PART IV

URBAN TRANSPORT MASTER PLAN

CHAPTER 15

TRANSPORT DEMAND FORECAST

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15.1 APPROACH

(1) Four Steps Approach

Consideration of the urban area throughout Vientiane is necessary as a base to precisely determine transport investment decisions regarding comprehensive and continuing transportation planning process. A significant element of the transportation planning process involves projecting future transportation demand. The most accepted method of projecting future transportation demand, and for evaluating investment strategies to serve the projected demand, is the use of travel demand and forecasting models. In this case, the models have utilized socio economic data that was presented in Chapter 14 to estimate travel demand coupled with a simulation of the transportation system to represent transportation supply. Together, the socio economic data, the simulated network, and mathematical travel models simulate the ability of the transportation system to serve the estimated demand.

Travel models have been implemented using a wide variety of model structures, computer software systems, and data requirements. The procedure applied to forecast transportation demand is based on the conventional four step model.

- Trip Generation - the prediction of trips produced and attracted to each zone;
- Trip Distribution - the prediction of origin-destination flows, the linking of trip ends predicted by trip generation;
- Modal Split - the estimation of percentages of trip flows made by each transportation mode in the model; and
- Traffic Assignment - the allocation of trips to routes in the transportation network.

The four stages represent a sequential decision structure.

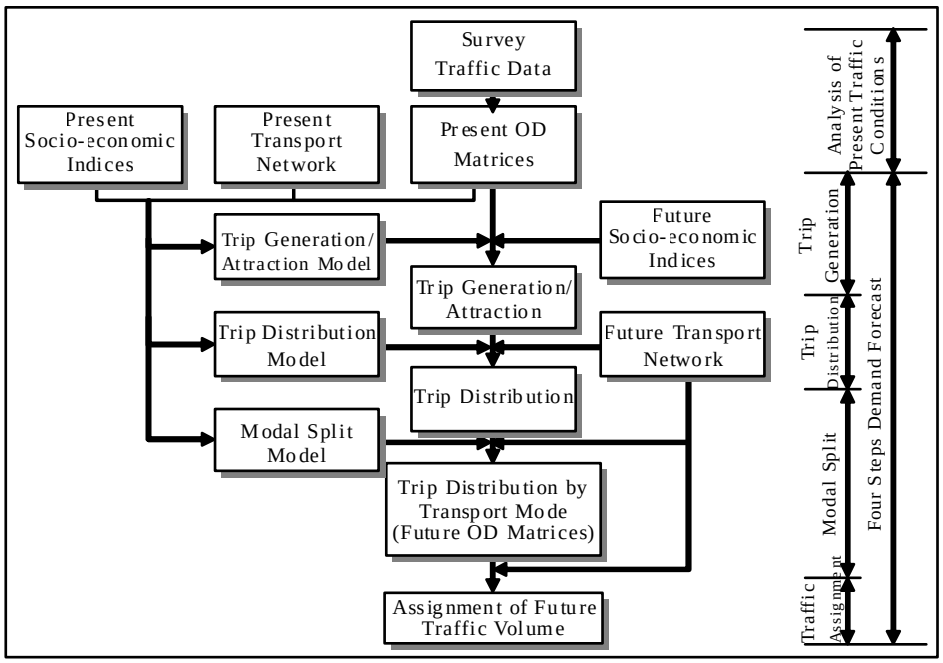


Figure 15.1-1 Flow of Transport Demand Forecast

(2) Zone System in Study Area

The model predicts trips over the transportation network based on attributes of traffic analysis zones developed in Chapter 5. Zonal attributes used in trip generation include population and employment. A key component of the model development process was the development of the zone system to cover the Study Area.

The study area is defined from zone numbers, 1 to 36 in traffic survey zoning system, and outside the study area is defined from zones, 37 and 52.

(3) External Zone Transportation Demand

Traffic that enters or leaves the modeling area around its perimeter is not specifically included in four steps approach as outlined above. The modeling area contains 7 locations where the road network connects with the “outside modeling area”. It is at these locations where internal/external interactions must be accounted for at these locations.

Traffic count data from the cordon line survey at the external stations provides the total volume of traffic that constitutes the internal/external interaction, although some portion of the traffic volume at these locations merely passes through the modeling area without an internal origin or destination. Those “pass-through” trips are called external-external (E-E) trips, the remaining portion of total traffic has an internal origin or destination and are classified as either external-to-internal (E-I) or internal-to-external (I-E) trips.

(4) Modeling and Forecasting Tools

In all steps of travel model calibrations and demand forecast, JICA STRADA system and EXCEL spread sheet are employed. JICA STRADA is a software tool for the planning, managing, and analyzing of transportation systems. The software provides a set of tools for travel demand modeling as well as capabilities for presentation graphics and transportation models. JICA STRADA system applied for simulation of travel time and cost. Modeling and forecasting in trip generation, trip distribution and traffic assignment is computed by JICA STRADA system. For better precision and efficiency, logit model as modal split steps is programmed by using Excel spread sheet.

(5) Trip Purpose Classifications

Trip generation is the fist step in the modeling process that utilizes the socio economic data to calculate the trip making characteristics (person trips) of each zone that will eventually be modeled on the road network. In this process, person trips are classified into four main trip purposes grouping form eight categories of the person trip survey as follows:

i. To Home Trips (HOME)
ii. To Work Trips (WORK)
iii. To School Trips (SCHOOL)
iv. Others Trips (OTHERS)

These trip purposes are consistent with the transportation model and allow travel characteristics associated with each to be quantified separately in many different aspects.
(See Table 15.1-1)

Table 15.1-1 Trip Purpose Category in Demand Forecasting

Trip Purpose Category in person trip Survey		Trip Purpose Category in Demand Forecasting	
1	To Home	1	HOME
2	To Work	2	WORK
3	To School	3	SCHOOL
4	Personal Business	4	OTHERS
5	Firm Business		
6	Social		
7	Shopping		
8	Others		

(6) Travel Mode Classifications

To secure enough sample and accuracy for the modal split stage, original travel modes in the person trip survey are joined into analysis travel mode system, which consist of three categories as shown in Table 15.1-2.

Table 15.1-2 Travel Mode Category in Demand Forecasting

Travel Mode Category in Person Trip Survey		Travel Mode Category in Demand Forecasting	
1	Walking	1	WALK
2	Bicycle		
3	Motor Cycle	2	MOTOR CYCLE
4	Tuk tuk	3	PUBLIC
5	Mini Public (Transport)		
6	Large Public (Transport)		
7	Pick up	4	CAR
8	Taxi		
9	Private Car		
10	Light Truck		
11	Heavy Truck		
12	Trailer		
13	Others		

15.2 FORECASTING TRIP PRODUCTION

15.2.1 Modeling Trip Rate per Person

In the analysis of trip rate per person obtained from the person trip survey conducted, a personal occupation is the most affected attribute on the trip rate. As for that by occupation, employee is 2.35 trips per day, that of student is 2.77 and un-employee is 2.08.

Table 15.2-1 Trip Rate Classification Table

Unit: Trip per person per day

Occupation	Trip Purpose				
	HOME	WORK	SCHOOL	OTHERS	TOTAL
Employee	1.148	0.732	0.029	0.439	2.349
Student	1.370	0.011	1.362	0.027	2.769
Un-employee	1.038	0.075	0.004	0.965	2.083
Total	1.202	0.434	0.431	0.377	2.445

15.2.2 Future Framework

Based on future socioeconomic prediction in chapter 14, total framework is summarized in Table 15.2-2.

Table 15.2-2 Future Framework

	2007	2013	2018	2025
GDP per capita(Vientiane) (US$)	957	1,435	2,168	3,870
Number of households	81,470	103,702	123,731	152,245
Car ownership rate per household	40.8%	49.4%	61.9%	84.0%
No. of private car	33,240	51,228	76,618	127,956
No. of Motorcycle rate per household	2.23	2.51	2.45	2.40
No. of Motorcycle	181,294	260,693	303,184	365,831
Population	447,037	553,784	643,867	763,180
Population 6 & above	379,982	481,238	569,822	692,204
Student at enrolment place base	119,887	134,966	147,533	165,125
Worker at office base	248,433	352,299	455,451	619,473
Un-employee	43,307	48,123	51,284	54,670

15.2.3 Future Total Trip Generation

Based on the Cross-Classification trip rate shown in Table 15.2-1 and the total future framework, the total trips generated in the whole study area is forecast to expand to 1929 thousand trips per day in 2025 from 958 thousand trips in 2007. (See Table 15.2-3)

Table 15.2-3 Future Total Trip Generation by Trip Purpose

Unit: person trip per day

Target Year	Trip Purpose				
	HOME	WORK	SCHOOL	OTHERS	TOAL
2007	471,471	170,264	170,754	145,144	957,633
2013	608,709	250,509	184,808	194,955	1,238,981
2018	740,984	322,793	203,941	241,307	1,509,025
2025	946,575	437,588	231,258	313,444	1,928,865

15.3 FORECASTING TRIP GENERATION AND ATTRACTION

15.3.1 Modeling Trip Generation and Attraction

The objective of trip generation and attraction model is to forecast the number of trips that will start and arrive in each traffic zone within the study area. The linear regression models by trip purpose are adopted in the study. The model parameters are calibrated shown in Table 15.3-1.

Gi = ai*X1i + bi*X2i + C

Aj = aj*X1j + bj*X2j + C

Where, Gi: Trip Generation in zone i

Aj : Trip attraction in zone j

X1i, X2j: Attributes in zone i, j

ai, aj, bi, bj: Coefficient

C: Constant

Table 15.3-1 TRIP Generation And Attraction Model Parameters

Model Type	Trip Purpose	Population 6&above	Worker at office base			Student at enrolment base	Constant	Correlation Coefficient
			Primary	Secondary	Tertiary			
Trip Generation	HOME	-	1.8362	1.5614	1.6370	1.1770	-690.31	0.9811
	WORK	0.4318	-	-	-	-	16.7756	0.9447
	SCHOOL	0.4786	-	-	-	-	-378.94	0.9402
	OTHERS	0.3164	-		-	-	604.68	0.9477
Trip Attraction	HOME	1.2448	-	-	-	-	-325.83	0.9718
	WORK	-	-	1.1009	0.8204	-	-278.43	0.9922
	SCHOOL	-	-	-	-	1.2357	557.30	0.9331
	OTHERS	-	1.5075	0.1695	0.9245	-	-698.87	0.8871

15.3.2 Verification of Trip Generation and Attraction Models

Figure 15.3-1 shows the verification results between observed and estimated trips.

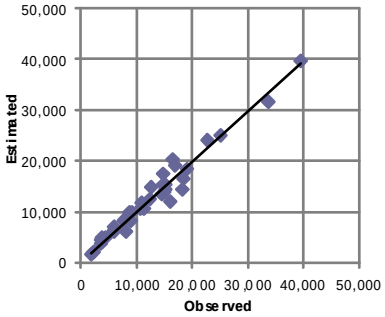
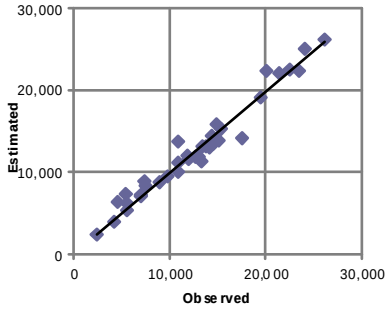
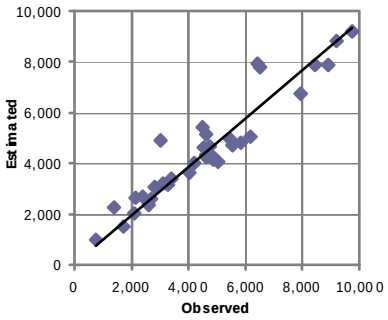
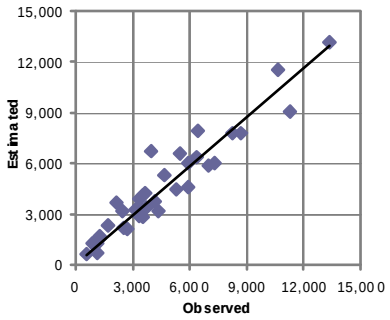
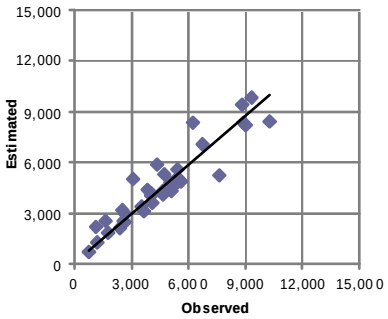
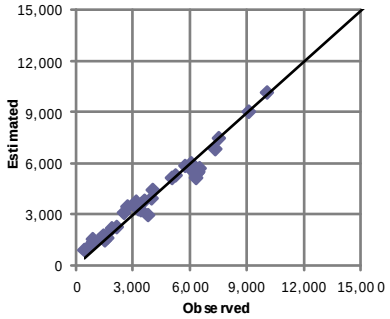
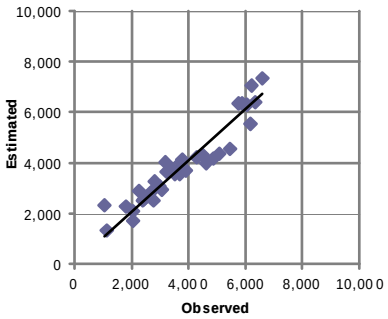
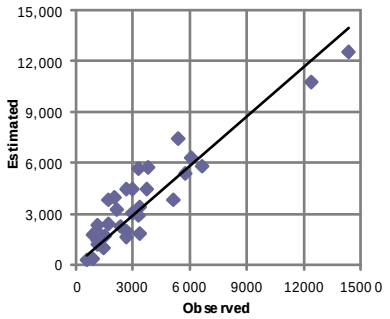
Purpose	Trip generation model	Trip attraction model
HOME		
WORK		
SCHOOL		
OTHERS		

Figure 15.3-1 Verification of Trip Generation and Attraction Model

15.3.3 Future Zonal Framework

Figure 15.3-2 shows future framework in 2025 comparing with that in 2007. The data tables of future framework are attached in Appendix 15.

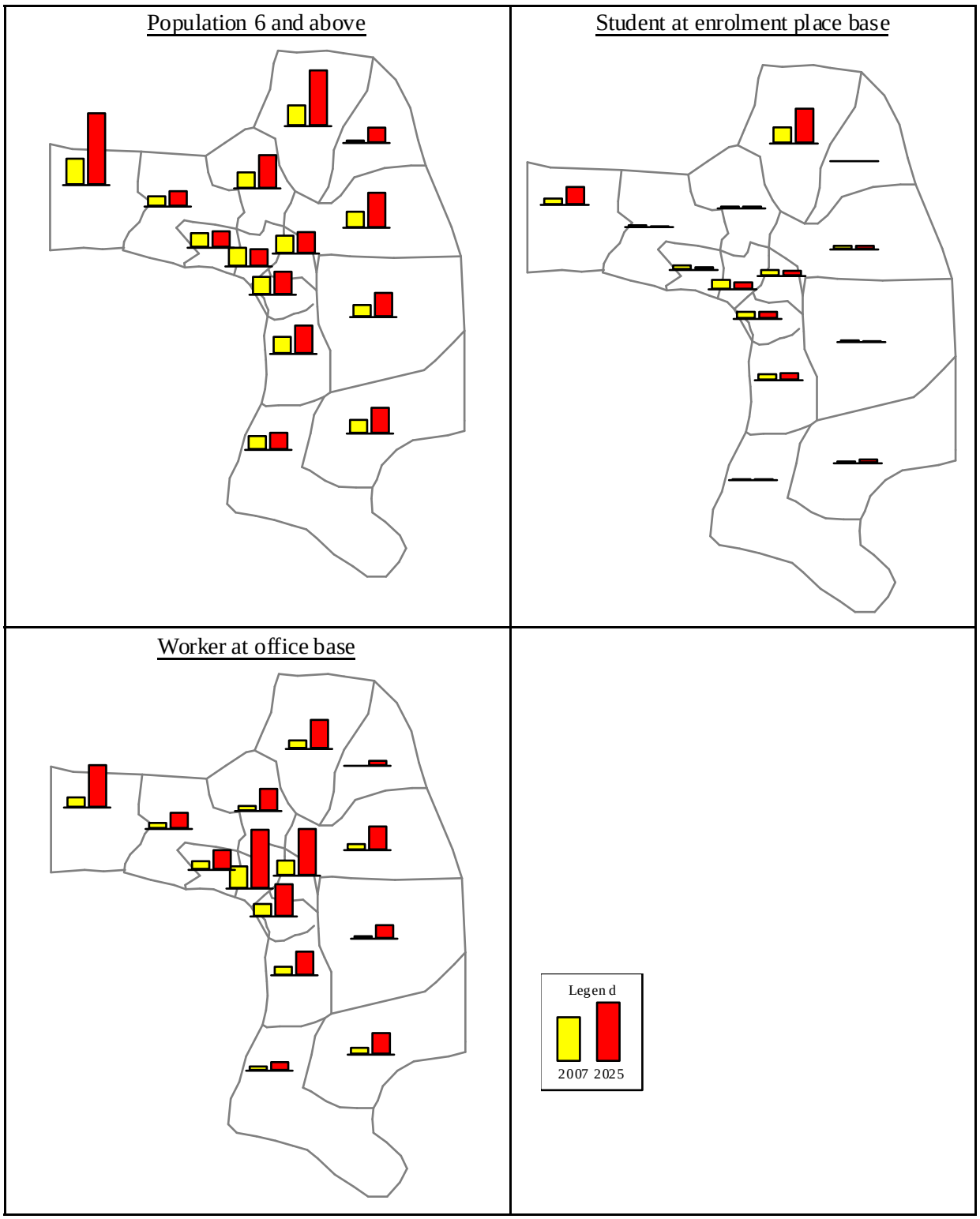


Figure 15.3-2 Zonal Framework in 2007 and 2025

15.3.4 Future Trip Generations and Attractions

Figure 15.3-3 shows the future trip generations by zone in 2007 and 2025. The estimation results are attached in Appendix 15.

