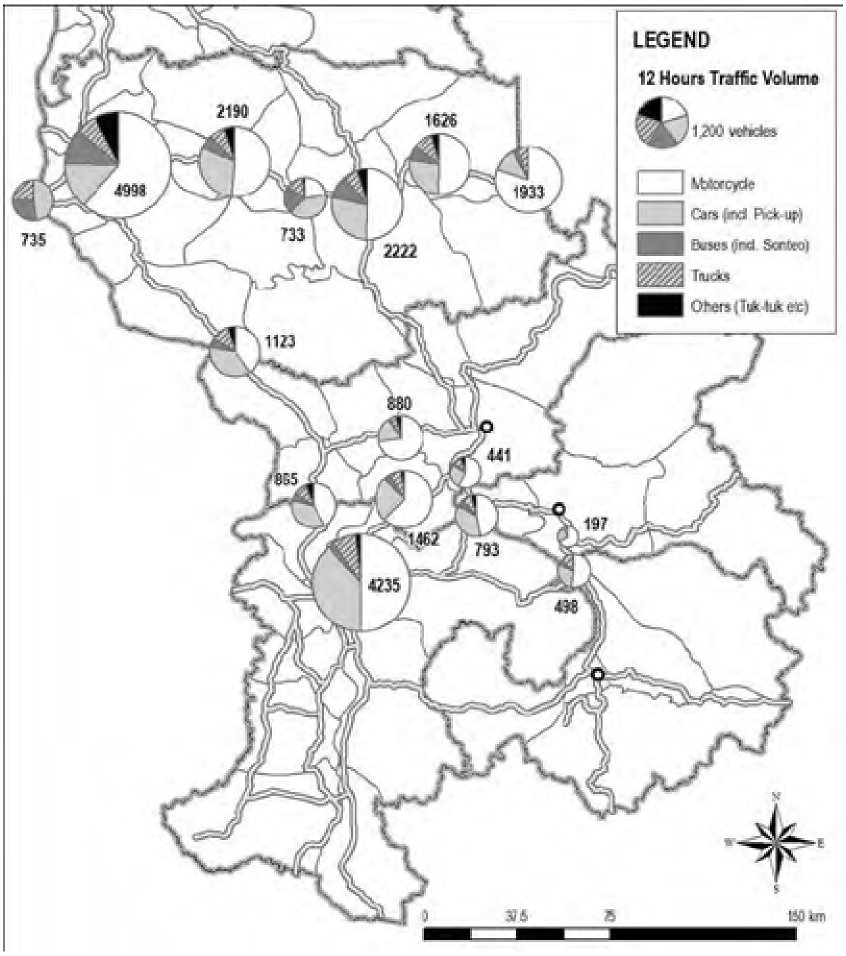
Figure 2.3.20 Hourly Fluctuation and Vehicle Composition in 12 Hours



Source: JICA Study Team

Figure 2.3.21 Hourly Fluctuation and Vehicle Composition in 12 Hours (cont'd)

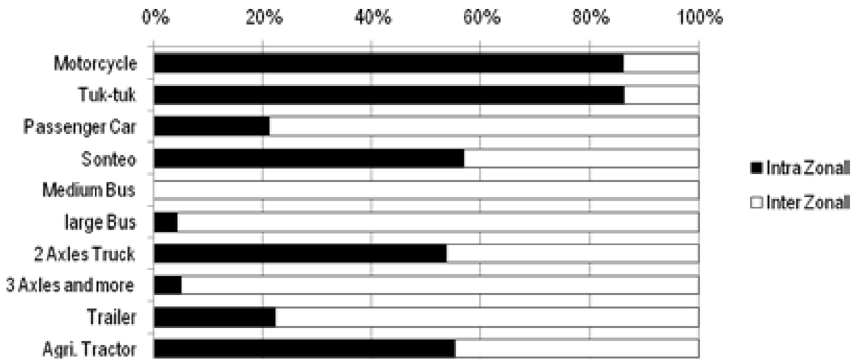
Figure 2.3.22 shows the results of the traffic count survey at the 9 locations and the traffic count survey at 7 sections along NR-9 which were conducted during the follow-up Study for the Improvement of NR-9 (JICA, ongoing) in March 2010. More traffic was observed in the suburbs of Savannakhet (Seno) along NR-9 and Pakse along NR-16.



Source: JICA Study Team and Follow-up Study for the Improvement of NR-9 (JICA, ongoing)

Figure 2.3.22 12 Hours Traffic Volume in 2010

For the estimation of internal vehicle trip ratio by Provincial zone, the roadside interview survey at survey location No.9, where relatively high traffic volume was observed in the study area including inter-zonal trips with other provincial zones, was conducted. Figure 2.3.23 shows the results of roadside interview survey and Table 2.3.14 shows intra-zonal vehicle trip ratio by Provincial zone.



Source: JICA Study Team

Figure 2.3.23 Intra-Zonal Traffic Ratio by Provincial Zone

Table 2.3.14 Intra-Zonal Vehicle Trip Ratio by Provincial Zone

Vehicle Type	Intra-Zonal Ratio
Motorcycle	86.1%
Cars	21.2%
Buses	8.1%
2 Axles Truck	53.6%
3 and more Axles Truck	4.9%
Trailer	22.3%
Others	55.3%

Source: JICA Study Team

(5) Trip Generation Survey

In the southern region, many industrial and agricultural projects were developed and these development projects generate vehicular traffic. Future vehicular trip generation by these development projects should be considered in the future traffic demand in the study area. The purpose of trip generation survey is to obtain the vehicular trip generation unit per investment volume to forecast future vehicular trip generation of the development project.

Trip generation survey was conducted, interviewing 18 factories, 14 mining places and 8 plantation farms in the whole of Lao PDR including the study area. Based on the results of trip generation interview survey, vehicular trip attraction models are estimated as follows:

$$TA_i = \alpha_i \cdot P + \beta_i$$

where, TA_i : Vehicular trip attraction of mode i (vehicle / day)
α_i : Coefficient of mode i
β_i : Constant of mode i
P : Initial investment cost (million USD)

Table 2.3.15 Vehicular Trip Attraction Model

		Factory			Mining Place			Plantation Farm		
		Coefficient	Constant	R2	Coefficient	Constant	R2	Coefficient	Constant	R2
Motorcycle		10.22	33.08	0.95	117.48	-24.78	0.82	7.74	7.3	0.76
Passenger Car		8.27	-0.14	0.99	599.88	-162.89	0.89	7.43	1.76	0.86
Buses		N/A	N/A	N/A	122.56	-32.13	0.99	N/A	N/A	N/A
2 Axles Truck	Loading	1.03	1.86	0.99	17.9	-2.4	0.76	0.64	0.73	0.99
	Empty	2.15	2.46	0.99	28.13	-5.86	0.97	0.64	0.73	0.99
3 Axles and more	Loading	0.97	1.86	0.99	74.78	-3.96	0.98	2.83	-0.76	0.77
	Empty	1.55	2.46	0.99	44.06	-10.06	0.79	2.83	-0.76	0.77
Trailer	Loading	0.81	0.84	0.99	37.33	-12.19	0.97	N/A	N/A	N/A
	Empty	0.81	0.84	0.99	37.33	-12.19	0.97	N/A	N/A	N/A

Source: JICA Study Team

2.4 Social Development

2.4.1 Social Indicators

Comparison of social indicators regarding consumption, education, health and infrastructure, the following two characters were observed. The first one was disparity between provinces: good performance in Savannakhet and Pakse, and poor performance in Saravane, Sekong and Attapeu. The other character was disparity by geographical area: good performance in the western part of the study area (along Mekong River and NR-13) and poor performance in the eastern part (along Vietnam border).

(1) Consumption

Table 2.4.1 indicates monthly income and percentage of own products by province in the study area. The data was collected in the Expenditure and Consumption Survey in 2002/03 (LECS 3) and in 2007/08 (LECS 4). Monthly income in Savannakhet and Champasak had been lower than national average in LECS 3 but it exceeded the national average in LECS 4. On the other hand, the monthly income of the other 3 provinces was lower than the national average. In fact, the amount of Saravane and Sekong was less than half the amount for Vientiane Capital.

In accordance with the increase in income, the percentage of own products has been decreasing. Even in Saravane Province, the percentage has dropped from 47% in LECS 3 to 43% in LECS 4. This implies that even residents in rural areas need to buy good at markets for daily life; hence accessibility to markets and commercial facilities is increasingly more important.

Table 2.4.1 Monthly Income and Percentage of Own Products

	Monthly Consumption (LAK1000)		Percent of Own Products	
	LECS 3	LECS 4	LECS 3	LECS 4
Savannakhet	965	2,365	33.9	22.5
Saravane	684	1,456	47.4	42.5
Sekong	804	1,519	46.5	35.3
Champasak	1,054	2,300	22.9	20.2
Attapeu	838	1,760	38.3	30.4
Lao PDR	1,091	2,171	28.6	23.4
Vientiane Capital	1,900	3,183	6.1	5.3

Source: LECS 3 and LECS 4 reports

(2) Education

Table 2.4.2 indicates level of school attendance of the population over 6 years of age. The percentage of “Never been to school” of 4 provinces (Savannakhet, Saravane, Sekong Attapeu) is higher than the national average. In particular, Saravane and Attapeu recorded high percentages.