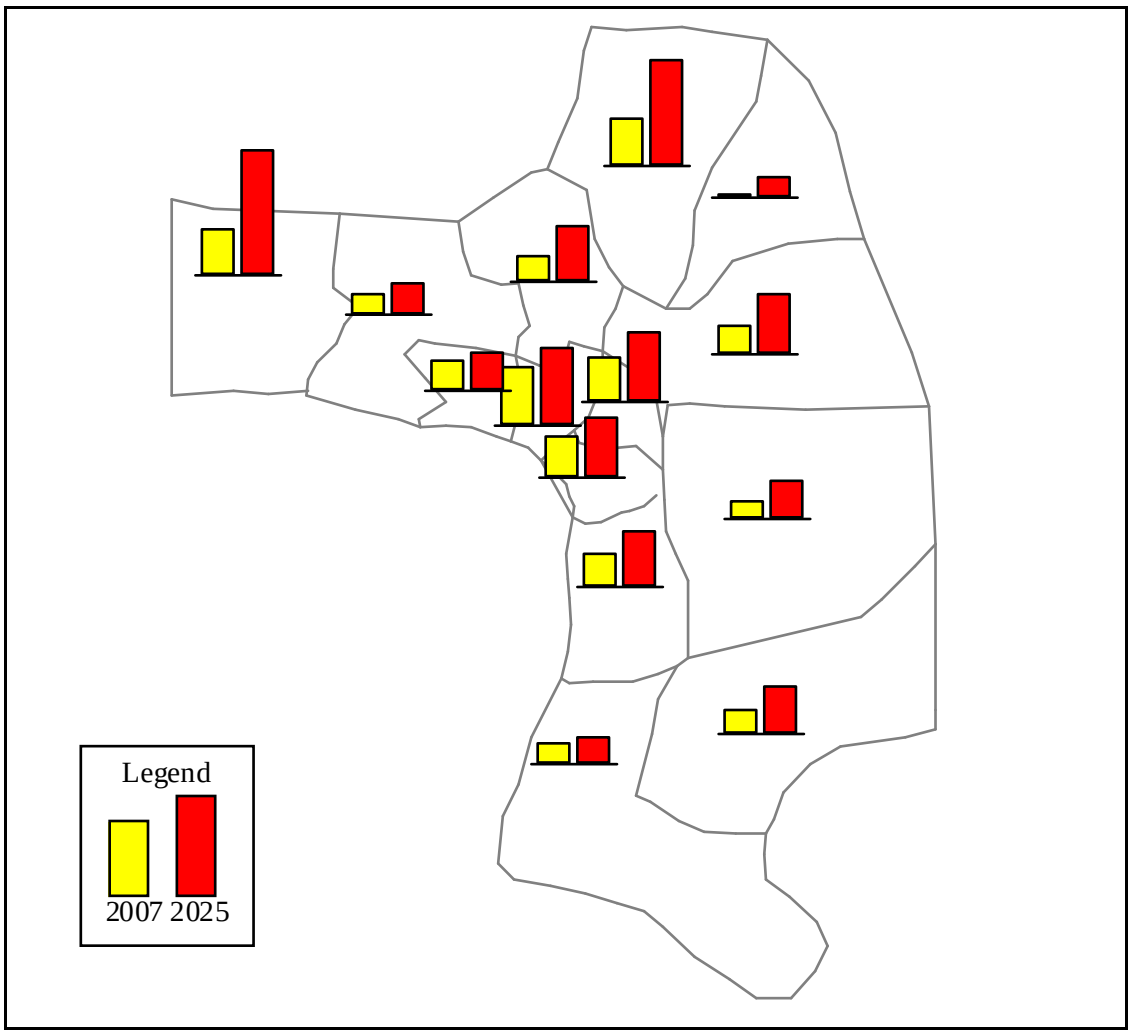


Figure 15.3-3 Trip generation in 2007 and 2025

15.4 FORECASTING TRIP DISTRIBUTION

Trip distribution is the second major step in the travel demand modeling process. Trip production (the first major step) provided methodology for estimating trip generations and attractions for each purpose within each zone. Trip distribution is the process that links the generations to attractions for each zone pair.

15.4.1 Building Trip Distribution Model

In this study, the gravity model for inter-zonal trips and trip rate model for intra-zonal trips are applied for trip distribution forecast, shown in following equations. Intra zone trip length (Lij) is assumed to be 0.5 km in each zone for inter-zonal model.

Inter zonal trip $Xij = K * Oi^{\alpha} * Dj^{\beta} / Lij^{\gamma}$

Intra zonal trip $Xii = Ri * Oi$

$Ri = Xii / Oi$

Where; Xij: inter zonal trip distribution from zone i to j

Xii: intra zonal trip distribution in zone i

Oi: trip generation in zone i

Dj: trip attraction in zone j

Lij: travel length from zone i to j (km)

Ri: intra trip rate

K, α, β, γ: model parameters

To balance a sum of trip distribution in certain zone, the doubly-constrained method is applied after estimation of each distribution by the gravity model. This type of model is also known as Fratar Balancing. The forecast matrix should then be such that the sum of each trips generated per zone is within a given convergence criterion of the corresponding forecast generation for that zone, and the sum of each trips attracted per zone is within a given convergence criterion of the corresponding forecast attraction.

Calibration results of the gravity models before applying the doubly-constrained method are shown in Table 15.4-1.

Table 15.4-1 Inter Zone Trip Distribution Model Parameters

Trip Purpose	α	β	γ	K	Correlation Coefficient
HOME	1.01243	0.91334	-1.03538	1.693E-005	0.72515
WORK	0.74954	0.88214	-0.66976	3.243E-004	0.70573
SCHOOL	0.58940	0.75776	-0.69185	3.402E-003	0.61270
OTHERS	0.72187	0.72683	-0.78453	1.7643E-003	0.63687

Intra zonal trip rates derived from the person trip survey are indicated in Table 15.4-2. These rates are applied for future demand forecasting, assuming to be constant.

15.4.2 Verification of Trip Distribution Models

Figure 15.4-1 shows trip length distribution between observed and modeled for model verifications.

Table 15.4-2 Intra zone trip rate

Zone	Xii/Gi				Xjj/Aj			
	HOME	WORK	SCHOOL	OTHERS	HOME	WORK	SCHOOL	OTHERS
101	10.7%	34.2%	21.6%	34.4%	25.0%	8.1%	15.9%	36.0%
102	15.3%	34.3%	20.8%	57.7%	35.5%	13.5%	26.5%	16.4%
103	11.2%	31.0%	50.7%	39.7%	34.4%	11.1%	12.9%	22.6%
104	38.3%	31.6%	39.9%	21.0%	31.3%	42.6%	32.3%	53.2%
105	51.1%	17.1%	13.1%	52.0%	25.1%	34.3%	59.2%	63.9%
106	48.7%	14.8%	8.3%	32.1%	18.0%	39.5%	33.9%	64.9%
107	77.4%	40.3%	57.5%	55.3%	51.1%	60.3%	90.8%	78.5%
201	17.6%	37.7%	47.8%	55.9%	44.9%	16.8%	16.6%	26.2%
202	47.9%	32.0%	27.1%	35.7%	31.4%	35.5%	66.2%	56.5%
203	70.1%	20.9%	37.1%	28.4%	29.0%	50.2%	92.9%	68.6%
204	41.1%	47.2%	35.8%	72.8%	52.8%	33.8%	66.8%	38.3%
205	92.9%	33.1%	56.0%	48.6%	46.9%	79.3%	96.5%	96.0%
206	68.0%	40.3%	73.0%	52.7%	56.3%	65.3%	65.2%	76.1%
207	84.8%	38.7%	49.6%	54.0%	48.2%	81.5%	81.9%	88.6%
208	80.2%	39.8%	56.8%	42.8%	45.4%	71.0%	86.0%	85.5%
301	26.5%	36.3%	44.0%	61.5%	45.9%	21.6%	40.2%	26.4%
302	30.2%	19.7%	52.9%	24.3%	31.9%	16.5%	46.3%	34.6%
303	26.1%	26.4%	19.8%	36.1%	28.1%	16.8%	18.4%	66.5%
304	42.3%	25.4%	29.2%	36.8%	29.1%	37.6%	36.5%	67.3%
305	82.8%	43.8%	65.0%	50.4%	53.4%	73.7%	91.2%	80.3%
306	74.7%	28.2%	56.5%	56.5%	45.6%	73.4%	81.9%	68.2%
401	15.6%	32.7%	45.5%	29.7%	31.2%	13.2%	19.0%	35.8%
402	17.4%	16.8%	18.9%	16.6%	17.0%	11.4%	16.0%	32.8%
403	7.0%	27.3%	7.0%	47.0%	30.0%	11.8%	3.9%	7.5%
404	20.8%	23.6%	27.3%	25.3%	24.4%	26.3%	15.3%	38.8%
405	54.1%	39.6%	17.5%	44.9%	33.4%	56.5%	55.8%	49.4%
406	51.6%	49.8%	51.0%	25.0%	43.6%	42.1%	59.7%	65.2%
407	48.8%	34.9%	63.3%	66.2%	55.6%	43.2%	52.2%	47.9%
408	41.2%	31.3%	25.5%	31.6%	28.7%	40.5%	33.8%	62.3%
501	82.6%	26.1%	47.0%	55.5%	45.3%	61.6%	96.3%	82.6%
502	91.4%	38.8%	78.0%	73.7%	70.0%	82.0%	89.3%	93.2%
503	73.5%	65.4%	60.1%	56.2%	61.8%	67.1%	73.7%	84.8%
504	69.3%	64.7%	40.5%	64.3%	59.1%	61.3%	94.3%	77.2%
601	67.9%	36.8%	43.7%	40.3%	40.5%	51.2%	74.7%	82.1%
602	38.8%	46.4%	83.8%	61.8%	68.1%	50.3%	30.6%	64.7%
603	81.5%	29.4%	16.5%	40.9%	27.7%	73.0%	86.4%	84.4%

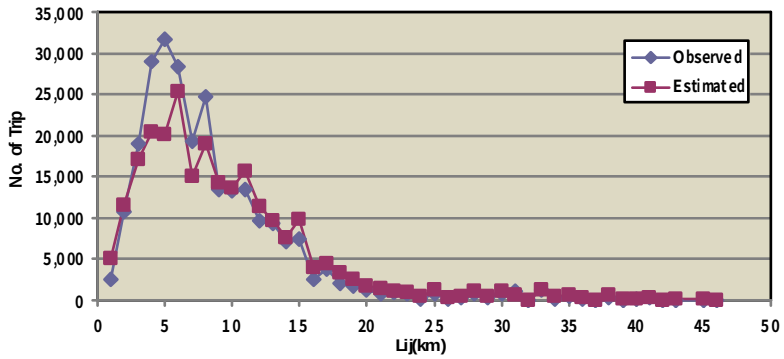
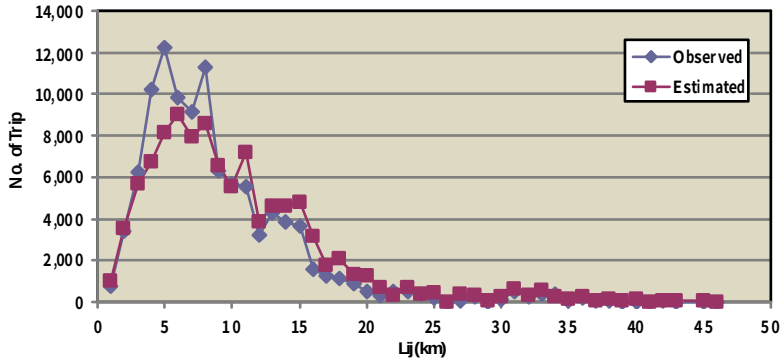
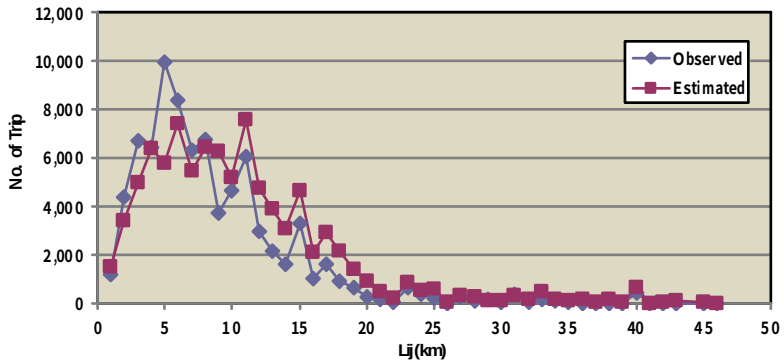
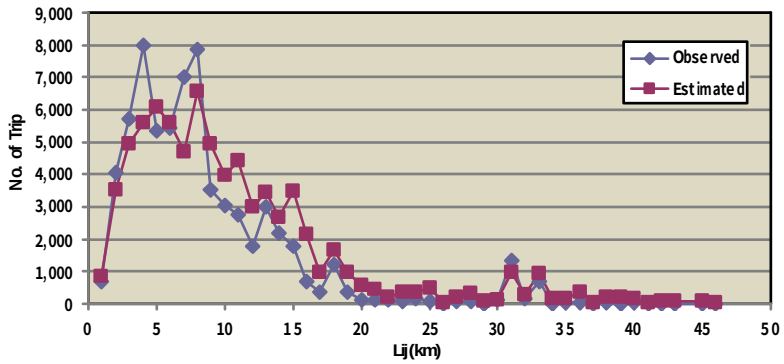
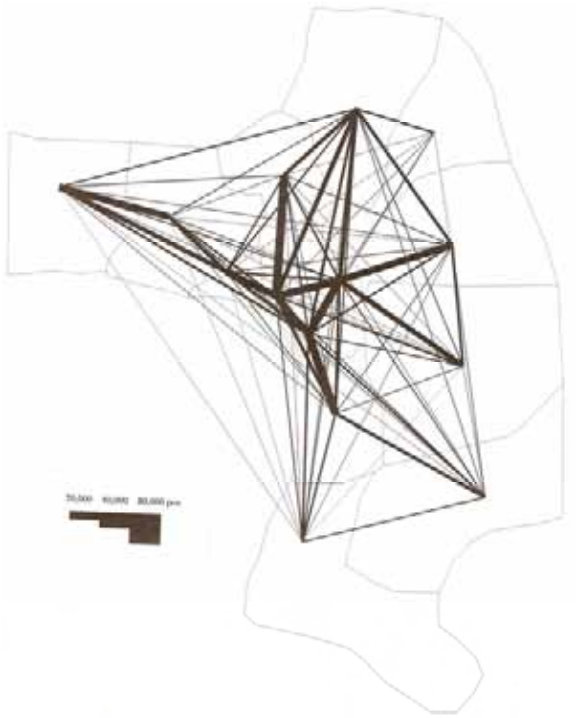
Trip Purpose	Trip length distribution
HOME	
WORK	
SCHOOL	
OTHERS	

Figure 15.4-1 Verification of Trip Distribution Models

15.4.3 Future Trip Distribution

Based on the trip distribution in 2007 and 2025, the charts by desired line, which clarify the trip distribution and interaction among zone pairs, are presented in Figure 15.4-2.



(Year 2007)

(Year 2025)

Figure 15.4-2 Desire Line of Total Trips in 2007 and 2025

15.5 FORECASTING MODAL SPLIT

Modal split models are used to analyze and predict the choices that individuals or groups of individuals make in choosing the transportation modes that are used for particular types of trips. Typically, the goal is the prediction the share or absolute number of trips by mode. The applied method to study modal split is the logit model.

15.5.1 Modal Split Hierarchy

The modal split models in this study comprise binary logit models, that is, "Walk split model", "Motorcycle split model" and "Car-Public (Transport) split model" shown in Figure 15.5-1. Walk split model provides the modal share between WALK and all other modes. Motorcycle split model is to split person trips other than walking into Motorcycle and other modes (Car and Public Transport mode). Car-Public split model provides the modal splits of person trip between car and Public Transport modes (Tuk tuk, Bus). The modal split models are established by trip purpose, using the person trip survey data.

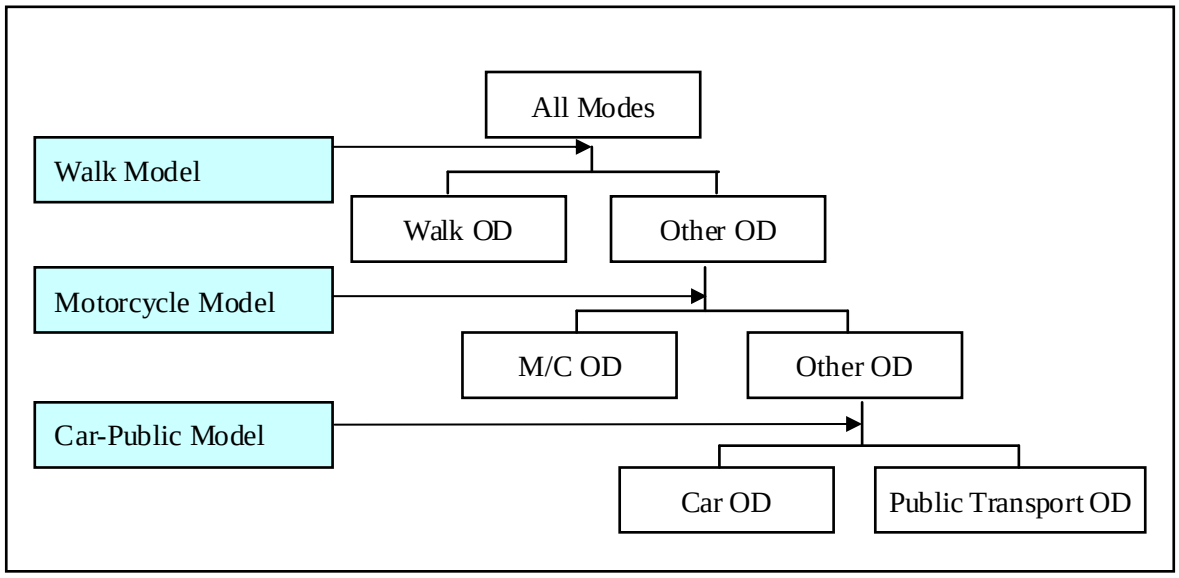


Figure 15.5-1 Structure of Modal Split Model

15.5.2 Walk Split Model

(1) Model formulation

With wide usability and the proven application, the logit models are selected for Walk split model in the study. The independent variable employed in the model is travel length (km) of the shortest pass on the road network. Based on the analysis of WALK share, that is affected by trip length and also personal characteristics, which is trip purpose and household car ownership. Considering the expansion of car ownership in future framework, Walk split are modeled by trip purpose considering car ownership rate. The equation of Walk split

models is as follows.

Pij_walk = 1/exp{-(a*Car_rate_i+b*Car_rate_j+c*Lij)}

Pij_walk : Walk share

Car_rate: Car ownership rate in origin or destination zone

Lij : Travel length from i to j (km)

a,b,c : parameters

(2) Calibration results

Following parameters were calibrated and identified by the method of maximum likelihood, which attempts to find the set of parameters that is most likely to have resulted in the choices observed in the person trip survey data. (See Table 15.5-1)

Table 15.5-1 Model Parameters of Walk Split Model

	HOME	WORK	SCHOOL	OTHERS
Car_rate_i	-	-5.70928	-1.47827	-3.13801
Car_rate_j	-4.10684	-	-	-
Lij_car	-0.20042	-0.20051	-0.23828	0.25822

15.5.3 Motorcycle Split Model

The logit model is selected for Motorcycle split model in the study. The equation of Motorcycle split models is as follows.

Pij_MC = 1 / exp [- {a*Car_rate_i+b*Car_rate_j+ c*MC_rate_i+d*MC_rate_j + e*(Tij_MC/Tij_Car)}]

Pij_MC : Motorcycle share

Car_rate_i, Car_rate_j: Car ownership rate in origin (i) or destination zone (j)

MC_rate_i,MC_rate_j: Motorcycle ownership rate in origin (i)or destination zone (j)

Tij_Car : travel time by car mode

Tij_MC: travel time by Motorcycle

a,b,c,d,e : parameters

As same as Walk split model, following parameters were calibrated and identified by the method of maximum likelihood. (See Table 15.5-2)

Table 15.5-2 Model Parameters of Motorcycle Split Model

	HOME	WORK	SCHOOL	OTHERS
Car_rate_i	-	-1.94189	-0.64885	-1.81292
Car_rate_j	-1.28695	-	-	-
MC_rate_j	-	0.80511	0.09570	0.63427
MC_rate_j	0.75869	-	-	-
Tij_MC/Tij_Car	-	0.04094	1.86252	-

15.5.4 Car - Public Transport Split Model

(1) Model formulation

The logit model is selected for Car-Public Transport split model in the study. The equation of Car-Public Transport split models is as follows.

Pij car = 1/exp{-(a * Car_rate_i + b * Car_rate_j + c * (Cij_Car/Cij_Public (Transport)) + d * (Tij_Car/Tij_Public (Transport))

Where; Pij: Car share

Car_rate_i, Car_rate_j: Car ownership rate in origin (i) or destination zone (j)

Tij_Car : travel time by car mode

Tij_PT : travel time by Public mode

Cij_Car: travel cost by car mode

Cij_PT : travel cost by Public mode

a, b,c,d: parameters

(2) Assumption of travel time and cost estimate

Travel time and cost among all zone pairs are estimated using JICA STRADA assignment module with the assumption of following mode condition. These condition and values are finally fixed after the verification of equivalency to the observed travel data in the person trip survey. (See Table 15.5-3 and Table 15.5-4)

Travel time Tij = Tij_ simulation + Tij_ access + Tij_ egress + Tw

Travel cost Cij = A Lij =< C

Cij = A + B*(Lij - c) Lij > C

Where; Ti_ simulation: Travel Time from i to j by JICA STRADA assignment module

Tij_ access: Travel time from origin zone to transport network

Tij_ egress: Travel time from transport network to destination zone

Tw: Waiting time at Public (Transport) stop

Lij: Travel length from i to j (km)

a, b, c, d: parameters

Table 15.5-3 Assumption of Travel Time Simulation

	Tij_ access/egress Zone Access	Tw Waiting Time
Car	3 min	0 min
Public	5 min	20 min

Table 15.5-4 Assumption of Travel Cost Simulation

	A(constant)	B(slope)	C(km)
Car	0	1000	0
Public	2500	150	10

(3) Calibration results

The Following parameters were calibrated and identified by the method of maximum likelihood. (See Table 15.5-5)

Table 15.5-5 Model Parameters of Car-Public Split Model

	HOME	WORK	SCHOOL	OTHERS
Car_rate_i	-	6.03760	6.45243	3.00821
Car_rate_j	4.63100	-	-	-
Tij_car	-1.54947	-2.15691	-2.05789	-0.38015
Tij_public	-0.01896	-0.04530	-	-0.12762

15.5.5 Verification of Modal Split Model

Figure 15.5-2 and 15.5-3 shows the verification results of modal split models developed.

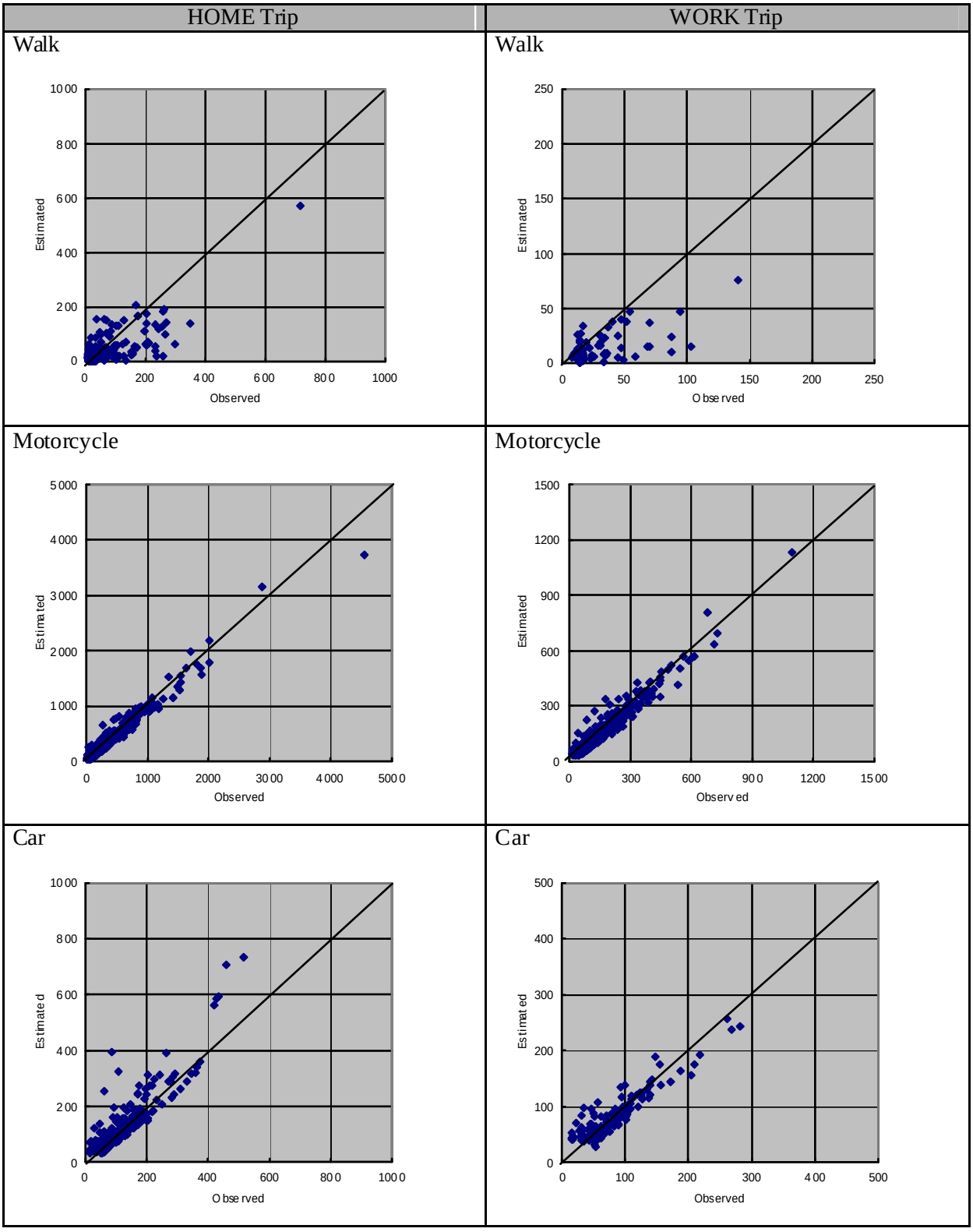


Figure 15.5-2 Verification of Modal Split Model (Home and Work)

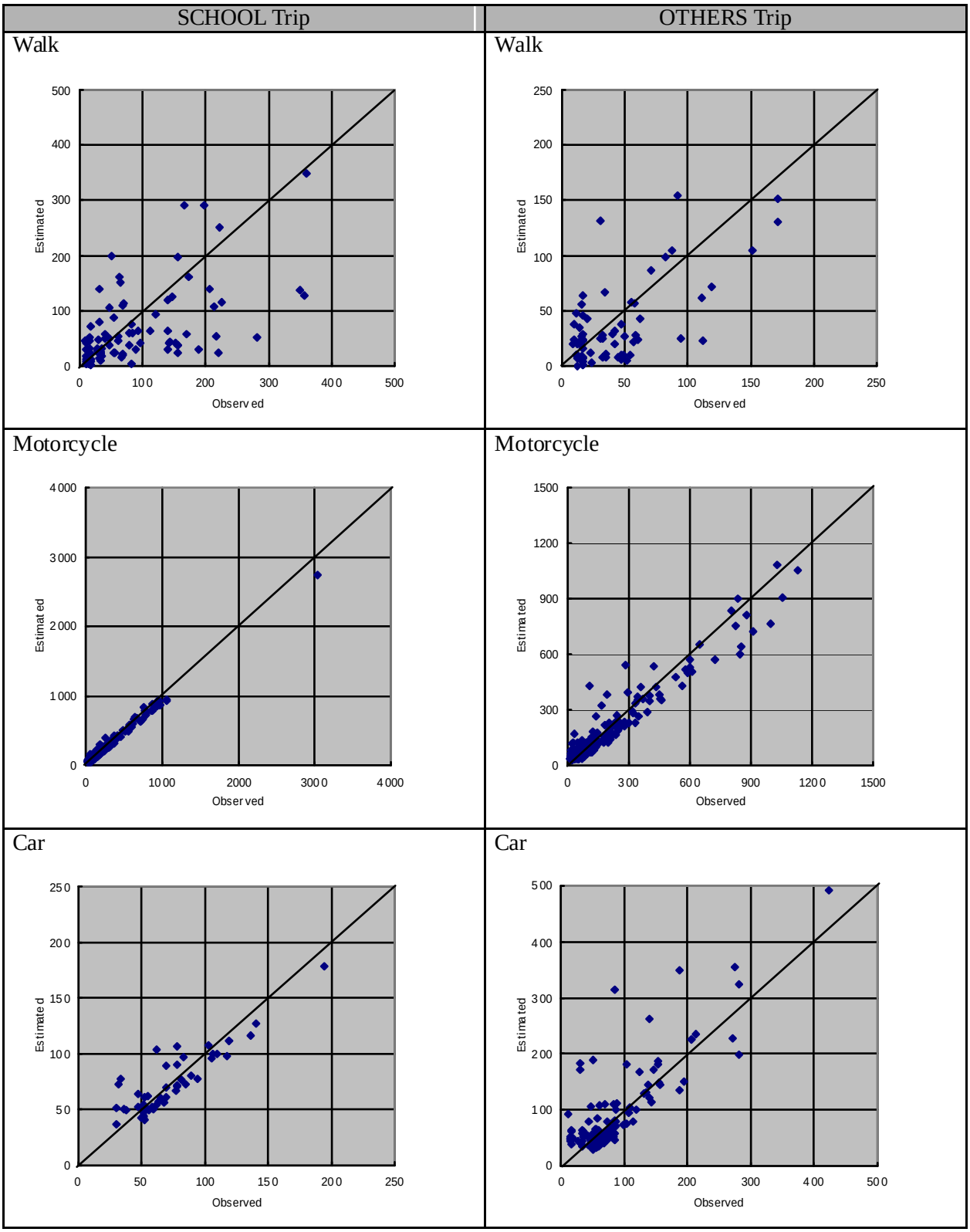


Figure 15.5-3 Verification of Modal Split Model (School and Others)