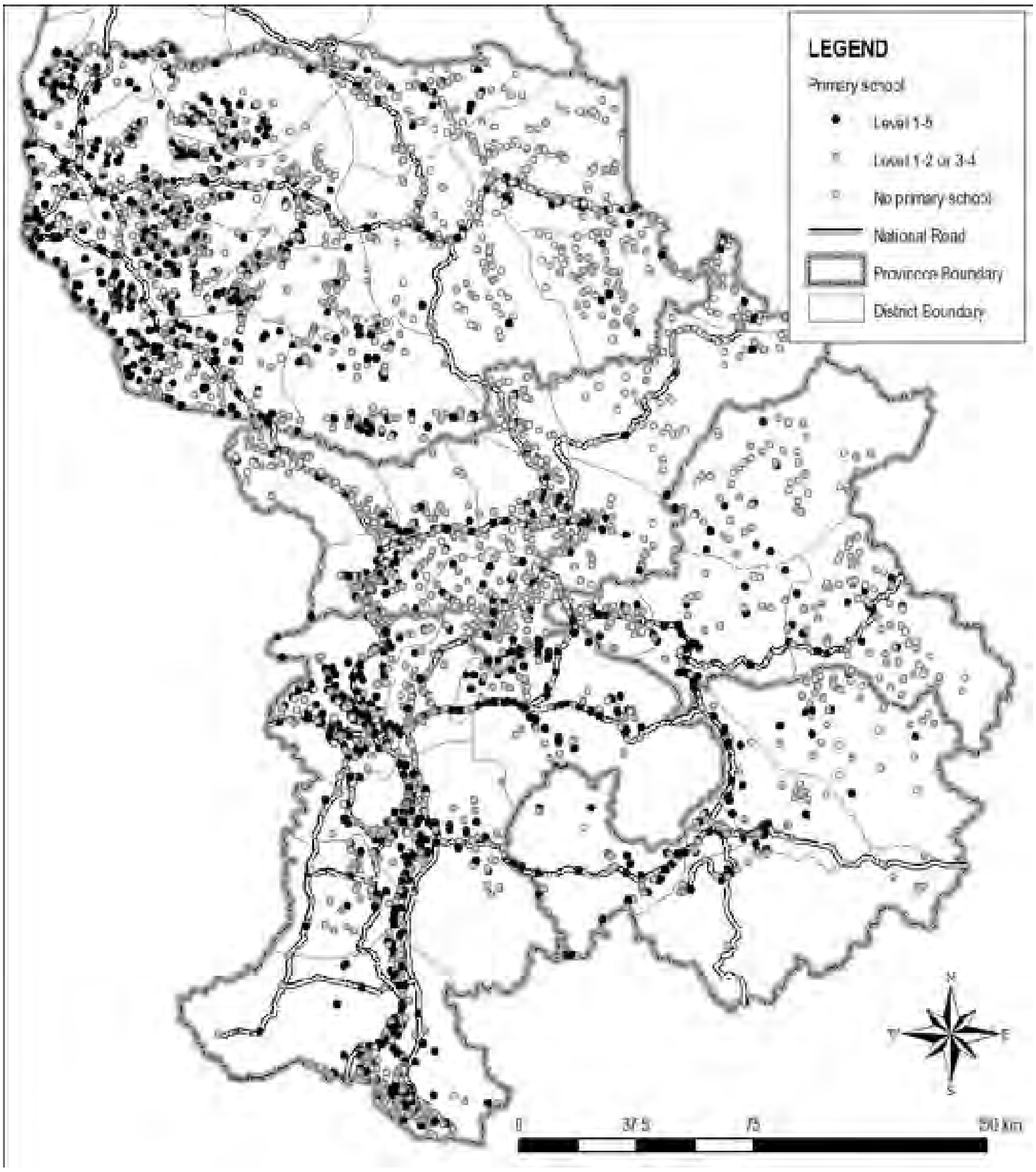
Table 2.4.2 School Attendance of Population more than 6 Years Old

(Unit: %)

	Male/Female	Never been to school	At school	Left school	No Response
Savannakhet	Male	34.9	23.0	40.6	1.5
	Female	21.1	27.7	50.3	0.9
Saravane	Male	43.8	20.9	34.2	1.1
	Female	25.3	27.9	46.1	0.7
Sekong	Male	45.7	22.4	29.7	2.2
	Female	27.6	27.5	43.6	1.3
Champasak	Male	20.5	25.0	52.6	1.9
	Female	9.9	30.7	58.3	1.1
Attapeu	Male	40.9	23.6	33.8	1.7
	Female	23.4	29.4	46.1	1.1
Total of 5 Provinces	Male	32.7	23.3	42.5	1.6
	Female	18.7	28.8	51.6	1.0
Lao PDR	Male	29.5	25.6	42.4	2.5
	Female	16.1	31.3	51.1	1.5

Source: Census 2005

Figure 2.4.1 shows the prevalent situation pertaining to primary school distribution. Primary schools are properly distributed in the western part of the study area. However, villages without primary schools are observed in the eastern part of the study area.



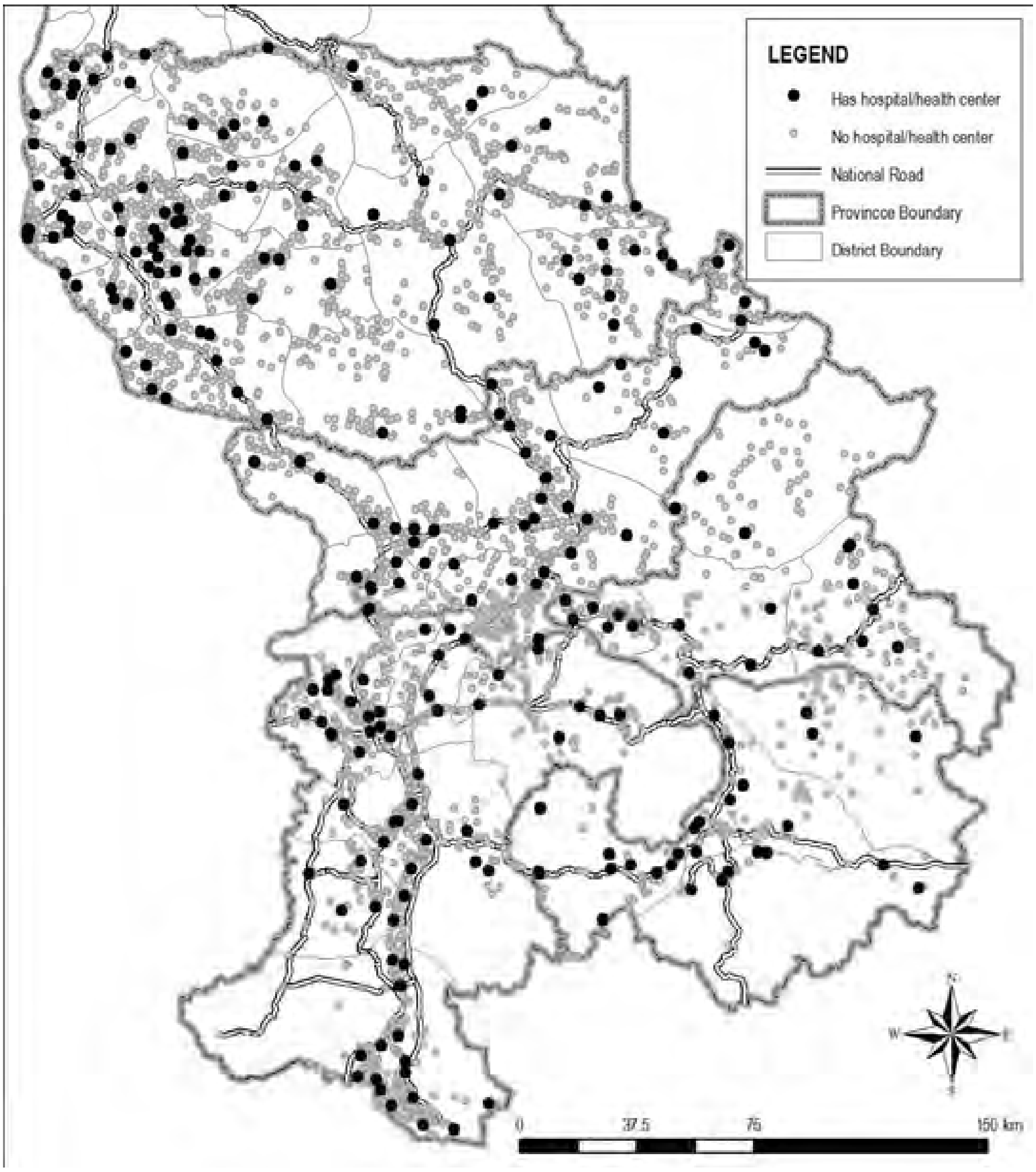
Source: Data from Ministry of Education 2010

Figure 2.4.1 Primary School Distribution in Study Area

JICA is conducting a project "Improvement of Primary School Facilities in the Southern 3 Provinces in Lao PDR." In the project, 74 primary schools will be improved in the Saravane Distict (14 schools), Laongam District (14), Lamam District (9), Thateng District (12), Samakkhixay District (13) and Sanamxay District (12). The project will be completed in 2010.

(3) Health

Figure 2.4.2 shows the locations of hospitals/health centers. Most of the hospitals/health centers are located along National Roads. As is the case with primary schools, the hospitals/health centers are more densely distributed in the western part of the study area than the eastern side.



Source: Data from Ministry of Health 2010

Figure 2.4.2 Locations of Hospitals/ Health Centers

Table 2.4.3 shows the number of health centers, beds in the health centers, average staff per health center, and health center per 1,000 persons. The numbers of Health Centers in Champasak and Savannakhet were lower than the national average. The other provinces exceeded the national average of health centers per 1000 persons. However, average number of staff per health center was quite low in Attapeu Province.