15.5.6 Future Modal Split

Using the modal split models built above, the future modal split of person trips was projected. The projection was performed under the framework of Do-nothing case in 2013, 2018 and 2025 (Table 15.5-6). The future demand for Motorcycle and Car was estimated 1,129 thousand trips and 437 thousand trips in 2025. Comparing the future estimations with the existing case, number of car trips increases almost four times, the share of car mode trips reaches double, by reflecting the high increment of car ownership rate. On the other hand, number of Public Transport trips the same as present, but the share of Public Transport decrease. (See Figure 15.5-4 and Figure 15.5-5 and Table 15.5-7)

Table 15.5-6 Future Modal Share in Do-Nothing Case

	WALK	Motorcycle	Car	Public	TOTAL
2007	241,268	572,739	106,199	37,427	957,633
	25.2%	59.8%	11.1%	3.9%	100.0%
2013	276,109	770,482	153,432	38,957	1,238,981
	22.3%	62.2%	12.4%	3.1%	100.0%
2018	308,991	919,993	241,273	38,768	1,509,025
	20.5%	61.0%	16.0%	2.6%	100.0%
2025	349,556	1,112,153	428,993	38,163	1,928,865
	18.1%	57.7%	22.2%	2.0%	100.0%

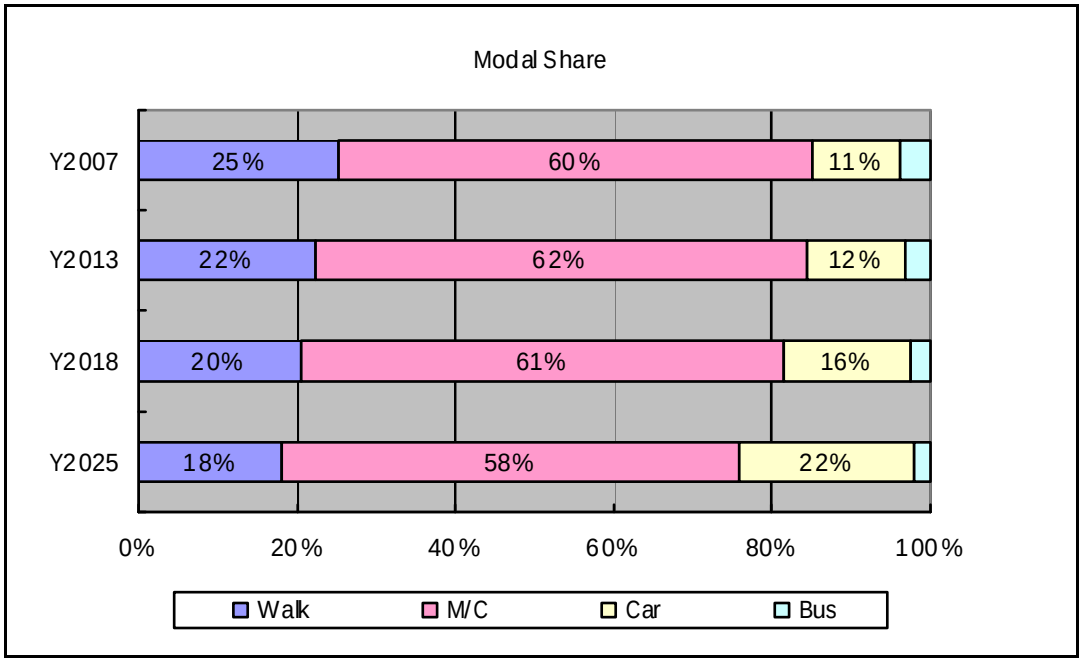
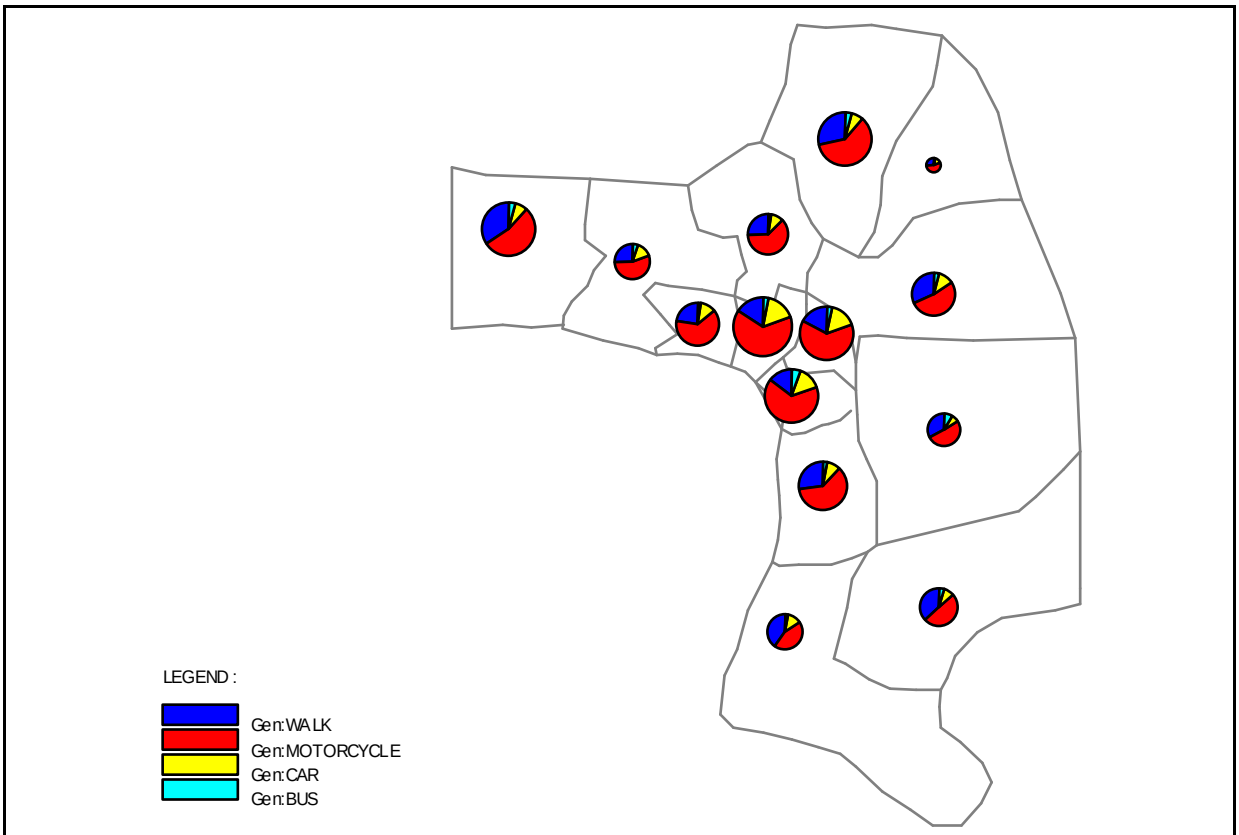
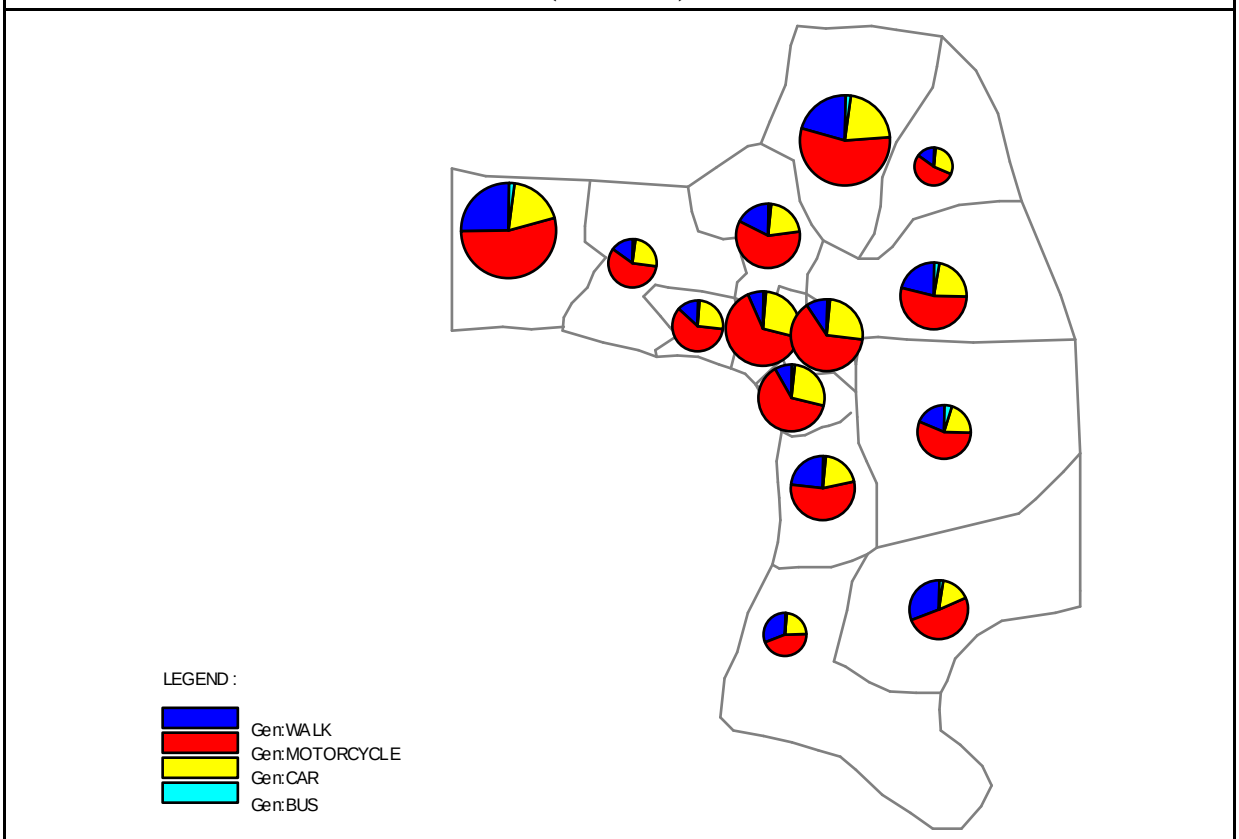


Figure 15.5-4 Future Modal share



(Year 2007)



(Year 2025)

Figure 15.5-5 Modal Share by Zone (Generation Base) in 2007 and 2025

Table 15.5-7 Trip Generation by Mode

Zone	2007					2025				
	Walk	M/C	Car	PT	TOTAL	Walk	M/C	Car	PT	TOTAL
101	3,078	17,785	3,795	496	25,154	2,941	31,085	13,866	743	48,635
102	4,769	25,162	6,163	1,841	37,935	3,187	38,666	15,902	846	58,601
103	4,528	20,049	6,436	1,251	32,264	3,027	33,453	14,811	776	52,067
104	6,349	15,339	2,400	365	24,453	3,534	16,207	6,650	358	26,749
105	3,806	12,305	1,942	462	18,515	5,890	26,971	8,244	838	41,943
106	2,932	8,798	1,765	305	13,800	4,629	19,518	8,259	417	32,823
107	7,565	13,626	1,723	556	23,470	12,394	34,241	10,591	1,001	58,227
201	4,892	18,934	3,241	707	27,774	2,764	20,827	9,180	515	33,286
202	4,731	12,333	2,664	426	20,154	4,069	16,726	6,450	418	27,663
203	4,347	10,041	968	387	15,743	5,029	17,479	7,524	354	30,386
204	6,034	21,674	4,338	1,668	33,714	6,235	31,093	12,301	893	50,522
205	4,653	4,400	1,499	381	10,933	5,139	14,610	7,084	703	27,536
206	8,778	16,768	1,982	697	28,225	17,555	48,508	15,254	1,342	82,659
207	7,345	13,851	2,474	1,024	24,694	20,555	47,180	17,791	1,866	87,392
208	16,080	20,490	2,909	1,805	41,284	35,830	68,646	21,008	2,549	128,033
301	8,096	35,784	9,387	2,729	55,996	8,215	62,372	24,067	1,602	96,256
302	6,321	20,780	3,517	559	31,177	4,410	23,835	10,363	550	39,158
303	2,667	7,264	2,052	271	12,254	3,277	19,953	8,199	461	31,890
304	4,887	14,943	3,143	544	23,517	8,117	32,155	13,503	832	54,607
305	15,256	18,808	3,532	2,050	39,646	21,570	47,130	19,494	2,945	91,139
306	12,698	21,083	2,895	3,143	39,819	16,922	52,920	18,306	4,325	92,473
401	3,004	11,582	2,621	576	17,783	3,146	20,826	9,822	508	34,302
402	611	3,442	968	232	5,253	492	5,623	3,208	141	9,464
403	2,008	14,236	4,030	3,630	23,904	1,152	17,275	7,605	464	26,496
404	4,024	21,097	3,462	612	29,195	3,379	22,395	10,740	498	37,012
405	4,673	14,994	1,971	493	22,131	4,207	23,221	8,036	622	36,086
406	10,395	20,088	2,458	904	33,845	12,335	26,776	8,776	788	48,675
407	7,870	18,967	3,492	847	31,176	8,052	21,828	7,923	683	38,486
408	3,692	10,066	1,669	309	15,736	10,362	26,870	9,666	797	47,695
501	5,579	8,954	2,298	551	17,382	9,264	15,592	7,610	467	32,933
502	11,870	11,433	2,927	823	27,053	10,867	14,244	6,644	389	32,144
503	13,864	20,007	2,721	1,550	38,142	27,962	48,243	14,191	1,796	92,192
504	3,418	3,805	828	834	8,885	7,337	12,146	3,504	981	23,968
601	12,372	18,212	2,660	1,816	35,060	22,957	54,750	23,567	2,577	103,851
602	16,049	41,323	4,290	2,275	63,937	29,204	88,677	31,214	3,035	152,130
603	2,027	4,316	979	308	7,630	7,399	27,176	15,454	736	50,765
Total	241,268	572,739	106,199	37,427	957,633	353,404	1,129,217	436,807	38,816	1,958,244

15.6 EXTERNAL ZONE DEMAND

The traffic demand related to external zones is classified into external-external, internal-external, external-internal trips. Existing demand obtained from the Cordon Line Survey is added to the Person Trip Survey data. Future demands related to external zone were forecast by the growth factor method. Applied growth factors in the year of 2013, 2018 and 2025 against 2007 are listed in Table 15.6-1.

Table 15.6-1 Growth Factors for External Zone Demand

Area		Zone No.	Motor Cycle	Pass. Car	Public	Truck	Remarks
STUDY AREA		1 –36	130% 150% 204%	130% 150% 204%	130% 150% 204%	150% 227% 404%	Growth rate of the person trip base estimation
Out of Study Area in Vientiane	Sikhotabong	37	111% 126% 138%	111% 126% 138%	111% 126% 138%	150% 227% 404%	
	Sayseta	38	108% 119% 127%	108% 119% 127%	108% 119% 127%	150% 227% 404%	
	Hathsayfong	39,40	109% 120% 129%	109% 120% 129%	109% 120% 129%	150% 227% 404%	
	Xaithany	41,42	120% 148% 173%	120% 148% 173%	120% 148% 173%	150% 227% 404%	
	Sangthong	43	117% 140% 159%	117% 140% 159%	117% 140% 159%	150% 227% 404%	
	Naxaythong	44	112% 128% 140%	112% 128% 140%	112% 128% 140%	150% 227% 404%	
	mayparkngum	45	112% 128% 141%	112% 128% 141%	112% 128% 141%	150% 227% 404%	
Outside Vientiane Area		46-49	112% 120% 129%	112% 120% 129%	112% 120% 129%	171% 241% 411%	Growth Rate of GDP per Capita in Laos
Thailand		50	148% 204% 283%	148% 204% 283%	148% 204% 283%	143% 189% 247%	Growth Rate of Friendship passengers and commodities.
Remarks			Growth rate of population		Growth rate of population	Growth rate of GDP per Capita in Vientiane	

Note: Upper: 2013/2007, Middle: 2018/2007, Lower: 2025/2007

15.7 TRAFFIC ASSIGNMENT

The traffic assignment process allocates vehicle traffic to individual roadway links. This step takes as input a matrix of flows (vehicles) that indicate the volume of traffic between origin and destination pairs.

15.7.1 Vehicle Assignment Model

(1) Assignment Method

Various assignment techniques are used ranging from manual methods to complex iterative procedures by computer programs. In this study, the used method the capacity restraint assignment which is the most straightforward for use in network models, and the most efficient particularly where the number of zones in the trip matrix is large. This assignment technique is based on the speed – flow relationship, and the flow chart of the applied methodology is shown in Figure 15.7-1.

In this assignment technique, and by calculating the required travel time for each link according to its travel speed and road conditions, the program determines the fastest routes between each origin and destination by evaluating the consuming time on links, and assigns the trips between the given origin and destination to these routes starting at the destination and working back to the origins. As congestion increases till a certain level, alternative routes are introduced to handle the unassigned traffic. Zone-to-zone routing is built, which is the fastest path from each zone to any other, and all trips are assigned to these optimum routes.

Since the link-travel time varies with the traffic volume of vehicles using that link, which can be explained as a degree of link congestion, the OD tables are divided to apply an iteration procedure on five stages. At each iteration, and depending upon the current link loadings, the flows are divided between all the shortest routes generated and a new travel time is computed for the average assigned link flow at each pass. The iteration continues to re-estimate the speed on that links considering the assigned traffic on links, and to produce alternative routes so that more accurate allocation can be achieved. The accumulated assigned traffic volume from each OD pair on the links composes the total assigned traffic volumes per direction for the network.

JICA STRADA is used to estimate traffic volumes.

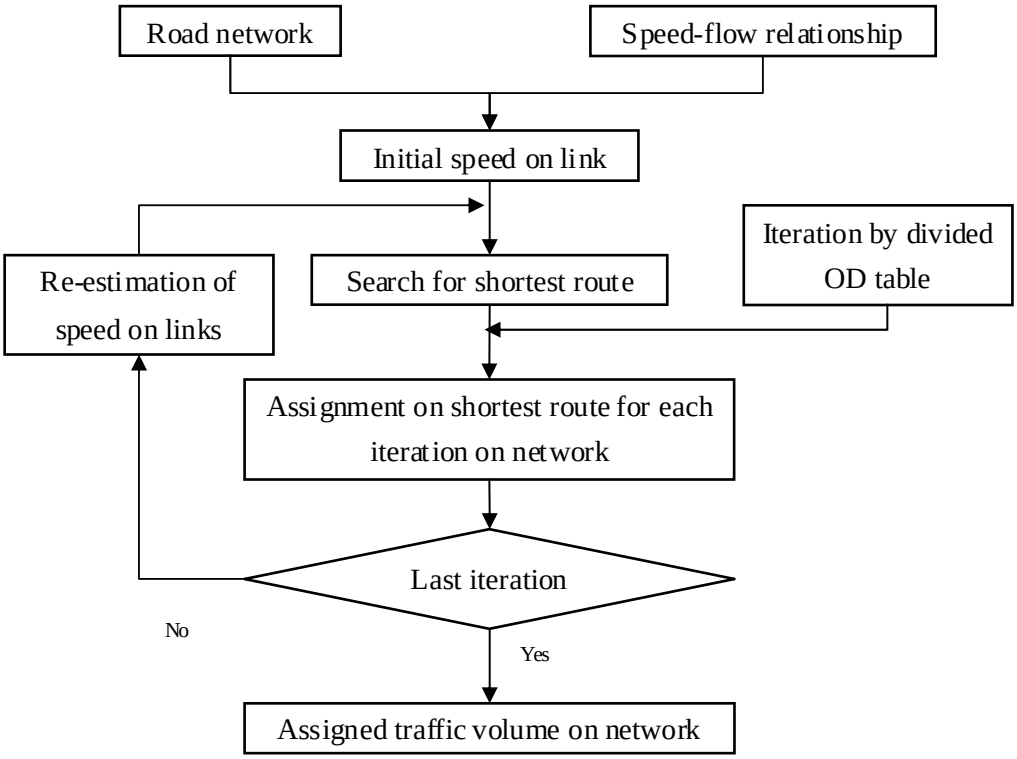


Figure 15.7-1 Traffic Assignment Procedure

(2) Auto Occupancy Rate and Passenger Car Unit

Trips generated by trip purpose during the trip generation step (and consequently through the trip distribution step) are in person trips, as discussed above. Auto occupancy rates and passenger car units (PCU) are utilized to convert from person trips to vehicle trips prior to assigning the traffic to the roadway network. These factors are obtained from the Screen Line Survey and the Cordon Line Survey in Table 15.7-1.

Table 15.7-1 Occupancy Rate and Passenger Car Unit

Mode	Auto Occupancy Rate		Passenger Car Unit	
	Screen Line Data	Cordon Line Data	Screen Line Data	Cordon Line Data
Motor Cycle	1.20	1.32	0.33	0.33
Private(Car)	1.65	2.39	1.16	1.31
Public	5.63	9.41	1.13	1.31

Note: PCU: Passenger Car=1.0, Tuktuk=0.75, Public (Transport)=2.0, Light Truck=1.5, Heavy Truck=2.0

(3) Speed-Flow Relationship

The speed – flow relationship used in the traffic assignment procedure is shown Figure 15.7-2. When the traffic volumes are over the maximum capacity 0.3*Qmax, it is assumed that vehicle speed drastically reduces. The basic free flow and capacity is shown in Table 15.7-2.

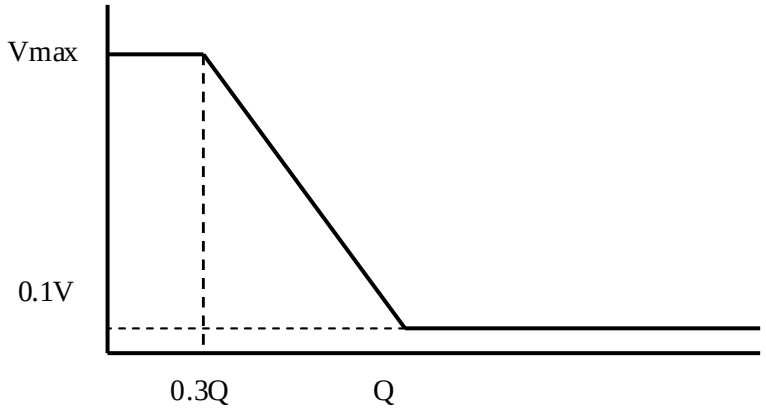


Figure 15.7-2 Speed –Flow Relationship

Table 15.7-2 Free Flow Speed and Capacty by Road Type

Road Class	Location	Lane	Free Speed (km/hr.)	Capacity (PCU/day)
Principal Arterial	Urbanized	2	50	12,000
		4	60	48,000
		6	60	72,000
	Plain	2	50	10,000
		4	60	44,000
		6	60	66,000
Arterial Road	Urbanized	2	40	9,000
		4	50	40,000
	Plain	2	50	8,500
		4	60	35,000
Collector	Urbanized	2	40	8,500
		4	50	30,000
	Plain	2	50	8,000
		4	60	25,000

(4) Traffic Assignment Validation

In general, trips between individual pairs of zones are uncertainly estimated by aggregation of the trips matrices cells and the allocated through assignment techniques to routes cover large number of zones pairs. Therefore, it is necessary to examine the result of the assignment so as to ensure that trips are assigned in a realistic pattern well matching to the actual situation.

To check the assignment validity, all vehicles types in the form of passenger car units (PCU) across the Screen-line and the Cordon-line as show in Figure 15.7-3.

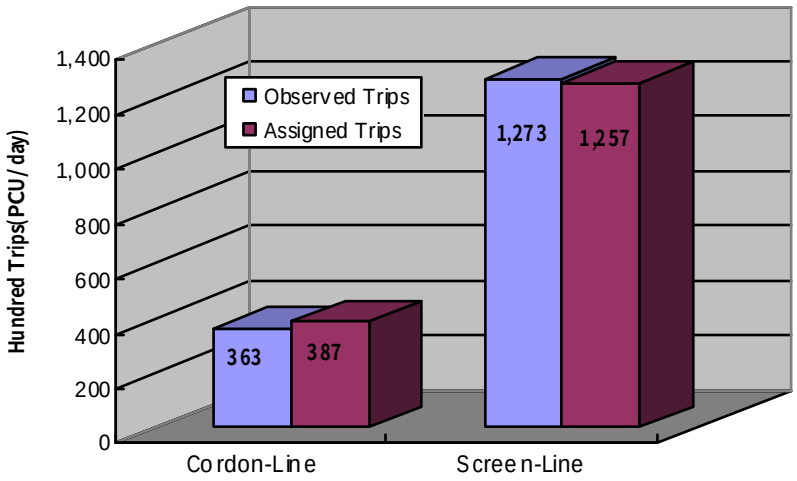


Figure 15.7-3 Cordon Comparison between Observed and Assigned Traffic in 2007

In addition a comparison between the observed and individual traffic count at 34 observed stations shown in Figure 15.7-4. This comparison between observed traffic count and assigned traffic flow at individual sites is done via the Mean Absolute Difference (MAD) [1]Ratio. For daily traffic counts, the value of the MAD ratio is 0.18 which is considered to reflect a good calibration. By all indicators the assignment has accurately replicated year 2007

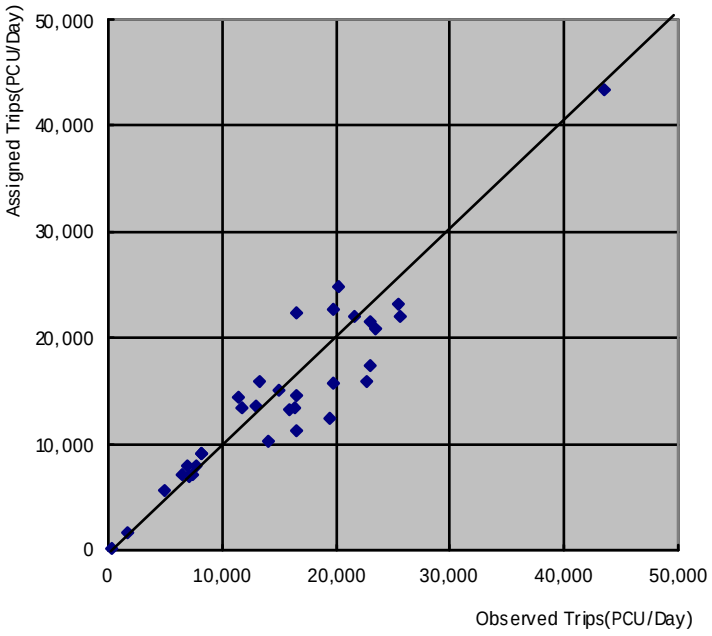


Figure 15.7-4 Comparison between Observed and Assigned Traffic at Individual Sites

[1] MAD Ratio is defined by the following formula: MAD Ratio $= \sum \left| \frac{count - assignment}{assignmet} \right| / n$

where n is the number of observations.

15.7.2 Transit (Public Mode) Assignment Model

The all-or-nothing assignment method prepared in JICA STRADA system, is chosen for Public mode assignment model.

15.8 ASSESSMENT OF PRESENT TRANSPORT NETWORK

For the objective of the transport poly and countermeasure studies, it was first assumed that no improvement would be applied to transportation supply, what is called "Do-Nothing" case analysis. The car assignment results of existing case (2007) and Do-Nothing case in 2013, 2018 and 2025, were summarized as follows. (See Table 15.8-1)

Table 15.8-1 Car assignment Results in Do-Noting Case

	Year 2007	Year 2013	Year 2018	Year 2025	Ratio 2025/2007
Total Vehicle Trips (PCU)	418,775	526,527	680,207	958,144	2.29
PCU-km	2,122,318	3,556,424	5,027,836	7,467,732	3.52
PCU-Hour	50,210	103,310	180,090	364,006	7.25
Volume / Capacity	0.39	0.66	0.93	1.45	3.71
Average Speed (km/h)	42.3	34.4	27.9	20.5	0.48

Comparing the future road traffic with the existing one, it is apparent that the radical corridors will become heavily congested in the future. Thus, the following remarks are pointed out. (See Figure 15.8-1 to15.8-4)

a) Traffic Indicator

Annual traffic indicators of vehicle trips are evaluated from the view points of changes in vehicle trips, pcu-hr, pcu-km and average speed.

The vehicle trips are forecast to increase from 418,775 trips in 2007 to 958,144 in 2025 with a growth of about 2.3 times. In addition, the indicators of pcu-hr and pcu-km are also increasing, especially the pcu-hr that increases from 50,210 pcu-hr in 2007 to 364,006 in 2025 with a growth of about 7.3 times.

As a result, the average travel speed is decreased from 42.3 km/hr in 2007 to -20.5 km/hr in 2025, which means that the level of service on the road network will face a severe situation from the economic and environmental points of view.

b) Traffic Congestion

Results of analyzing the volume to capacity ratio V/C to investigate the road congestion in

2007 show desirable ratio 0.39.

Results of the year 2025 show unacceptable level of traffic congestion with an average value of 1.45.

c) Summary

- If any countermeasures against traffic congestion are not implemented in the transport sector, when road traffic volumes drastically increase, the level of service will become worse.
- Some countermeasures to decrease car traffic and increase public mode transport are desired in near future.

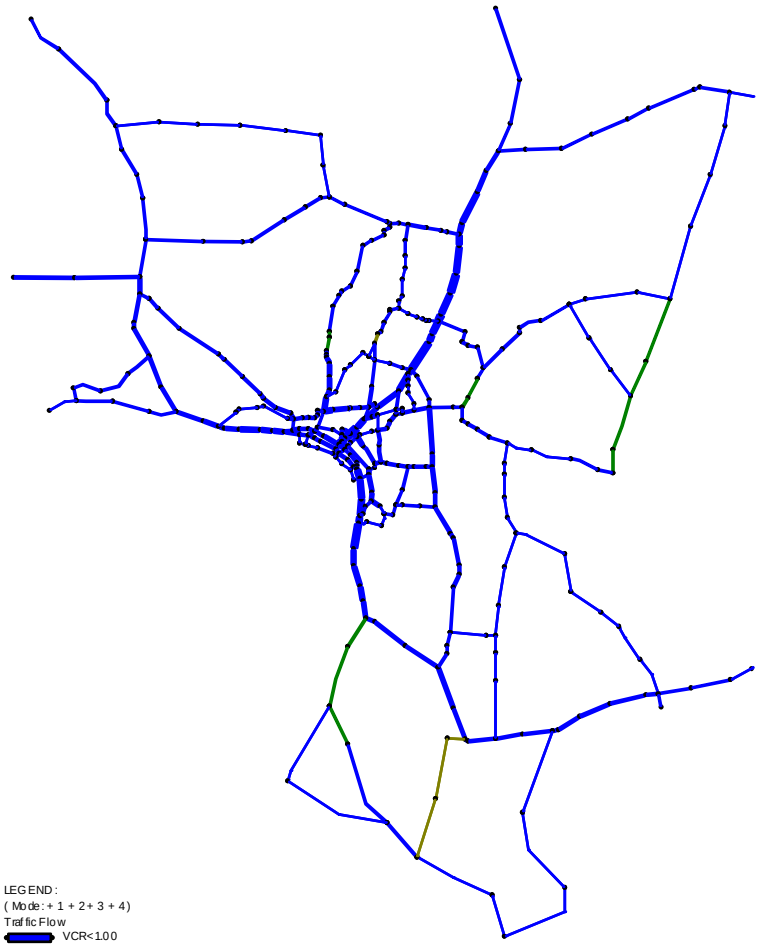


Figure 15.8-1 Traffic Assignment Result In Existing Case(2007)