Table 2.4.3 Number of Health Centers, Beds in Health Centers and Average Staff in 2005

	Number of Health Centers	No of Beds in Health Centers	Average Staff per Health Center	Health Centers per 1,000 persons
Savannakhet	111	387	1.8	134
Saravane	48	97	1.7	148

Sekong	14	41	2.1	165
Champasak	63	174	2.7	104
Attapeu	24	75	1.1	214
Total of the Study Area	260	774	2.0	133
Lao PDR	823	2,076	2.2	147

Source: Data from Ministry of Health

(4) Access to Safe Water

Table 2.4.4 illustrates the situation pertaining to water sources in the 5 provinces. The percentage of access to piped water in all 5 provinces is lower than the national average. In particular, the percentages are quite low in Champasak, Attapeu and Savannakhet.

The well is the major water source in the study area with the exception of Sekong Province. The percentage of mountain source is high only in Sekong Province.

Table 2.4.4 Situation of Water Source

(Unit: %)

	Piped water	Well	River, stream or dam	Mountain source	Rain water from tank	Other	Not stated
Savannakhet	9.4	68.9	14.7	5.3	0.3	1.0	0.4
Saravane	10.6	53.8	28.5	6.2	0.0	0.3	0.5
Sekong	11.8	30.2	22.9	33.6	0.2	0.9	0.4
Champasak	8.1	55.6	32.2	2.8	0.0	0.3	1.0
Attapeu	9.2	51.6	35.3	3.0	0.0	0.5	0.5
Total of 5 provinces	9.3	59.5	24.2	5.6	0.1	0.6	0.6
Lao PDR	13.1	46.8	20.9	19.5	0.1	0.6	0.9

Source: Census 2005

(5) Electricity and Road

Table 2.4.5 illustrates the rate of electrification and accessibility to roads. The rates in Savannakhet and Pakse are a little higher than the national average. On the other hand, the rates were almost half of the national average in Sekong and Attapeu Provinces.

Regarding accessibility to roads, every province recorded 100% in the dry season; but these figures dropped to less than 80% in Saravane and Sekong, and less than 90% in Savannakhet and Champasak. The average distance to the nearest road is extremely long in Sekong Province.

Table 2.4.5 Rate of Electrification and Accessibility to Roads

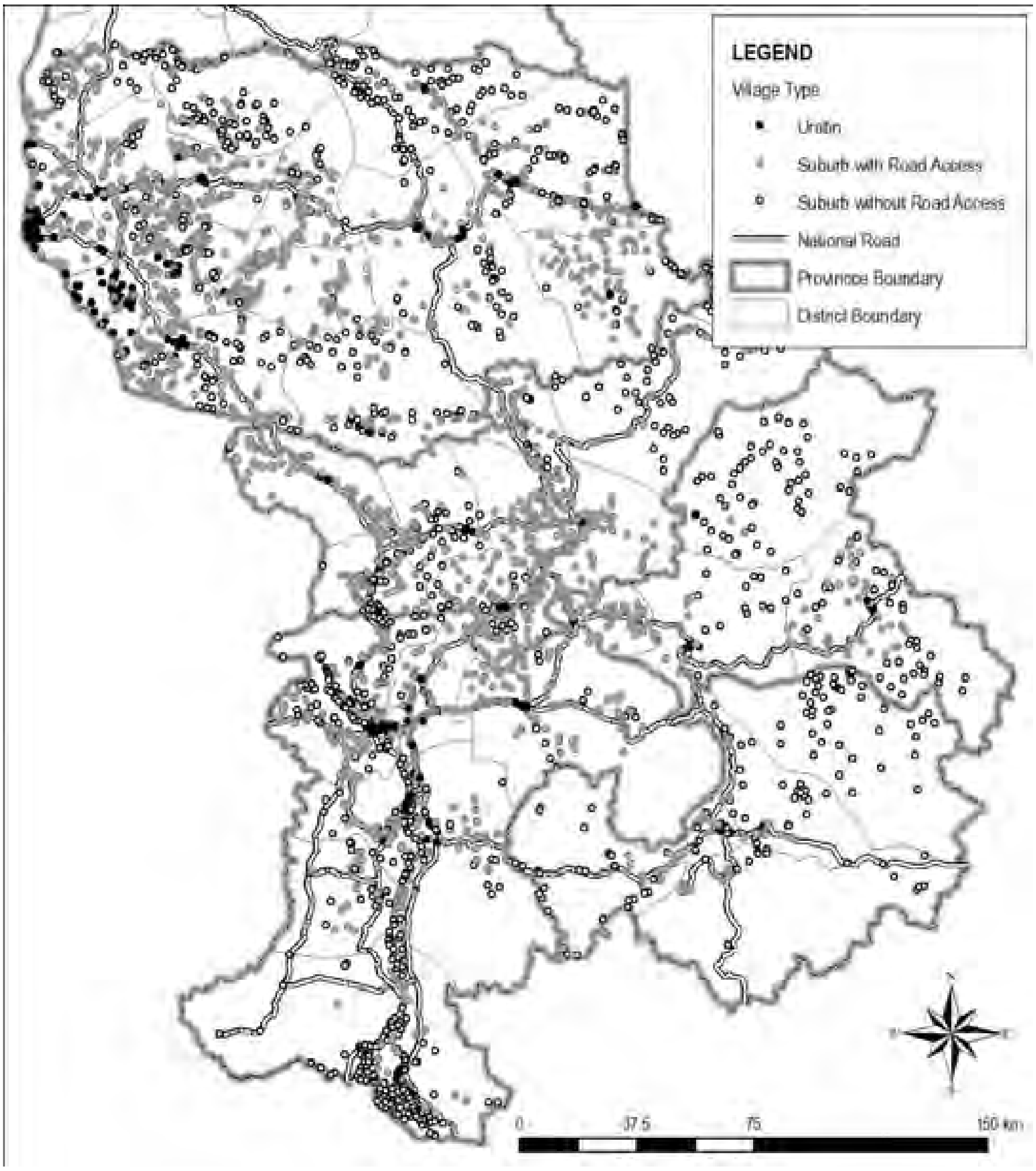
	Rate of Electrification (%)	Av distance to nearest road (km)	Accessibility in dry season (%)	Accessibility in rainy season (%)	Av distance to public transport (km)
Savannakhet	69	4	100	87	11
Saravane	50	18	100	76	11
Sekong	29	51	100	79	10
Champasak	67	10	100	85	9
Attapeu	33	18	100	92	11
Lao PDR	61	17	100	84	10
Urban	99	0	100	98	5
Rural with Road	53	5	100	80	11
Rural w/o Road	26	18	83	17	10

Source: LECS 4 Report

2.4.2 Poverty Household, Poverty Village and Poverty District

(1) Classification of Villages

Every village in Lao PDR is classified as either an Urban Village or a Rural Village. Since the Census 2005, Rural Village was broken down into Rural Village with Road and Rural Village without Road. As described in 2.1.1 (1), 5 criteria are used to classify an Urban Village. Figure 2.4.3 shows distribution of the 3 village types. Rural Village without Road is mostly distributed in the eastern part of Savannakhet and Saravane, and the whole area of Sekong Province and Attapeu Province.