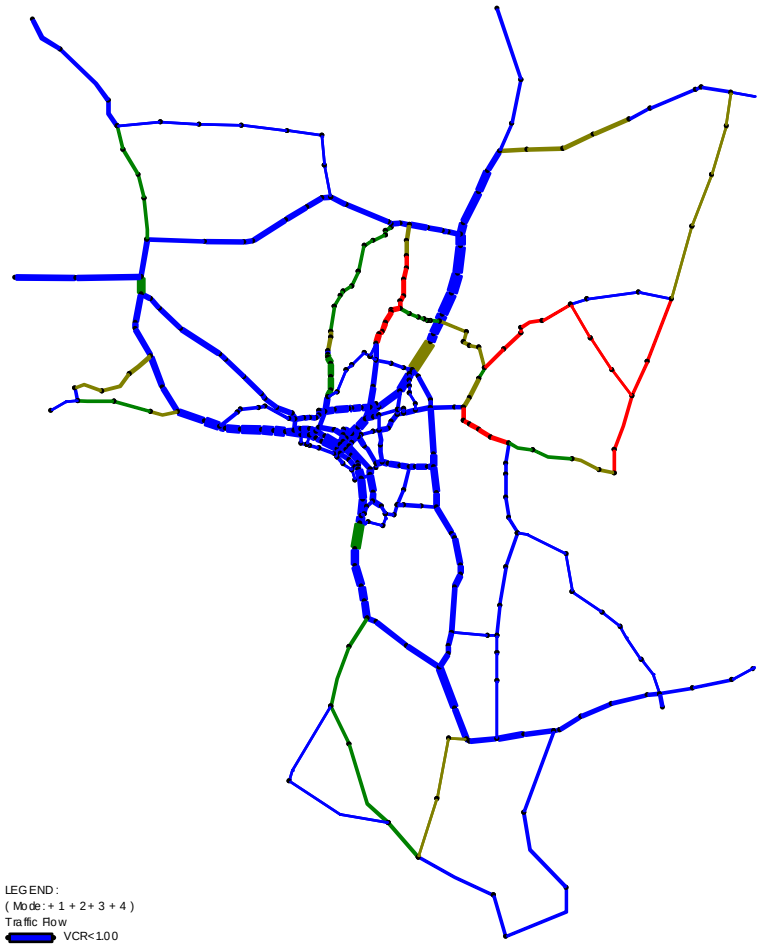


Figure 15.8-2 Traffic Assignment Result in Do-Nothing Case 2013

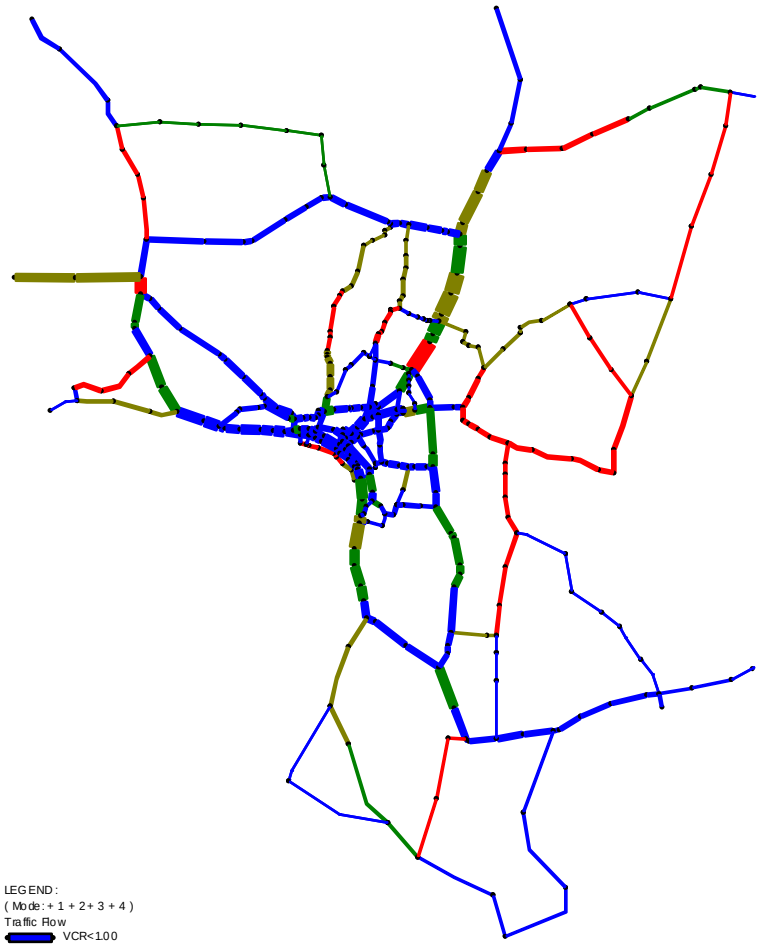


Figure 15.8-3 Traffic Assignment Result in Do-Nothing Case 2018

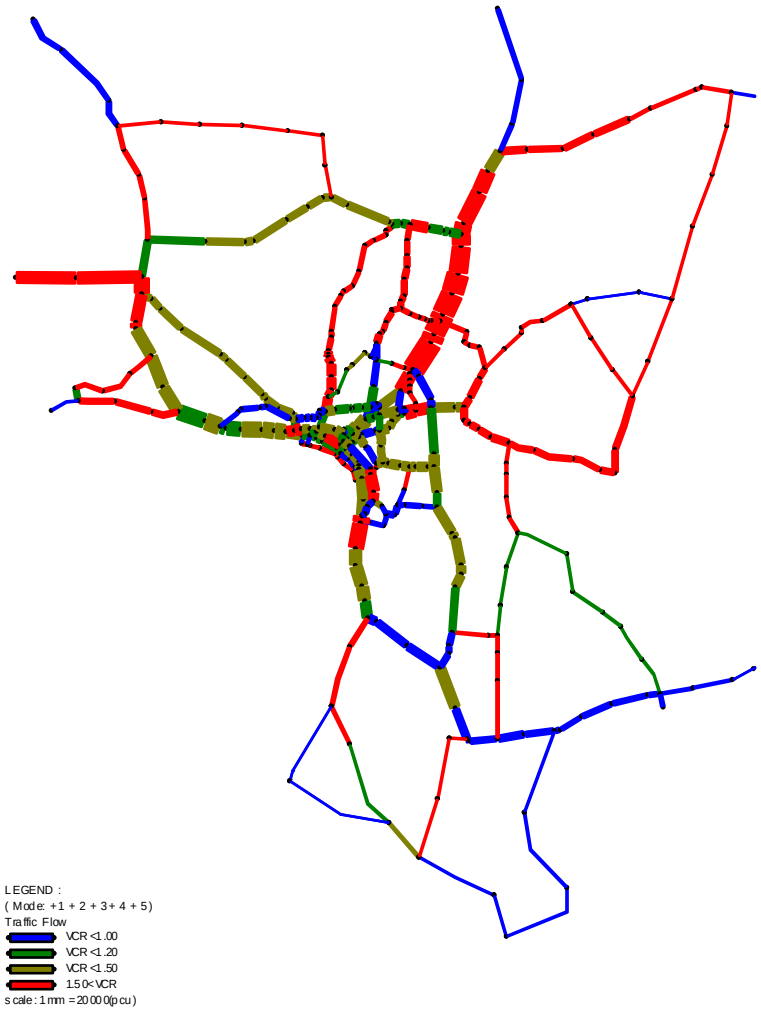


Figure 15.8-4 Traffic Assignment Result in Do-Nothing Case 2025

CHAPTER 16

URBAN TRANSPORT DEVELOPMENT STRATEGIES

CHAPTER 16 URBAN TRANSPORT DEVELOPMENT STRATEGIES

16.1 PRESENT TRANSPORT ISSUES

The present transport conditions were assessed and its issues were identified in Chapter 11, findings and issues of which are summarized in the following sections taking account of the results of the future demand forecast conducted in Chapter 15.

16.1.1 Present Situations of Vientiane

Vientiane is expected to perform the following functions, and the issues of urban transport to be addressed are summarized below for respective functions.

(1) Function as Capital City to be a Center of Governmental and Socio-Economic Activities

To establish urban transport policy and transport improvement strategy in order to strengthen functions as a capital city.

(2) Function as the Center of Social and Economic Development for the Central Region

To establish transport policy and facility plan to support logistics and industrial zones in order to strengthen regional economic activities.

(3) Function as International Transport Hub for GMS*

- To upgrade the regional roads to form international transport hub and to appropriately treat the through traffic by providing outer ring roads.

GMS: Great Mekong Sub-Region, which is intended to form "East-West Corridor" connecting Northern, Central (Vientiane, Savannakhet) and Southern (Pakse) regions of Lao PDR, and Thailandocean harbors of Vietnam, and to establish the national border economic zone (refer to Figure 16.1-1). As shown in the figure, Vientiane is expected to assume the role as an international transport hub since being located at the meeting point of the central corridor.

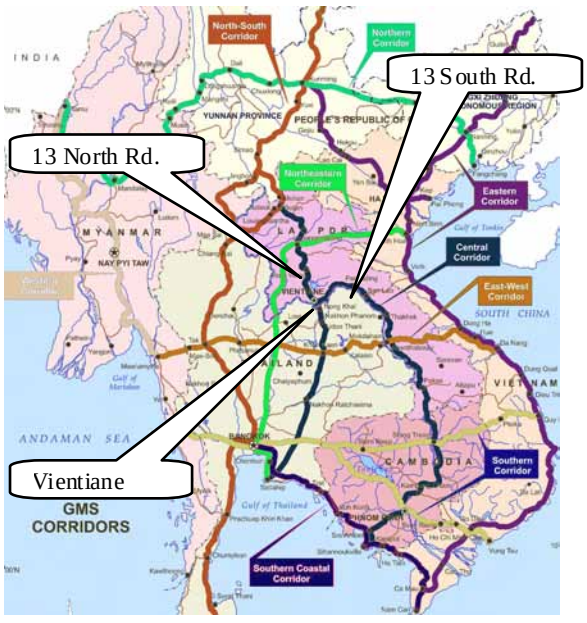


Figure 16.1-1 GMS Corridors

16.1.2 Features of Vientiane

(1) Urban Structure

- Urban area has been expanding toward the north-east forming a fan-shape from the Mekong River.
- Government facilities and central business district (CBD) are concentrated in the central city.
- In suburban area, commercial and light industrial areas are located along the main roads, with residential areas being dispersed in the whole city area.
- The area is not intensively used with most buildings low to middle-rising and many green areas remaining.
- Road density is relatively low.

(2) Landscape and Historical/Cultural Heritages and Environment

- Urban landscape is good and attractive with many green areas, open spaces and old-style buildings as shown in Picture 16.1-1.
- The historical center in the central city covers 180 ha, which is divided into two districts (Sissattanak and Chanthabuly) and 14 villages for 16,700 inhabitants.
- Among its 2,475 buildings, more than 300 have been identified as heritage buildings by IEUPAUP in 2002(VUTMP).
- With due consideration of the heritage value for tourism industry in the central city, urban transport plan shall be established
- No serious environmental problems are found.
- It is recommended to maintain the present attractive scenery for tourists within the central city area.

Picture 16.1-1 Panoramic View of the Central City from Don Chan Palace Hotel

16.1.3 Road Network and Road Condition

(1) Road Network

- Road network in the central city is principally formulated with the grid pattern, while major roads in the suburban area are developed in the radial pattern from the central city. Road network in suburban area, however, is formed disorderly.
- Roads are categorized only from administrative view point such as national roads, provincial roads and district roads. Functional hierarchy system such as the arterial street, collector street and local street systems needs to be introduced and established considering each road's role in the present land use and future land use plan.
- Completion of the inner ring road utilizing T4 Road is required in near future to disperse future rapid traffic demand in outskirt of the central city. In case of utilizing T4 Road as the inner ring road, the following works are needed.
  - Extension of T4 Road up to NongDuag Road.
  - Improvement or elimination of off-set intersection of South 13 Road and T4 Road.
  - Widening of narrow sections in the west area from South 13 Road.
- Road network regarded as collector and local roads especially in suburban areas are missing and not connected effectively with each other and main roads.
- In order to save energy consumption and infrastructure development costs and to prevent future traffic problems such as traffic congestion, traffic accidents, and aggravation of air pollution caused by future traffic demand, introducing appropriate public transport system is needed along with expanding and developing road network in accordance with urban development plan.

(2) Road Conditions

- Main roads in the study area are basically paved with asphalt (40%), bituminous (44%), cement (3%) and gravel (13%), among which the surface conditions of bituminous and gravel pavements are generally in poor condition.
- Since a large part of local streets including drainage facilities and Road NO.1 in the central city has been improved through VUDAA Project funded by ADB and Japan's Grant Aid Project respectively, focusing on the road conditions in its area is principally not to be necessary in the Study.
- There are many intersections disorderly along major roads with minor roads. Access to/from major roads from/to minor roads should be controlled by establishing road network with consideration of road functions in terms of maintaining traffic mobility on the major roads, reducing the number of traffic accidents and guiding appropriate land use.
- Roads regarded as collector and local roads in suburban areas are in poor condition due to

insufficient road maintenance including drainage facilities.

- The following bridges on the main roads with two lanes are required to be replaced due to bottle necks in traffic function and poor conditions in structural soundness.
  - Bailey bridge with wooden deck, carriage way of 4.0m wide and 30.3m in length at 0.92km (Km6 Nong Niang – Jct. Dong).
  - Steel girder bridge with wooden deck, carriage way of 2.9m wide and 22.0m in length at 3.28km (Jct. SaNamMar – Jct. B. Mai)
  - Bailey bridge with steel deck, carriage way of 4.0m wide and 18.3m in length at 3.58km (Jct. SaNamMar – Jct. B. Mai).
  - Bailey bridge with wooden deck, carriage way of 4.0m wide and 24.3m in length at 12.25km (Rd.13S km21 – B. Khok sa At)

16.1.4 Traffic Condition

(1) Number of Registered Vehicles

- The number of total registered vehicles in Vientiane in 2006 is more than 232,000 and is increasing at a rate of about 11.0% per year, which rapid increase rate has been maintained since 1998 which is turning year of increasing trend of the total number of registered vehicles.
- An increase rate of motorcycle is about 10.7% per year, which is the same as that of the total registered vehicles, while an increase rate of cars is about 20.0% per year, which rapid increases have been maintained since 1998 and 2002 respectively, years of which are turning points of increasing trends of respective registered vehicle numbers. One family owns 0.4 cars and 2.2 motorcycles on average according to the household interview survey conducted in the Study.
- Judging from the above trend, motorization development in Vientiane seems to have been on the exploding motorization stage since 1998, in which stage growing concerns are generally to expand and develop road network and take appropriate measures for the traffic safety.
- To cope with issues of increasing traffic demand, however, measures to convert private vehicle usage to public transport usage should be taken along with expanding road capacity in terms of securing better environmental circumstances and saving infrastructure development costs.

(2) Traffic Volume

- Though traffic volume has rapidly been increasing, serious traffic congestion has not been generated yet.
- According to the analysis of future demand forecast for “Do Nothing Case”, developing

the present road network, expanding/improving public transport modes and improving/widening the road conditions are required since the following situations are anticipated.

- Increase in the vehicle trips will become about 2.5 times in 2025 comparing to the present vehicle trips, from 418,775 trips in 2007 to 1,033,151 in 2025.
- Increase of the PCU-hr will become about 7 times in 2025, from 46,168 pcu-hr in 2007 to 320,703 pcu-hr in 2025.
- The average travel speed will decrease more than half the present average speed, from 45.5km/hr in 2007 to 22.0 km/hr in 2025.
- Serious traffic congestions are expected in 2025 without appropriate road network expanded and developed, situations of which will critically hamper the economic and social activities and cause serious air pollution, traffic noise and vibration and deteriorate urban amenities.

- The above results suggest that the following measures be taken:
  - Establishment of both basic road network and public transport system is needed so as to accommodate future traffic demand and to reduce traffic volume on roads, respectively.
  - As one of preventive measures for establishing road network in the future, ROW widths shall be secured along the planned road network by means of limiting new construction of private house/commercial buildings within the ROW. It is recommended for securing ROW to take a phase manner in order to minimize negative social impact.

(3) Traffic Characteristics

- Peak hour ratios in the morning and evening are 15.0% and 10.8% respectively. If this peak hour traffic volume is being maintained in this pattern in the future, reducing or cutting the peak hour traffic volume to an appropriate level will become a major issue. In order to cope with this issue, both managing traffic demand and expanding traffic capacity are needed.
- Trips by motorcycle in the Study area account for 65 % of the total trips, while trips by public transport such as bus and tuk-tuk account for about 6 %. Providing public transport with good quality, sufficient capacity, convenient service and an appropriate fair system in a phase manner is needed to encourage converting private vehicle usage to the public transport usage especially for commuting, which leads to one of measures to prevent the chaos situation of traffic congestion with mixing modes, in particular during peak hours in future.