Source: Census 2005

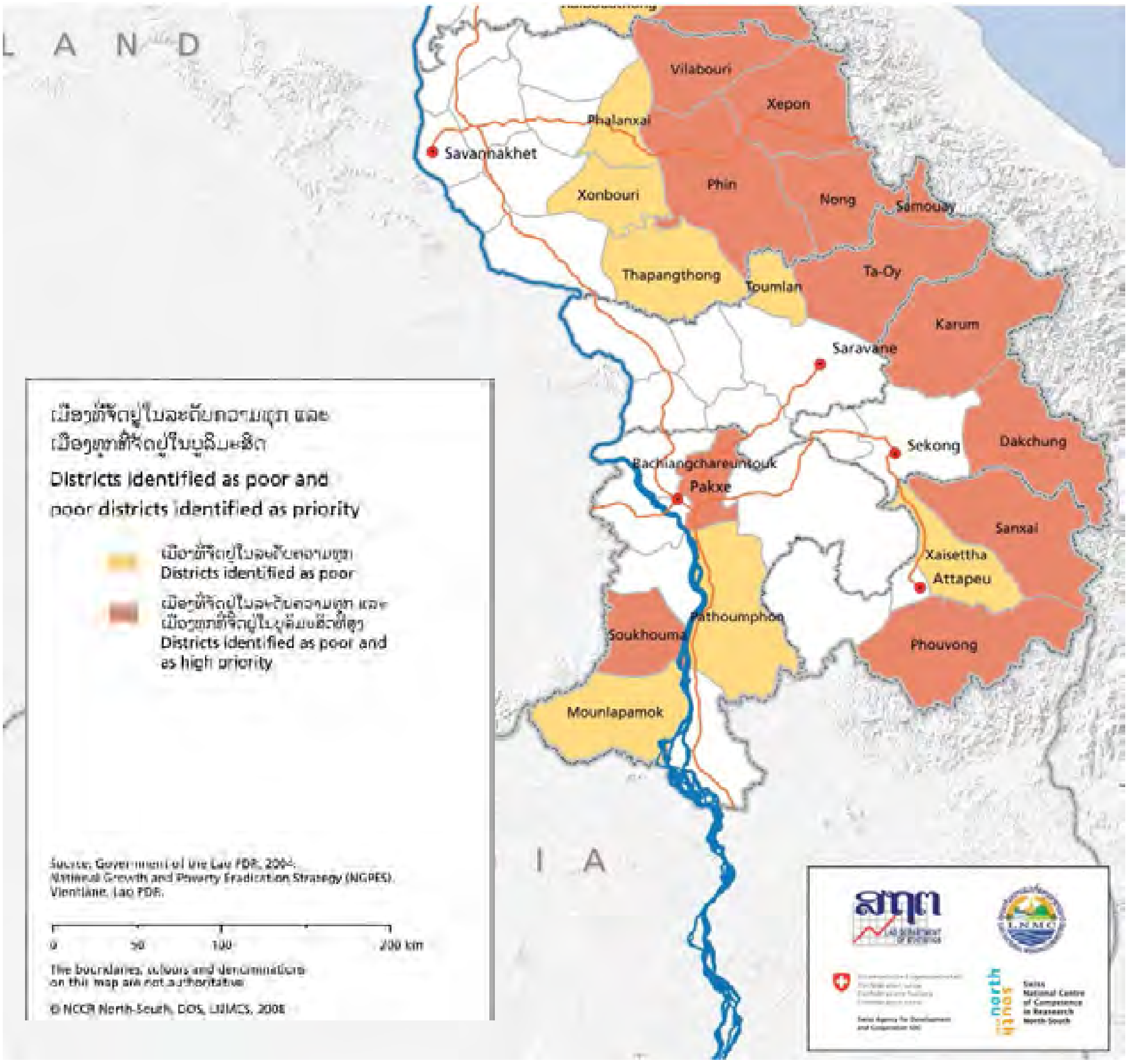
Figure 2.4.3 Classification of Villages

(2) Poor Household, Poor Village and Poor District

Poverty reduction is a pillar of the national vision aimed at accomplishing graduation from LDC by 2020 as well as economic development of Lao PDR. Therefore, the Lao PDR government has been making an effort to reduce poverty with the assistance of international partners.

Prime Minister Instruction No 010/PM defined poverty household, poverty village and poverty district by the following criteria: (1) more than 70% of district population cannot get 2,100 kcal food intakes per day; (b) accessibility to schools, healthcare centers, roads and safe water are also applied to define poor and poor with priority districts.

Figure 2.4.4 illustrates poor districts with priority in the study area. Out of the 141 districts throughout the country, 47 districts were identified as poor with priority and 32 districts as poor. 12 districts were identified as poor with priority and 7 districts as poor in the study area. Most poor with priority districts are located in the mountainous areas of the northern region and in the east side areas neighboring Vietnam in the central and southern regions.



Source: Socio-economic Atlas 2008, NCCR North-South, DoS, LNMCS

Figure 2.4.4 Poor Districts in the Study Area

Lao Government issued "Degree on The Standard of Poverty and Development in the period of 2011 to 2015" in October 2009. The degree set the following new poverty standard.

- Monthly income per person: Poverty is measured by monthly income per person. It is LAK192,000 in the whole country, LAK180,000 in the rural areas and LSK240,000 in the urban areas. If average monthly income of a household is lower than the specified level, then the household is identified as a poor household.
- A village which has the following conditions is identified as a poor village: more than 51% of the total households are poor; the village does not have a primary school and children have to travel one hour or more to the nearest primary school; the village does not have a medical bag or pharmacy, and villagers have to travel more than 2 hours to the nearest

healthcare center or hospital; the village does not have clean water; the village does not have road access or can access only during the dry season.

- If 51% of the total villages are identified as poor, a district is identified as a poor district.

This new criteria will be used in the future assessment of poverty. In addition to that, the government intends to change the strategy to address poverty reduction. Reduction of poor districts is a major target of the poverty reduction agenda by the government. The government will use the next 5-year plan to reduce the number of poor villages, according to an official from MPI. Therefore, activities for poverty reduction would be transferred from district level to the "Koumban (Village Cluster)," which is a group of some villages.

(3) Activity of Poverty Reduction Fund

Poverty Reduction Fund (PRF) was established by Prime Minister's Decree PM/073 on May 2002 in order to contribute to poverty eradication in Lao PDR. The PRF delivers development resources at village level, targeting the poorest districts in the country, and allocates the resources though participatory and decentralized decision-making process.

Kounban is a unit in the participatory project. Location and contents of projects are determined by the needs of people. The PRF prepares budgets for the projects as well as training programs for project implementation. Completed projects are transferred to departments such as DPWT, OPWT and DOE, and these departments operate and maintain the facilities.

Table 2.4.6 PRF Geographical Coverage in the Study Area

Province	Districts	Remarks
Savannakhet	Nong, Vilaboury, Sebanhiang,	From September 2003 (starting of the PRF) Withdrawal from Khong, Mounlapamok and Pathoumphone in September 2008
Champasak	Khong, Sukhouma, Mounlapamok, Pathoumphone	
Savannakhet	Phin	From September 2004
Saravane	Taoy, Toumlan, Samuay	From June 2005 Withdrawal from Toumlan in September 2008
Champasak	Bachieng	From September 2008

Source: Data from the Poverty Reduction Fund

2.4.3 Social Condition Survey

(1) Objectives and Scope of the Survey

In order to grasp current situation of the socio-economic conditions of provinces and districts in the study area, it is necessary collect socio-economic data and information. It is also important to collect information on accessibility of local inhabitants to social infrastructure and centers of economic activity such as markets so as to evaluate the impact of improvement road network. In this regards, a socio-economic survey to collect and analyze the data and information was carried out by a Lao consultant team.

The socio-economic survey consisted of the following two tasks:

- Profiling of districts: collecting and analyzing information on socio-economy and social development of districts in target provinces. Collected information was compiled into district profiles.
- Interviews in selected villages: collecting and analyzing data and information and conducting interviews about (1) situation of poverty; (2) access to elementary schools, district hospital, provincial capital, markets and workplaces; and (3) issues on road and transport. The collected information was compiled into profile of target villages.

By the time the JICA Study Team compiled the Interim Report, the profiling of districts had been conducted. After the selection of target routes, interviews with selected villages were carried out.

(2) Result of the Survey: Profile of Districts

Table 2.4.7 and Table 2.4.8 illustrate the socio-economic profiles of the districts. Data indicated in the profile was collected by the Regional Development Office (RDO) of each province and Census 2005 in each province.

Table 2.4.7 Profile of Districts in the Study Area (1/2)

Province Code	Province Name	District Code	District Name	Village			Population & Household			Public Health	Education
				No of Urban Village	No of Rural Village w/Road	No of Rural Village w/o Road	Male	Female	No of Household	Dispensary	Primary School
13	Savannakhet	01	Kaisonephomvihan	31	36	0	58860	60964	19229	14	67
13	Savannakhet	02	Outhoomphone	33	30	6	43536	42466	12706	7	69
13	Savannakhet	03	Atsaphangthong	5	34	0	20142	21474	6608	5	39
13	Savannakhet	04	**Phine**	12	55	35	26977	28125	8032	7	91
13	Savannakhet	05	**Sepone**	8	40	40	23204	23075	8400	11	82
13	Savannakhet	06	**Nong**	1	18	54	11514	11403	3714	5	67
13	Savannakhet	07	**Thapangthong**	2	26	14	16878	17292	5171	5	42
13	Savannakhet	08	Songkhone	12	69	14	44954	46006	15920	9	95
13	Savannakhet	09	Champhone	10	86	2	52722	56679	18422	13	102
13	Savannakhet	10	**Xonbuly**	1	60	2	26415	28293	7696	6	63
13	Savannakhet	11	Xaybuly	3	38	12	28558	29017	8797	12	53
13	Savannakhet	12	**Vilabuly**	1	47	19	16265	16648	5343	5	66
13	Savannakhet	13	Atsaphone	13	24	19	26396	27266	8271	6	56
13	Savannakhet	14	Xayphoothong	3	37	0	23830	24023	8796	6	40
13	Savannakhet	15	**Thaphalanxay**	6	36	12	16634	17369	5227	4	54
14	Saravane	01	Saravane	7	133	0	44507	46520	14894	10	130
14	Saravane	02	**Ta oi**	3	52	1	12039	11871	3638	7	52
14	Saravane	03	**Toomlarn**	1	36	0	11428	11748	2778	4	26
14	Saravane	04	Lakhonepheng	4	80	0	20686	21456	7841	6	68
14	Saravane	05	Vapy	2	56	0	17188	17519	5624	3	57
14	Saravane	06	Khongxedone	6	87	3	29246	30041	9565	4	82
14	Saravane	07	Laongarm	7	83	13	30341	31684	10656	3	88
14	Saravane	08	**Samuoi**	1	41	15	6307	6211	1819	8	35
15	Sekong	01	Lamarm	7	29	6	14319	14857	4374	6	42
15	Sekong	02	**Kaleum**	2	7	49	6924	7263	2319	2	52
15	Sekong	03	**Dakcheung**	6	45	33	9380	9957	3514	7	82
15	Sekong	04	Thateng	3	52	0	15827	16722	4993	6	55
16	Champasack	01	Pakse	34	8	0	37047	40284	12800	3	42
16	Champasack	02	Sanasomboon	11	19	14	32111	35090	12261	6	44
16	Champasack	03	**Bachiangchaleunsook**	7	37	1	23978	24698	8894	5	45
16	Champasack	04	Paksxong	4	82	2	32380	32364	11498	7	82
16	Champasack	05	**Pathoomphone**	11	57	0	27062	28166	9313	6	68
16	Champasack	06	Phonthong	12	45	14	44580	44559	15937	9	67
16	Champasack	07	Champasack	9	54	12	27906	29984	9634	3	65
16	Champasack	08	**Sukhuma**	2	14	40	26338	26761	9033	6	56
16	Champasack	09	**Moonlapamok**	1	7	28	16074	17037	5532	6	36
16	Champasack	10	Khong	4	60	50	41142	43307	14361	12	109
17	Attapeu	01	**Xaysetha**	4	11	7	12559	19324	5768	5	22
17	Attapeu	02	Samakkhixay	12	16	0	16373	16102	6061	4	29
17	Attapeu	03	Sanamxay	1	40	0	14345	15058	5835	8	41
17	Attapeu	04	**Sanxay**	4	26	15	9389	9434	3077	3	14
17	Attapeu	05	**Phouvong**	1	11	3	5568	5684	1988	6	15

Note: Name of district with bold font indicates "district identified as poor", and name of district with bold font and dark cell indicates "district identified as poor and high priority"

Source: Data from Regional Development Office (RDO) of each province, Census 2005 report of each province

Table 2.4.8 Profile of Districts in the Study Area (2/2)

Province Code	Province Name	District Code	District Name	School attendance: Percent of Population School attendance	School attendance: Percent of Female School attendance>6yrs	Census 2005: No of Children born during the last 12 months	Census 2005: Infant Mortality Rate	Calculation by JICA Study Team: Dispensary per 1000 population	Calculation by JICA Study Team: Primary School per 1000 population	Calculation by JICA Study Team: Dispensary per village	Calculation by JICA Study Team: Primary School per village
13	Savannakhet	01	Kaisonephomvihan	32.7	30.4	1,608	107.7	0.12	0.56	0.21	1.00
13	Savannakhet	02	Outhoomphone	25	23.0	1,496	100.2	0.08	0.80	0.10	1.00
13	Savannakhet	03	Atsaphangthong	26	23.3	1,099	73.6	0.12	0.94	0.13	1.00
13	Savannakhet	04	**Phine**	16.1	13.5	1,630	109.2	0.13	1.65	0.07	0.89
13	Savannakhet	05	**Sepone**	13.5	11.3	917	61.4	0.24	1.77	0.13	0.93
13	Savannakhet	06	**Nong**	12.1	7.8	550	36.9	0.22	2.92	0.07	0.92
13	Savannakhet	07	**Thapangthong**	21.8	18.9	811	54.3	0.15	1.23	0.12	1.00
13	Savannakhet	08	Songkhone	26.9	25.0	1,401	93.9	0.10	1.04	0.09	1.00
13	Savannakhet	09	Champhone	28.9	27.0	1,504	100.8	0.12	0.93	0.13	1.04
13	Savannakhet	10	**Xonbuly**	23.8	20.9	915	61.3	0.11	1.15	0.10	1.00
13	Savannakhet	11	Xaybuly	28.1	26.5	871	58.4	0.21	0.92	0.23	1.00
13	Savannakhet	12	**Vilabuly**	19.5	16.2	803	53.8	0.15	2.01	0.07	0.99
13	Savannakhet	13	Atsaphone	26	23.1	1,128	75.6	0.11	1.04	0.11	1.00
13	Savannakhet	14	Xayphoothong	26.8	25.0	656	44.0	0.13	0.84	0.15	1.00
13	Savannakhet	15	**Thaphalanxay**	22	18.9	943	63.2	0.12	1.59	0.07	1.00
14	Saravane	01	Saravane	26.6	23.5	2,044	210.5	0.11	1.43	0.07	0.93
14	Saravane	02	**Ta oi**	11.3	7.4	1,060	109.2	0.29	2.17	0.13	0.93
14	Saravane	03	**Toomlarn**	14.1	6.3	883	90.9	0.17	1.12	0.11	0.70
14	Saravane	04	Lakhonepheng	24.8	21.8	749	77.1	0.14	1.61	0.07	0.81
14	Saravane	05	Vapy	31.4	28.5	772	79.5	0.09	1.64	0.05	0.98
14	Saravane	06	Khongxedone	27.2	23.4	1,028	105.9	0.07	1.38	0.04	0.85
14	Saravane	07	Laongarm	23.7	21.5	1,856	191.2	0.05	1.42	0.03	0.85
14	Saravane	08	**Samuoi**	16	12.2	476	49.0	0.64	2.80	0.14	0.61
15	Sekong	01	Lamarn	31.6	28.8	641	82.7	0.21	1.44	0.14	1.00
15	Sekong	02	**Kaleum**	13.9	11.2	451	58.2	0.14	3.67	0.03	0.90
15	Sekong	03	**Dakcheung**	22.1	20.5	767	98.9	0.36	4.24	0.08	0.98
15	Sekong	04	Thateng	25.2	22.6	932	120.2	0.18	1.69	0.11	1.00
16	Champasack	01	Pakse	35.1	32.0	853	57.6	0.04	0.54	0.07	1.00
16	Champasack	02	Sanasomboon	27.1	23.5	935	63.1	0.09	0.65	0.14	1.00
16	Champasack	03	**Bachiangchaleunsook**	27.6	26.0	959	64.7	0.10	0.92	0.11	1.00
16	Champasack	04	Paksxong	29.7	27.2	1,734	117.0	0.11	1.27	0.08	0.93
16	Champasack	05	**Pathoomphone**	27	24.6	1,058	71.4	0.11	1.23	0.09	1.00
16	Champasack	06	Phonthong	26.7	23.5	1,472	99.4	0.10	0.75	0.13	0.94
16	Champasack	07	Champasack	25.4	22.6	1,060	71.6	0.05	1.12	0.04	0.87
16	Champasack	08	**Sukhuma**	22.5	19.6	1,190	80.3	0.11	1.05	0.11	1.00
16	Champasack	09	**Moonlapamok**	25.2	22.8	1,139	76.9	0.18	1.09	0.17	1.00
16	Champasack	10	Khong	26.9	24.5	1,917	129.4	0.14	1.29	0.11	0.96
17	Attapeu	01	**Xaysetha**	25.2	21.5	615	63.7	0.16	0.69	0.23	1.00
17	Attapeu	02	Samakkhixay	32.3	29.5	664	68.7	0.12	0.89	0.14	1.04
17	Attapeu	03	Sanamxay	27.2	25.4	1,016	105.2	0.27	1.39	0.20	1.00
17	Attapeu	04	**Sanxay**	20.6	18.1	445	46.1	0.16	0.74	0.07	0.31
17	Attapeu	05	**Phouvong**	19.4	16.5	403	41.7	0.53	1.34	0.40	1.00

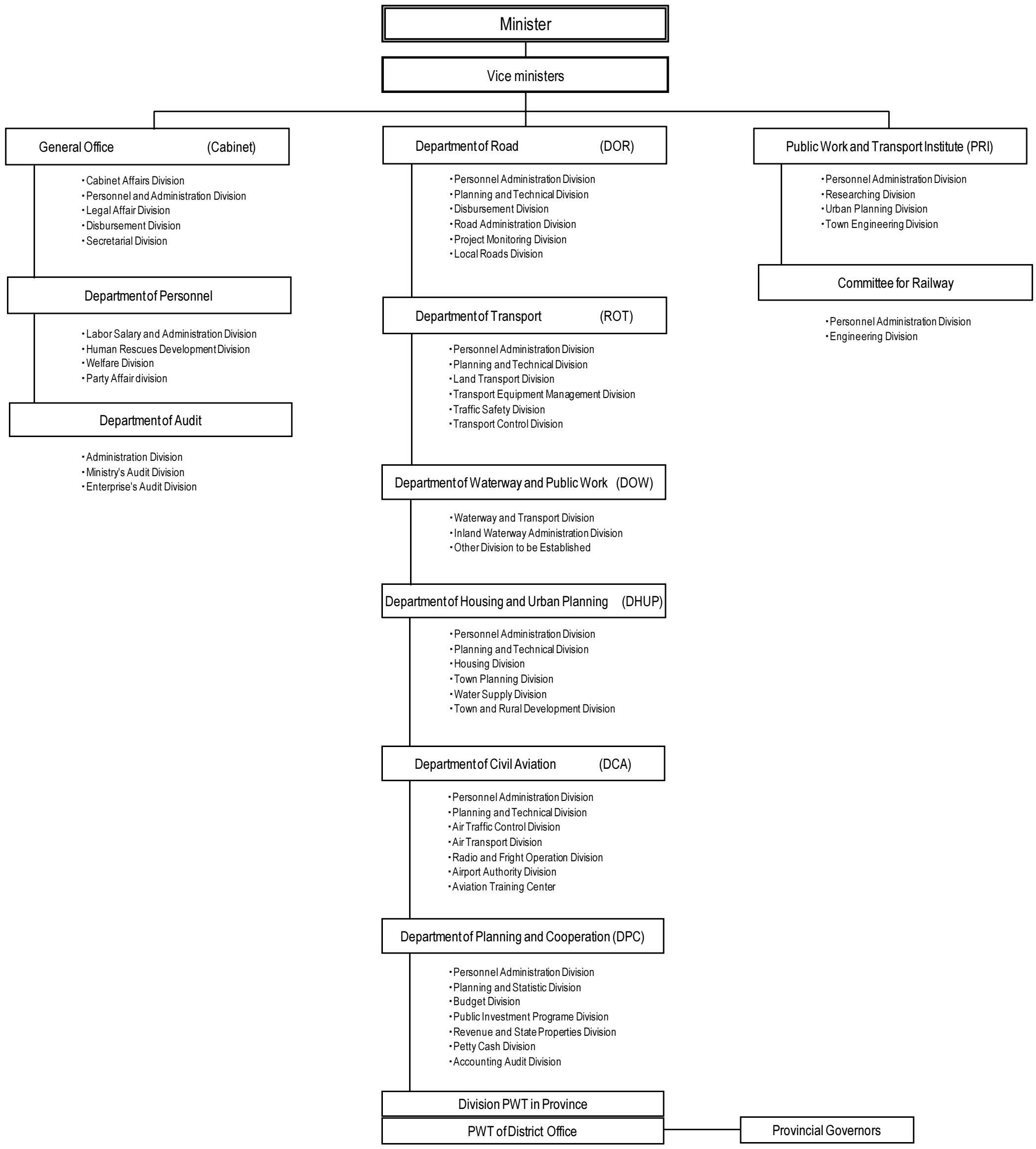
Note: Name of district with bold font indicates "district identified as poor", and name of district with bold font and dark cell indicates "district identified as poor and high priority"