16.1.5 Traffic Management and Safety

(1) Traffic Management

- Separating carriage ways for rapid speed vehicles from slow speed vehicles such as motorcycles and tuk-tuks is needed at least on major roads with appropriate road surface markings, and strongly enforce the rule on drivers to follow.
- There are observed some excessively large intersections without road surface markings. The intersections should be designed as compactly as possible with road markings; to stream and guide traffic flow in order; to reduce the number of traffic conflict points; and to shorten exposure time of pedestrians and vehicles in the intersection, resulting in expanding traffic capacity of the intersection and reducing traffic accidents at the intersections.
- Such traffic devices as road surface markings, traffic guide signs and traffic signals shall be uniformed including not only shapes but also locations and colors.
- Though there are many intersections without traffic signals along major roads in suburban area, many of which are black spots, traffic signals are to be installed by such donor countries as France, China and Vietnam. Installation of traffic signals need not be treated in the Study.
- Since the issues of the traffic management in the central city have been studied in the Vientiane Urban Transport Master Plan (VUTMP) and the proposed projects have been implemented, it is not focused on in the Study.

(2) Traffic Safety

- The number of injury accidents has been increasing since 2002; minor injuries in 2006 are 1.1 times as many as that in 2002; medium injuries 1.5 times; serious injuries 4.6 times, while fatality accidents have been stable over 6 years with ranging between 112 and 147.
- The number of traffic accidents show steep increase after office hour (16:00) up to 20:00, causes of which are presumably to be matter of visibility due to poor street lighting system and drunken driving, and haphazard or disorderly driving by the young.
- Such violating traffic regulation as drunken driving, high speed and no helmet accounts for about 88% of the total fatality accidents. Enforcing or adhering to traffic regulations will contribute considerably to reducing fatality accidents, which leads to reducing serious injury accidents.
- With respect to the composition of traffic accident types in 2006, accidents between motorcycles account for 47.2 %, which is almost a half of the total number of accidents, followed by ones between motorcycles and cars for 29 %, combined to become 76.2 %. According to the survey result above, treatment of motorcycles is a major issue to address in terms of the traffic safety as well as traffic congestion.

- MCTPC has formulated the National Level Road Safety Action Plan, which was officially approved by the Prime Minister, which is composed of 15 sectors covering almost all disciplines in the field of road traffic safety. The progress and situations of this plan shall be considered in this Study.

(3) Parking

- Though there is still much room for car parking in the central city even during peak hours since rate of parking demand to its capacity is 53% according to the Vientiane Urban Transport Master Plan (VUTMP). However parking spaces located in near such attraction points as Morning Market and Lane-Xang Hotel are practically in full space according to the survey conducted in the Study.
- The above situation makes car users feel that parking spaces are not enough.
- The above feeling is also likely to be related to their common practice that almost all car users (96%) park their cars where are within 2 minutes on foot from their destinations as shown in the interview survey conducted in the Study, the situation of which requires the enforcement of existing regulation on parking.
- Near the major attraction points in the central city, paid off-street parking lots should be provided by preparing vacant spaces and so on.
- On main roads in the suburban area, illegal parking is observed because parking spaces are generally not provided. Owners who construct commercial buildings/houses or large scale facilities should be obliged so as to provide off-street parking spaces by law.

16.1.6 Public Transport

(1) Interview Survey on Bus Service

- Regarding every each item questioned on bus services to be improved, more than 55% of bus users feel the necessity of improvement; shortening of travel time is the highest (71%), followed by shortening of waiting time (67%) and extension of service time (63%).
- Bus passengers have a quite strong complaint about air quality inside buses probably due to inflowing of polluted, uncomfortable and dusty air into the inside of buses without air conditioners.
- In order to promote the usage of buses, it is quite important to upgrade both bus services and quality of bus itself.

(2) Financial Situation of the Bus Company for Urban Transport in Vientiane

- Bus transit services in Vientiane areas and the Central Bus Station (CBS) are owned and

being operated by Vientiane State Bus Company (VSBC) being under DCTPC and the Mayor of Vientiane, which means that VSBC does not have power to set bus fare according to its own business policies.

- Though the number of passengers of VSBC buses has been decreasing since 2001, the total income of VSBC has been increasing thanks to increases in bus fare in 2002 and 2003. Deficits were, however, recorded in 2004 and 2005 mainly due to repeated increases in fuel price and maintaining relatively low fare by political considerations.
- VSBC cannot afford to expand business and purchase spare parts for old model buses in terms of financial condition.
- The financial situation is required to be improved; for example, by means of making management efforts, receiving a monetary subsidy from the government, improving bus management and operation system, introducing PPP and so on.

(3) Bus Management and Operation System in Vientiane

- Bus services at three bus stations, CBS mainly for intra-city service, the South and International Bus Station (SBS) mainly for international service and the North Bus Station (NBS) mainly for inter-province services, are owned and operated by different companies; CBS by VSBC and the other stations by different private bus companies.
- The government agencies responsible for controlling bus services are DCTPC and Vientiane Governor for urban bus services in Vientiane and MCTPC for international bus services.
- The above situations result in the following difficulties of public transport systems.
  - Confusion in management and operation system involving the government agencies because the role of each government agency concerned is not clarified.
  - Difficulty in providing smooth connection of bus services between CBS and the other stations due to conflicts on timetables among bus operating companies.
  - Difficulty in controlling the service fare and timetable between Vientiane and the other provinces.
- All facilities of CBS are required for renovation.
- Since loading and unloading is demand base, there are no shelters at bus stations and bus stops.

(4) Tuk-Tuk and Jumbo

- While tuk-tuk and jumbo are well organized and controlled through membership system by Vientiane Tuk-Tuk and Jumbo Association, the following problems are identified.
  - There are members who do not adhere to the regulations including parking at unauthorized spaces, overcharging and conflicts with passengers.

- The parking spaces for tuk-tuk and jumbo have been limited due to the increasing number of traffic volume.
- There are private vehicles that illegally provide services to the public.
- There are vehicles that are in poor conditions and have no inspection proved from the center of the association.

- An issue to address is to properly incorporate such paratransit as tuk-tuk, jumbo and sonteo into the urban transport system.

(5) Railway

- The railway extension project between Dongphosi Station in Vientiane and Friendship Bridge was constructed in April of 2008 with land acquisition for the first stretch of 3.45km funded by Thailand, the study of which was conducted in 2002 for a total length of 12.45km.
- As for the remaining section of 9.0km, the further study is being conducted by Agence Francaise de Development (AFD).
- The moves of the railway extension project are required to be taken into account in the Study.

16.2 URBAN TRANSPORT PLANNING POLICY

16.2.1 Planning Policy

Based on the assessment of present transport issues, urban development scenario and traffic demand forecast, the following planning policies are recommended.

(1) Appropriate Urban Development

Urban transport system is to be established so as to support the corridor network development scenario recommended in the Chapter 12.

- To connect the present missing links of ring roads and construct new ring roads for securing the preventive urban transport plan.
- To develop high-to-medium story residential buildings and intensified commercial / services activities along the major roads.
- To maintain the traffic conditions in the city area in not serious conditions in future through establishment of the urban transport corridor network.
- To be developed for urban facilities to meet the requirements in accordance with the population growth, including water supply and sewerage system, waste-disposal, public parks.
- To maintain the landscape, which is preferable to limit the height of buildings, low-to middle rise in the central city and low-rise in newly urbanized areas, and preserve marshes, green areas and open spaces.
- To conserve historical and cultural heritages.

(2) Appropriate Urban Transport System

The urban transport system, especially affordable means for public movement, shall be proposed to respond to the future traffic demand, and to be composed of appropriate transport modes including such public transport as bus/LRT services, paratransit, motorcycle and non-motorized vehicle in harmony with their respective roles complementing each other.

- Clear sharing of mass-transit as bus/LRT transport and paratransit roles.
- Effective and efficient usage and encouragement of public transport system.
- Appropriate conversion of motorcycle and car usage to public transport usage for commuting.
- Possibility of introduction of LRT system.
- Harmonized and effective system between each transport mode.
- Consideration of the role of Vientiane as part of the international/regional cross border logistics system such as GMS, ASEAN.

(3) Historical/Cultural City with Urban Environment and Tourism Heritage in the Central City

The plan shall be intended to preserve the historical heritage and urban scenery, and to ensure the urban environment and amenity.

- Preservation and maintaining of the historical center with the heritage value to attract visitors.
- Provision of serviceable and safe road facilities and well-designed access to attractive spots.
- Education and enforcement on disciplined traffic manner and secured traffic safety.

(4) Modern City with Urban Structure and Development Potentiality in the Suburban Area

The plan shall be instrumental to build the modern Metropolitan Vientiane with harmonization of urban environment and structure. Construction of a city with modern urban function is essential to attract foreign investment and attain economic growth.

- Advanced traffic facilities and management with international standards in terms of system and quality.
- Functional connection between new development areas such as industry, satellite city and logistics zones etc.
- Comfortable access to residential areas with prestige to prevent undesirable form of sprawl.

16.2.2 Development Strategy

The following strategies for the central city and suburban area are established to support and realize the policy and target.

(1) Strategic Approach to the Central City

In the present central city, which is defined in the Study as covering areas within the proposed inner ring road (T4), due consideration shall be given to the preservation of historical heritage and urban scenery with deliberate urban development control. The principle approach for the central city, therefore, shall be; strengthening of the public transport service; full utilization of existing facilities with minimum improvement intersections and construction of missing links; and promotion of effective management system involving education and enforcement.

- Effective traffic management system and securing traffic safety.
- Strengthening and upgrading of public transport service.
- Improvement of intersections including road surface markings.

- Renovation of bus terminals and facilities.
- Expanding paid off/on-street parking system.

(2) Strategic Approach of Suburban Area

The central city has limited development areas in terms of urban capacity and securing and maintaining present good scenery and open spaces, so that further concentration of socio-economic activities in this area will critically hamper the function of the city. Future population growth, therefore, shall be induced into the suburban areas. From this point of view the principal approach to this area is to formulate a systematic and functional transport network to be integrated into the proposed urban development scenario in order to provide serviceable access to new development areas.

- Integration of transport system into the proposed urban development scenario.
- Establishment of functional road hierarchy considering the long distance and international traffic.
- Intensifying and expanding of public transport services.
- Improving and widening of the existing main roads and constructing of missing links of main roads.
- Effectively and efficiently connecting with main roads among the central city and such planned development areas as satellite cities, industrial zones, logistics terminals and railway stations.
- Reconstruction of existing deteriorated and malfunctioning bridges on main roads.
- Securing ROW widths in a phase manner so as to minimize negative social impact.

16.3 TARGETS AND STRATEGIES OF TRANSPORT PLAN

16.3.1 Principal Policy

The purpose of the urban transport plan is to establish transport system which supports development of appropriate economic and social activities in Vientiane. Targets and strategies for such transport plan are illustrated in Figure 16.3-1. As easily seen in the figure, the targets proposed here are in line with the objectives and policy on "the National Strategy and Action Plan on Environmentally Sustainable Transport" of the Government of Lao PDR.

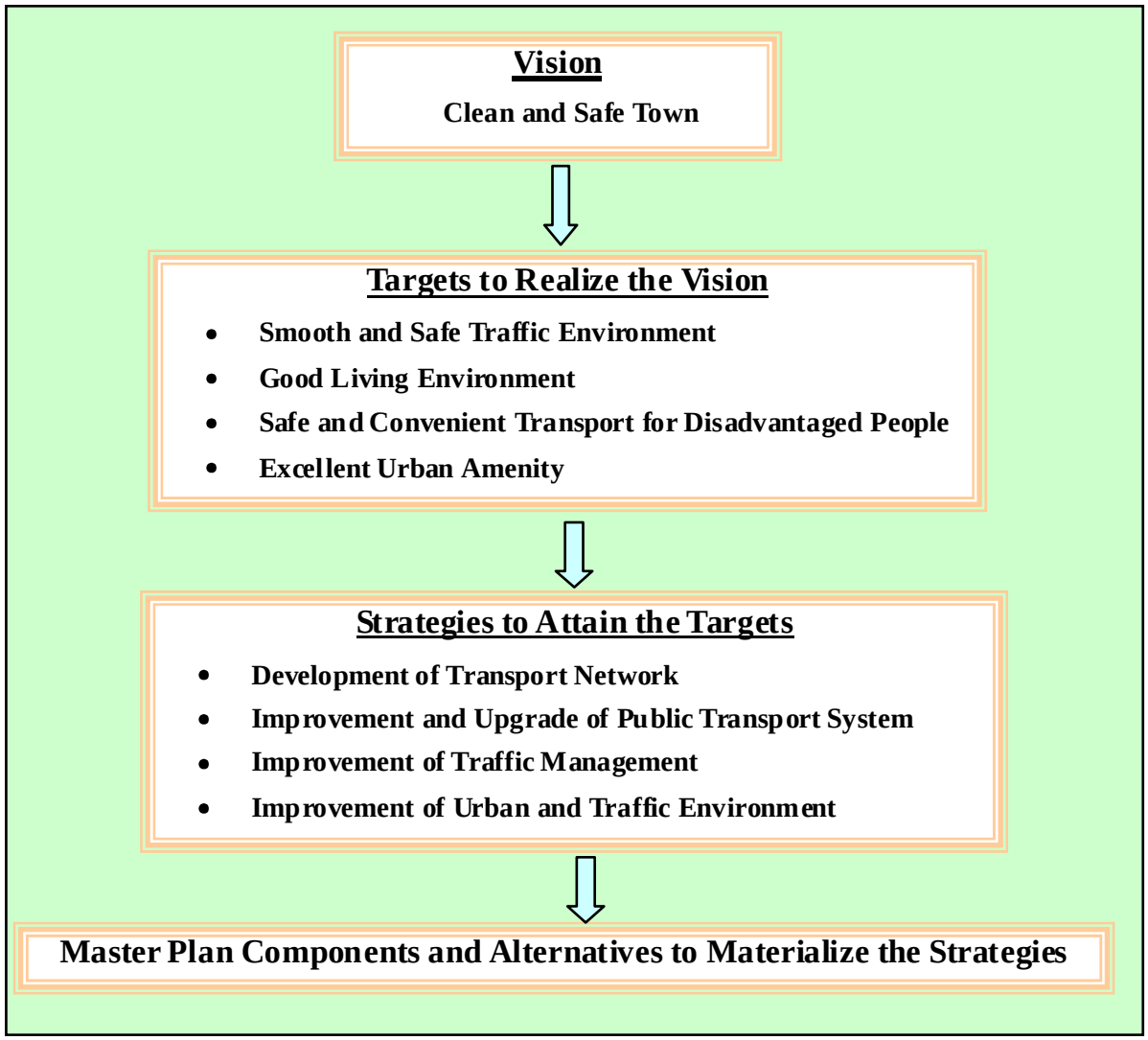


Figure 16.3-1 Principal Policy to Formulate Urban Transport Plan

16.3.2 Establishment of Strategies

The following strategies are set based on the Principal Policy above and in line with the Planning Policy and Development Strategy described in the previous sections.

Strategy 1: Development of Transport Network

Establishment of an appropriate functional road network to support the future development plans is indispensable for the desired socio-economic development, which formulates the skeleton of the transport network in the study area. The roles of the road network are as follows:

- To provide the basic infrastructure for urban transport system
- To serve the smooth operation of public transport services including bus service.
- To contribute to the improvement in traffic safety as well as in air pollution, noise and vibration with good road conditions and smooth traffic flow.

Strategy 2: Improvement and Upgrade of Public Transport System

As the population and economic grow, the public transport system will have to convert motorcycle and private car-dominant system to a comprehensive public transport system to cope with the increasing future traffic demand. An efficient and safe public transport system not only reduces the total number of traffic volume but also contributes to alleviating traffic congestion, reducing the number of traffic accidents and reducing air pollutants emitted by vehicles. The requirements for the efficient and safe public transport system are listed as follows:

- Appropriate system responsive to the future traffic demand.
- Transport system which is appropriate and suitable for Vientiane as the capital city.
- Transport system which can coexist and mutually complement the present paratransit system.
- Transport system which encourages motorcycle and private car users to convert their usage to public transport usage.
- Transport system which need not a large amount of investment and can flexibly respond to the future traffic demand increase.