Source: Data from Regional Development Office (RDO) of each province, Census 2005 report of each province

2.5 Capacity for Road Development and Maintenance

2.5.1 Organizational Capacity

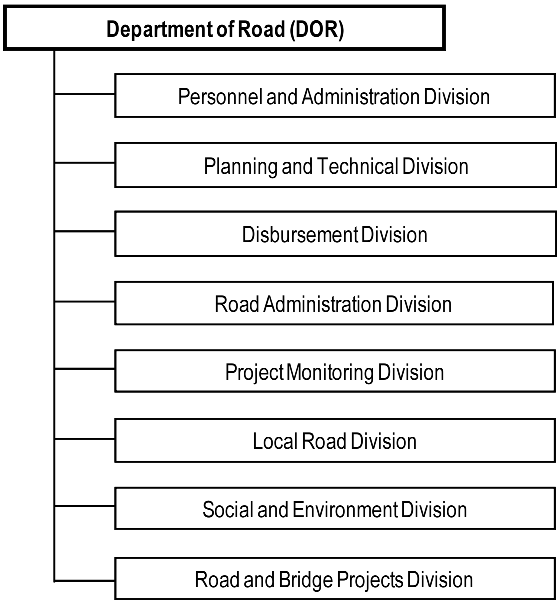
The Ministry of Public Works and Transport (MPWT) is an implementation organization for development and maintenance of roads, public transport, civil aviation, railway and housing in Lao PDR. 6 core departments in the ministry are responsible for transport management: Department of Road, Transport, Waterway and Public Works, Housing and Urban Planning, Civil Aviation, Planning and Cooperation. Within these six departments, road development, improvement, operation and maintenance are done by the Department of Road (DOR) and provincial Department of Public Works and Transport (DPWT). Road management data is managed by the Public Works and Transport Institute (PTI). The overall organization chart of the MPWT is shown as below.



Source: Prepared by JICA Study Team

Figure 2.5.1 Organization Chart of MPWT

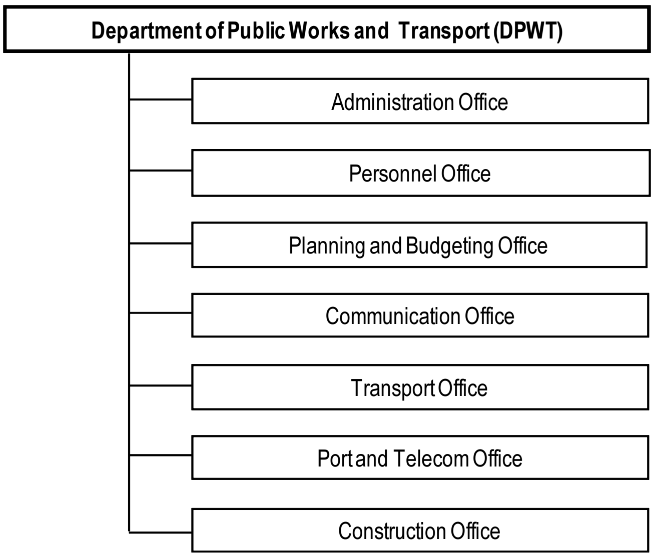
The DOR is composed of eight divisions: Personnel and Administration Division, Planning and Technical Division, Disbursement Division, Road Administration Division, Project Monitoring Division, Local Road Division, Social and Environment Division and Road and Bridge Projects Division. Each division instructs the DPWT to carry out the road construction, operation and maintenance works.



Source: Prepared by JICA Study Team

Figure 2.5.2 Organization Chart of DOR

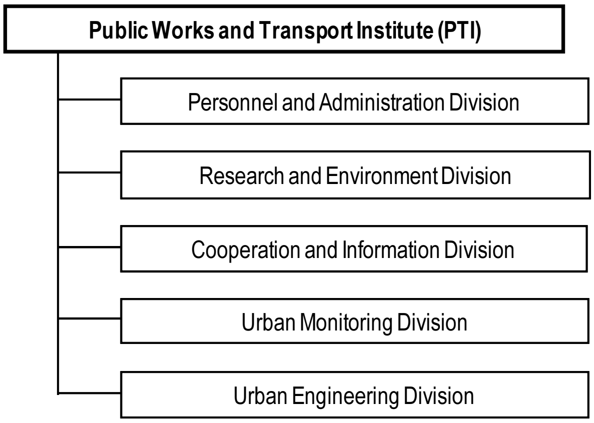
The actual road construction/maintenance works are implemented by the DPWT in each province. The DPWT is composed of seven divisions: the construction office is mainly responsible for road maintenance works. The staff consists of around 50 personnel, of whom 10 are in charge of road construction and maintenance.



Source: Prepared by JICA Study Team

Figure 2.5.3 Organization Chart of DPWT

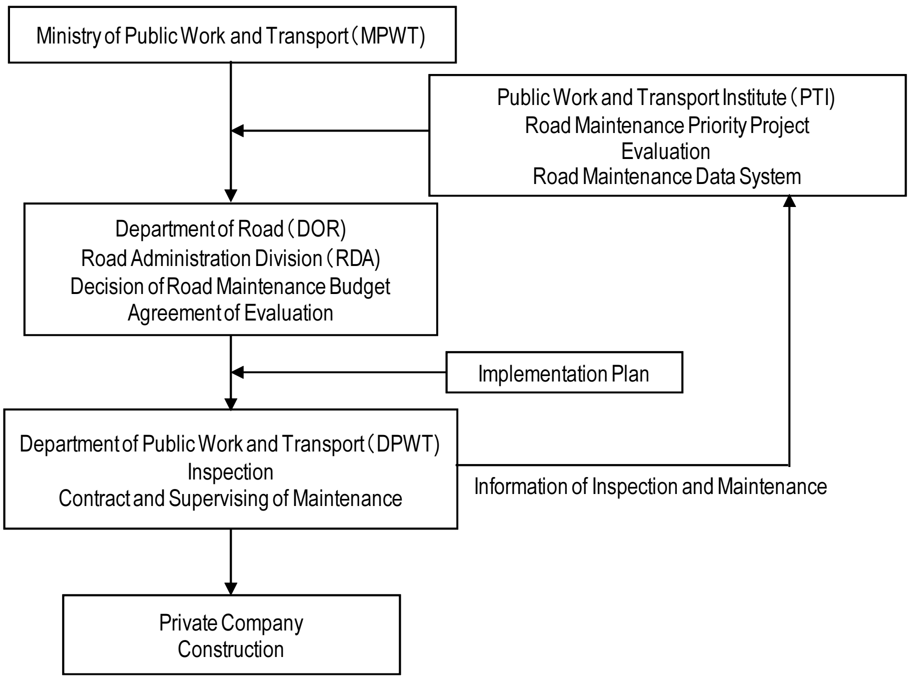
The PTI is composed of 5 divisions as shown in the figure 2.5.4. Road inventory and other relevant data are managed by the PTI.



Source: Prepared by JICA Study Team

Figure 2.5.4 Organization Chart of PTI

The implementation scheme of road maintenance in Lao PDR is described in Figure 2.5.5. The PTI, which the World Bank has long supported to build a road maintenance system, assesses priority projects using the road maintenance system and reports them to the DOR. The DOR, together with the Department of Planning and Cooperation, plans a year-round road maintenance programme and allocates the road maintenance fund to the DPWT, based on the PTI's assessment result. The DPWT carries out the physical maintenance works by contracting it out to private contractors. When the road maintenance is completed, the DPWT inspects and reports the condition of roads to the PTI and DOR.



Source: Prepared by JICA Study Team

Figure 2.5.5 Implementation Scheme of Road Maintenance

The role of each authority in road management is summarized in the table below.

Table 2.5.1 Role of Each Line Agency in Road Management

Line Agencies	Main Responsibilities
Ministry of Public Works and Transport (MPWT)	Decides budget distributions between road assets for national roads.
Governor	Decides budget distributions between road assets for local roads.
Ministry of Planning and Investment (MPI)	Consolidates budget requests from MPWT and the provinces and makes recommendations for allocations for approval by the Prime Minister and the National Assembly.
Public Works and Transport Institute (PTI)	- Responsible for all tasks related to the RMS. - Procures and monitors data collection for national roads and bridges, including quality assurance of data. - Checks and validates surveyed data for local roads and bridges. - Consolidates all road and bridge information in a central database (RMS). - Performs strategic expenditure analysis for alternative budget scenarios and analyses the road network performance under the budget constraints (using RMS). - Performs multi-year maintenance programmes analyses (3 years) for all road classes and submits the results (longlists) to the operational units (using RMS). - Preparation of an Annual Asset Report.
Technical and Environment Division (TED)	- Undertakes medium term and long term planning for road construction and maintenance. - Participates in the strategic expenditure analysis performed by PTI. - Reviews annual maintenance programmes for social and environmental issues. - Reviews road and bridge construction programmes for social and environmental issues.
Road Administration Division (RAD)	- Participates in the strategic expenditure analysis and multi-year programming performed by PTI including determination of MCA-criteria and weighting. - Prepares annual maintenance works programme for national roads and bridges based on input from RMS and the provinces. - Oversees and supervises the detailed design of maintenance works on national roads and reviews the feasibility of the proposed works (using HDM). This includes the request for specialised equipment based surveys from local consultants. - Oversees and supervises works contract procurement and implementation on national roads.
Local Roads Division (LRD)	- Initiates and monitors data collection for local roads and bridges. - Assists PTI with validation of data for local roads and bridges. - Facilitates the operation and use of the PRoMMS in the provinces. This includes consolidation of requests for PRoMMS system adjustments and upgrades. - For the strategic expenditure analysis, determines together with RDA MCA-criteria and weighting. - Reviews annual works programmes for local roads based on input from the provinces and RMS. - Monitors road and bridge works implementation on local roads.
Department of Public Works and Transport (DPWT)	- Collection of road and bridge inventory and condition data for local roads. - Recommends to RAD sections of the national road network to be maintained. - Analyses maintenance needs and prepares an annual maintenance works programmes for local roads and bridges (using PRoMMS). - Undertakes detailed project level surveys of road sections included in the annual work programme for national roads. This will include condition surveys, detailed design of the maintenance works. - Procures and implement s road and bridge maintenance works for national roads. - Procures and implements road and bridge maintenance works for local roads and bridges. - Prepares programmes for road upgrade and bridge replacement for local roads.

Line Agencies	Main Responsibilities
Road Maintenance Fund (RMF)	- Provides budgets for data collection on national roads. - Consolidates funds from development partners for national roads. - Analyses budget projections for medium and short term programming and medium term planning. - Provides budgets for annual maintenance works. - Approves and monitors annual maintenance works programmes.
Development Partners (DP)	- Provides budgets for road and bridge maintenance and construction. - Provides advice and 'no-objections' to construction and maintenance works programmes.
Urban Development Administration Authority	- Collection of road and bridge data for urban roads. - Update of the PRoMMS database and submission of data to PTI. - Preparation of annual works programmes for urban roads. - Implementation of maintenance works programmes for urban roads.

Source: Prepared by JICA Study Team

2.5.2 Financial Capacity

(1) Budget for Road Development and Maintenance

As seen in the recent years, the annual budgets of the MPWT are heavily channeled to the Department of Road mainly for development and maintenance of national roads. Another feature is that the national budget for road development and maintenance is very limited and the implementation of actual works is heavily dependent on foreign assistance.

Table 2.5.2 Annual Budget and Expenditure for Road Development and Maintenance

(million Kip)

Year	Road Budget			MPWT Budget in Total		
	National Budget	Foreign Assistance	Total	National Budget	Foreign Assistance	Total
2005/06	109,253	521,102	630,355	124,928	657,522	782,481
2006/07	147,172	496,450	643,622	173,397	605,799	779,196
2007/08	177,947	539,000	716,947	205,097	696,995	902,092
2008/09	292,159	350,132	642,291	307,696	457,331	765,027
2009/10	200,444	464,745	665,189	220,530	595,885	816,415

Source: MPWT

(2) Road Maintenance Fund

The RMF (Road Maintenance Fund) was established for road maintenance in 2001 with the support of the World Bank and other donors. It was officially introduced by decree (Decree No. 09/PM15/01/2001). The allocation of the RMF is restricted solely to road maintenance and its administration works. The RMF budget was heavily funded by external agencies such as the World Bank and SIDA. By 2007, the budget was fully covered by tax and fees, including fuel tax (300 Kip per litre for gasoline and diesel), toll fee (one toll gate is placed in each province and 5,000 Kip is charged for each passenger car), and penalty charge for overloading of trucks.

The amount and proportion of revenue toward the RMF is summarized in Table 2.5.3. The revenue of the RMF has been considerably increasing since the RMF was introduced and reached 176 billion Kip in the year 2008. In the same year, 87% of the revenue was collected from fuel tax, 12% from toll fees and 1% from overloading fines. The Lao Government taxes a levy on fuel for 300Kip per litre, which is equivalent to 5% of the fuel price. The government is currently considering introducing a higher fuel tax rate.

Table 2.5.3 Revenue for Road Maintenance Fund

(Unit: billion Kip)

Year	Fuel Tax			Toll Fee		Over Loading Fine		Other Donation		Total
	Kip/l	Revenue	%	Revenue	%	Revenue	%	Revenue	%	
2001	40	7.783	49.5	1.027	6.5	0.410	2.6	6.516	41.4	15.736
2002	40	13.820	52.4	8.927	33.8	2.476	9.4	1.171	4.4	26.397
2003	60	20.669	56.0	13.599	36.9	2.513	6.8	0.111	0.3	36.892
2004	100	35.319	64.8	15.947	29.2	3.266	6.0	0.006	0.0	54.538
2005	150	61.001	75.3	16.885	20.8	3.137	3.9	0.001	0.0	81.024
2006	200	92.125	80.5	20.262	17.7	2.050	1.8	0.008	0.0	114.445
2007	250	123.097	83.4	21.943	14.9	2.520	1.7	0.000	0.0	147.542
2008	300	151.000	85.8	23.087	13.1	1.971	1.1	0.000	0.0	176.058

Source: RMF

As the figure below shows, the road maintenance works were once heavily dependent on external assistance from the World Bank and SIDA. Currently, the RMF covers over 90% of the budget for road maintenance, which is accomplished from domestic financial sources.

Table 2.5.4 Budget for Road Maintenance

(Unit: billion Kip)

Year	RMF		WB (Loan)		SIDA (Grant)		Total
	Revenue	%	Revenue	%	Revenue	%	
2001	15.736	29.4	37.815	70.6	0.0		53.551
2002	26.397	18.2	118.996	81.8	0.0		145.393
2003	36.892	46.4	42.600	53.6	0.0		79.492
2004	54.538	48.1	58.831	51.9	0.0		113.369
2005	81.024	56.2	49.893	34.6	13.312	9.2	144.229
2006	114.445	77.7	18.667	12.7	14.130	9.6	147.242
2007	147.542	91.0	1.876	1.2	12.582	7.8	162.000
2008	176.058	90.2	0.300	0.2	18.836	9.6	195.194

Source: RMF

2.5.3 Legal Framework

In general, road definition, development procedure, maintenance, burden of expenditure and penalty are all defined by the Road Law. In Lao PDR, the current Road Law was enacted on the 26th April, 1999. It stipulates regulations and guidelines on road planning, design, construction, maintenance and appropriate conservation of right of way.

(1) Design Criteria and Standard

The geometric design standard for roads was introduced by the MPWT (the former MCPTC) in 1993 and was revised and updated into the Road Design Manual (RDM) in 1996. It still exists to date; however, it remains in provisional status and under revision by the MPWT. The geometric standard for roads specified in the RDM is shown in the table below.

Table 2.5.5 Geometric Standards for Roads

1	**Road Design Class**	I			II			III			IV			V			VI			VII		
2	**Traffic Volume (Veh./day)**	>8000			3000 - 8000			1000 - 3000			300 - 1000			100 - 300			50 - 100			<50		
3	**Terrain**	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
4	**Design Speed (Km/hr)**	100	80	60	100	80	60	80	60	40	80	60	40	60	40	20	60	40	20	40	30	20
5	**Formation Width (m)**	32.0	32.0	20.0	21.5	21.5	11.0	12.0	12.0	8.0	9.0	9.0	7.0	7.0	7.0	6.5	6.5	6.5	6.0	6.0	6.0	5.5
	Number of Lanes	4			2			2			2			2			1			1		
	Lane Width (m)	3.75	3.75	3.5	3.75	3.75	3.5	3.5	3.5	3.0	3.0	3.0	3.0	2.75	2.75	2.50	3.5			3.5		
	Carriageway Width (m)	15.0	15.0	14.0	7.5	7.5	7.0	7.0	7.0	6.0	6.0			5.5			3.5			3.5		
	Midiam (m)	3.0		2.0	-			-			-			-			-			-		
	Paved Shoulder (m)	0.5	0.5	2.0	0.5	0.5	2.0	2.0	2.0	1.0	1.0	1.0	0.5	0.75	0.75	0.5	-	-	-	-		
	Unpaved Shoulder (m)	0.5	0.5	-	0.5	0.5	-	0.5	0.5	-	0.5	0.5	-	-			1.5	1.5	1.3	1.25	1.25	1.0
6	**Max. Gradient (%)**	5	6	7	5	6	7	6	7	8	6	7	8	7	8	10	7	8	10	8	9	10
7	**Min. Horizontal Curve (m)**	400	250	130	400	250	130	250	130	60	250	130	60	130	60	20	130	60	20	60	30	20
8	**Min. Vertical Curve**																					
	Crest (m)	10000	5000	2500	10000	5000	2500	5000	2500	1000	5000	2500	1000	2500	1000	500	2500	1000	500	1000	500	500
	Sug (m)	3000	2000	1500	3000	2000	1500	2000	1500	600	2000	1500	600	1500	600	200	1500	600	200	600	400	200
9	**Superelevation (%)**	3 - 10																				
10	**Crossfall**																					
	Paved (%)	2 - 3																				
	Unpaved (%)	3 - 4																				
	Paved Shoulder (%)	>3																				
	Unpaved Shoulder (%)	>4																				
11	**Road Reserve (m)**	60						40						30						20		

Source: 1996 Road Design Manual

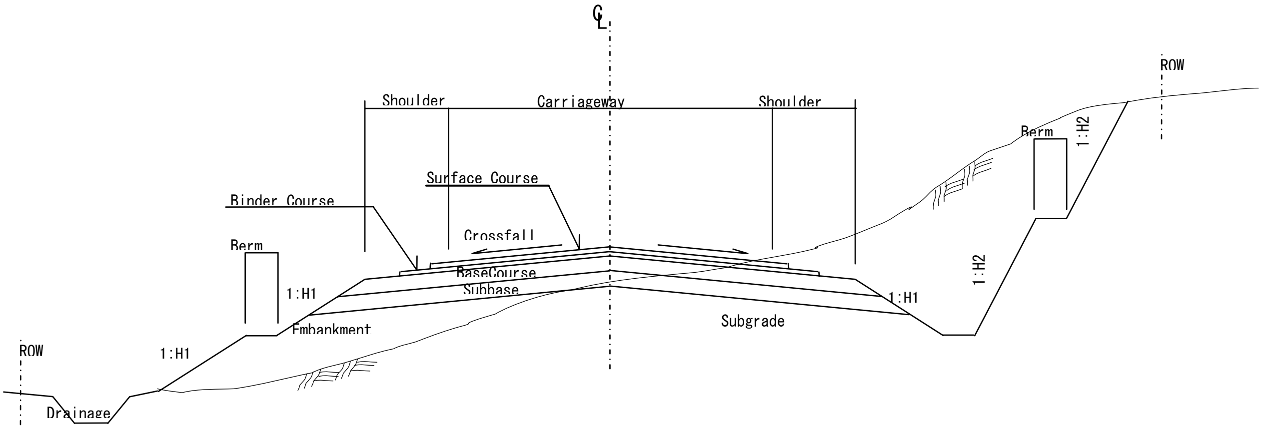
On the other hand, the various road projects undertaken in Laos adopted the modified geometric standard taking into account the traffic volume and terrain conditions of the project road. It seems the flexibility of the manual, which sets only minimum design standards, allows the designer to modify the standards according to the conditions on each respective proposed road.

(2) Pavement Design

The RDM describes two types of pavement design methods; one for heavy traffic roads and the other for low traffic roads. It also describes gravel surfacing design. For the pavement design of heavy traffic roads, the manual recommends the application of the Road Note 31 issued by the TRRL in the UK. However, previous studies on road projects examined several pavement design methods applied in other countries such as the US, Australia, and determined the appropriate pavement structure.

(3) Typical Cross Section

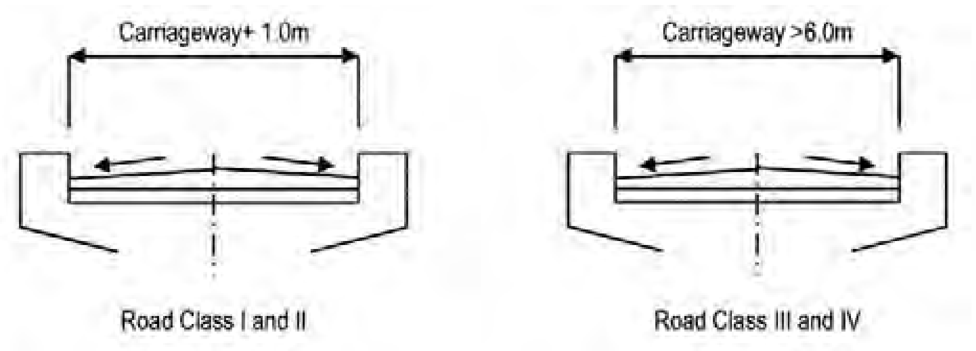
Based on the geometric design standard, a typical cross section of the national road is shown in Figure 2.5.6.



Source: JICA Study Team

Figure 2.5.6 Typical Cross Section of National Road

The RDMI recommends the minimum bridge widths, curb face to curb face width, for each road class. Whereas 6.0 m in width is applied for dual lane roads for the road classes IV and V and mountainous region for the road class III, an additional 1.0 m to the carriageway width is recommended for the road classes I and II.



Source: JICA Study Team

Figure 2.5.7 Typical Cross Section of National Road

(4) Bridge Design Standard

There is no specific design standard for the bridges in Laos. The RDM only designates the live load for bridge design, using AASHTO HS-25-44 for the road classes I to IV; and HS-20-44 for the road classes V to VII. The ADB and other donor projects have mainly adopted AASHTO Standards and Specifications for Highway Bridges.

(5) Standard Design Drawing

The standard design drawings for pre-stressed concrete (PC) girder bridges were produced by

SMCE (Australian consultant). These standard type bridges have been utilized in many projects. However, since there are no appropriate regulations and guidelines for control of the structure in the river such as Ordinance of Facility and Structure in River in Japan, planning and designing of the bridge by local consultants is not practicable. For instance, the standard drawing for PC girder allows for maximum span length up to 33m yet the Lao engineers adopt this standard drawing for all rivers, regardless of the discharge volumes of water. Planning and designing of the bridge must be appropriately conducted taking into account river flow and navigation conditions. The technical section of the MPWT shall be responsible to control the pre-design condition even when utilizing standard design drawings of PC bridges.

2.5.4 Local Capacity

(1) Local Capacity for Civil Works

Local contractors in Laos can be categorised into two different types of companies; state-owned company and private company. In terms of capacity, local contractors are relatively deficient compared to international contractors. Limited opportunities to participate in large-scale and complicated construction projects as well as the low level of competition in domestic market all contribute to the limited capacity of the local contractors. In recent years, these local contractors have steadily improved their capacity as a result of increase in opportunities of working with other international contractors on the donor-funded projects. For instance, certain local contractors have acquired adequate capacity in the construction of roads while others have gained practical experience in building medium-scale pre-stressed concrete bridges up to 100m in length. However, international contractors are still relied upon for bridge lengths exceeding 150m i.e. large scale bridges such as PC box Girder Bridges.

(2) Local Capacity for Maintenance Works

The DPWT, in each province, is the entity responsible for maintaining both national and provincial roads under its jurisdiction. The maintenance works are normally entrusted with the local contractors selected by competitive bidding process and awarded a performance based contract by road section for the duration of two years. The DPWT is the client, the supervisor and the administrator to control the contract and the quality of works on site. From the interviews with the DPWTs in the southern region, they face several issues with the contract based maintenance. A major issue is the contractor’s failure to satisfy their requirements. Particularly, the response to minor maintenance works such as sealing the cracks and patching potholes are not carried out timely at the DPWT’s request. Sometimes, the response to the request to repair the minor damages is delayed to such an extent that the severity of the damage increases significantly. In light of the above issue, some DPWTs propose having their own maintenance units to conduct these minor repair works. However, it should be noted that the site visits revealed that maintenance works were relatively well undertaken. The quality of works varied depending on the contractor’s ability and capacity. Accordingly, the capacity development of local contractors is still required so as to ensure road maintenance work is undertaken at a sufficient quality level.

(3) Local Capacity for Design Works

1) Capacity of Local Consultant

For the projects implemented under the local budgets by the MPWT, the engineering design and supervision of works have normally been contracted out to local consultants. For the supervision of works, the local consultants have commendable technical capacity since they are well experienced in various projects implemented by international donors. On the other hand, as regards design capacity, only less than 5 of the major local consultants are able to design and produce the drawings for road projects. Besides, some of them have capacity in the design of small scaled bridges such as box culverts and RC/PC simple girder bridges using standard drawings with maximum span of 33m. However, international consultants are usually relied upon for the design of bridges of more than 150m length, where PC box girders or steel girders bridges are normally introduced. The bridge planning and structural analysis of large scale bridges is so complicated that a high minimum level of technical skill and ability is required in order to utilize the software for design calculations. In this respect, the local consultants cannot solely complete the design for large scale bridges.

2) Construction Materials

The availability of construction materials particularly for road and bridge works is summarized in Table 2.5.6. In recent years, the rapid growth of the country's economy has promoted the domestic construction market as well. The procurement of construction materials has become much easier over the recent decades. For instance, several concrete plants have been built around Savannakhet and Pakse. These plants produce not only ready-mixed concrete but also precast products such as hume pipes, gullies and blocks. These factories can deliver standardized products that meet standards of international quality control.

Table 2.5.6 Availability of Construction Materials

Items	Domestic	Foreign	Remarks
Borrow	✓		lateritic soil
Sand	✓		river sand
Aggregate, Crusher-run	✓		lime stone
Stones	✓		sand/ mad stone, lime stone
Asphalt emulsion		✓	Thailand/ Vietnam
Cement	✓		Thakek/ Savannakhet/ Pakse
Reinforcement	✓	✓	Local products less than diameter 25mm
PC cable/anchor		✓	Japan,/Thailand/Malaysia/Indonesia, etc
Hume RC pipe	✓		
Gabion		✓	Malaysia/Indonesia, etc

Source: JICA Study Team

3) Equipment and Machinery

Local lease companies for construction machinery and equipment are currently not available in Laos (NB: there was an agent from a Thai lease company at time of study). The machinery and equipment are mostly owned by local contractors and were either individually imported or acquired as second-hand machinery from international contractors who had brought it into Laos PDR. The internationally financed projects normally require the procurement of machinery and equipment from other countries. Local contractors acquire such machinery and equipment and then use it on their road construction and maintenance works. Despite the fact that major equipment for road construction and maintenance such as excavators, bulldozers and rollers are owned by major local contractors, this equipment is outdated and deteriorated and does not meet the quality requirement for current construction works. In addition, the equipment and machinery for bridge construction is difficult to procure locally, especially in the case of large span PC or steel bridge projects.

4) Unit Costs of Road Construction and Maintenance

The MPWT introduced the standard unit costs for road construction and maintenance. The unit costs are quoted from the price comparative analysis of various road projects conducted by local government and international donors. The MPWT uses the unit costs mainly for the purpose of determining the ceiling price for local competitive bids on projects. However, it should be noted that the DPWTs have their own unit costs for road maintenance since road maintenance works are currently undertaken by local contractors.