Strategy 3 Improvement of Traffic Management

Traffic flow in disorder manner due to undisciplined driving behavior of cars and motorcycles is one of the major causes of traffic congestion and accidents. Other undisciplined behavior of vehicles such as illegal parking will cause serious traffic congestion and traffic accidents in near future as well. Appropriate traffic management including

improvement of geometry of the intersections, traffic signals, traffic signs and road markings is essential to the following. As far as Transportation Demand Management (TDM) is also one of the often-adopted measures. These measures, however, are considered as supplementary measures in the Study since the Study is intended to propose "preventive measures" for urban transport.

- Reduction of traffic accidents.
- Preventing serious traffic congestion in near future.

Strategy 4: Improvement of Urban and Traffic Environment

The following need to be implemented to correspond to the future traffic demand, minimizing unfavorable influences on the urban environment, such as noise, vibration and air pollution, forming desirable urban communities and maintaining the good/attractive urban environment for dwellers and visitors.

- Improvement of pavement conditions of arterial and collector roads.
- Expansion of public transport which favorably affects the urban environment.
- Enhancement of non-motorized transit including provision of pedestrian zones.
- Introduction of eco-friendly buses.

16.4 COMPONENTS FOR TRANSPORT MASTER PLAN ALTERNATIVES

16.4.1 Preventive Approach to Urban Transport Issues

Present traffic congestion and environmental conditions in Vientiane is not so serious yet comparing with other metropolises in the surrounding countries. However, it might be deteriorated in the future due to anticipated steep increase in traffic demand, if due consideration is not given. In view of this, the Study focuses on how to prevent the traffic congestion and deterioration of environmental conditions of Vientiane. "Preventive approach" is, therefore, adopted in studying the urban transport plan. Meaning of preventive approach in the Study is shown in Figure 16.4-1 and Figure 16.4-2.

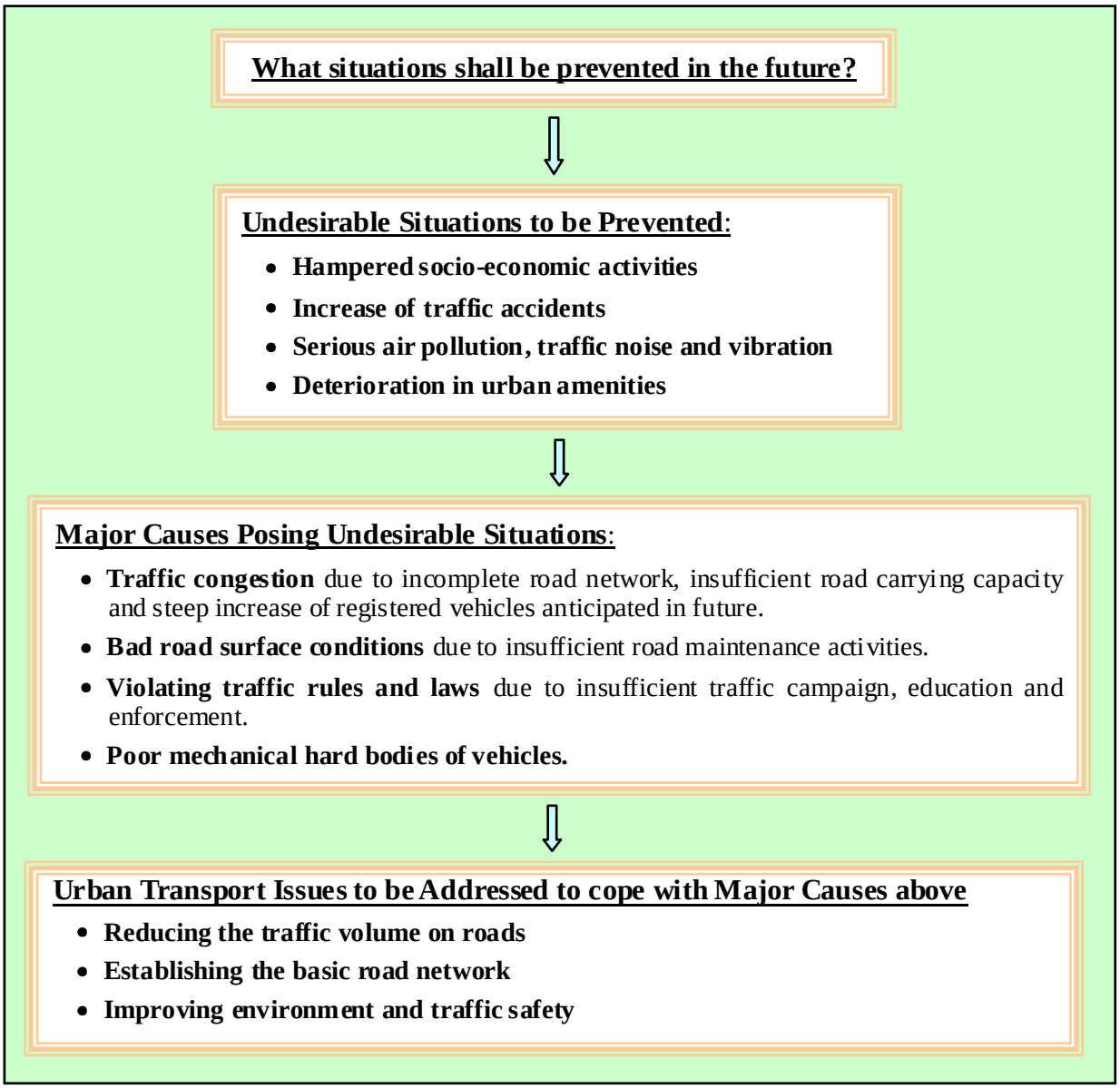


Figure 16.4-1 Meaning of Preventive Approach

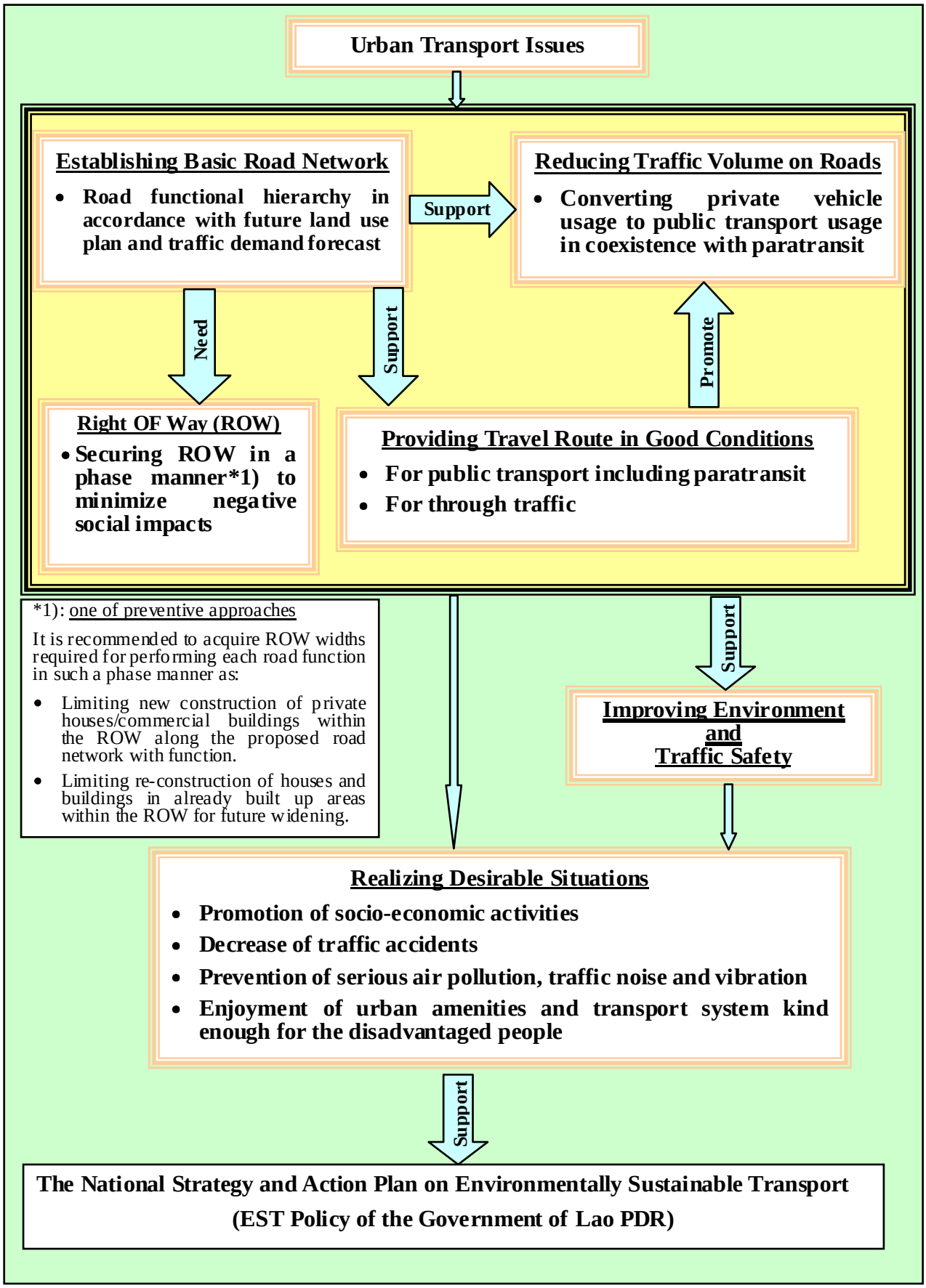


Figure 16.4-2 Preventive Approach for Urban Transport Issues

Urban Transport Issues

Urban transport issues can be addressed by incorporating supply-side, demand-side, and environment and traffic safety strategies into the urban transport system. The supply-side strategy encompasses measures such as expanding road capacity and improving public transport system that increase the carrying capacity of the transportation system. The demand-side strategy involves measures such as intensifying traffic demand control that reduce the number of private vehicle movements, especially during peak hours. These strategies are closely related to environment and traffic safety strategies. In general, supply-side strategies are much more costly to society as a whole than demand-side strategies. The latter impose most of their costs directory onto commuters to get them to change their behavior. In contrast, supply-side strategies cost commuters little directly, but require substantial social investments.

16.4.2 Measures to Solve Urban Transport Issues

(1) Basic Policy

From the view point of the present public transport system in Vientiane, centering on public transport system incorporating paratransit is to be recommended to solve the future urban transport issues as shown in Figure 16.4-3, which accords also with such projects as Environmentally Sustainable Transport in Laos (Policy Study) and Vientiane Sustainable Transport Initiative. Public transport-oriented system leads to reducing the total number of vehicles on roads, resulting in minimizing investment costs*1) for expanding road carrying capacity, reducing the number of traffic accidents and loads to environment.

*1) Please refer to Table 16.6-2. Comparing between Alternative 1 (present pattern development scenario) and 3 (bus favored scenario) regarding average traffic volume to road capacity (Ave. V/C) ratio, if the same level of service in both scenarios is required, Alternative 3 needs only about 58 % of carriage way width necessary for Alternative 1. If making operation of bus service profitable, development of clustered residential areas near bus stops is preferable. Clustered residential areas require smaller life infrastructures costs such as sewage system, facilities for water supply, total road length and facilities for electric supply than dispersed residential area.

Major components to establish the Master Plan alternatives are as follows.

Supply Side Measures (Increasing Carrying Capacity)

(a) Development of road network

- Completing basic road network.

(b) Widening of existing roads and improving existing road surface conditions

(c) Countermeasures against traffic accident prone spots and traffic bottle necks

- Improving intersections.

(d) Making transport system more efficient

- Programmed repairs and improvements aimed at properly maintaining existing arterial and collector streets.
- Coordinated timing of traffic signals along arterial streets.

(e) Expanding the capacity of existing bus transit systems including provision of bus priority or exclusive lanes

(f) Systematically incorporating paratransit system into public transport system

Demand Side Measures (Rectifying Vehicle Users' Behavior)

(a) Encouraging bus transport use and ride sharing

- Prohibiting free parking for workers/students commuting by private vehicles.
- Providing free parking for workers/students using car/motorcycle pools or van pools at public transport stops.
- Providing vans at company expense for employees who will use them to share rides with other employees.
- Providing free shuttle buses linking offices/schools to nearby public transport lines during peak hours.
- Subsiding fares for workers/students who commute on public transport.
- Persuading public bus suppliers to provide route buses or other transport services directly to or adjacent to offices/schools or job centers.

(b) Raising the cost of using private vehicles

- Raising taxes on the sale of gasoline or petroleum products.
- Increasing such costs of owning a vehicle as value added tax and registration tax.
- Raising the cost of parking
  - Parking charges in areas with heavy congestion should be higher than those in areas with light congestion.

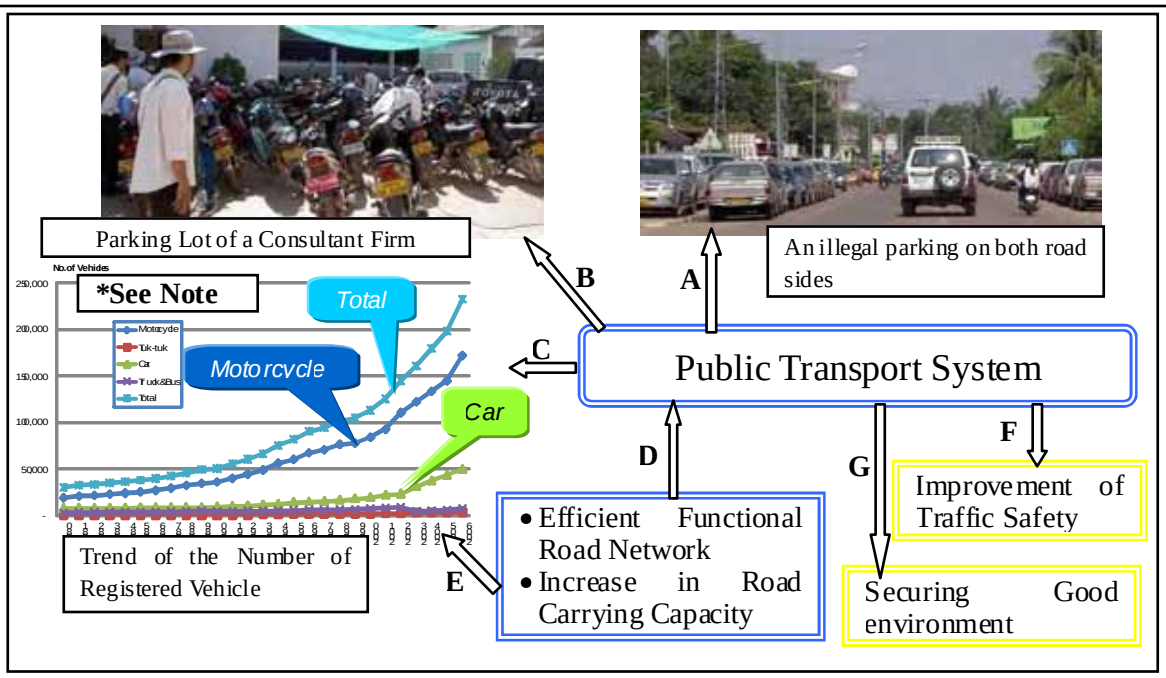
(c) Shifting peak-hour trips to other times of the day

- Many peak-hour trips could be shifted to other times of the day by staggering work hours among different organizations adopting flextime policies

(d) Peak-hour road pricing

(e) Increasing residential densities (this will produce the following benefits)

- Reducing total movements required by the population.
- Reducing the costs of infrastructure trunk lines (ex. major sewer, water, road and utility lines)
- Increasing the feasibility of using public transport for commuting (clustering high density housing near public transport stops could substantially increase public transport usage)



A: Support to reduction of illegal parking and securing spaces necessary for parking

If convenient public transport service and bus stops adjacent to major facilities are provided, this kind of situation could be avoided. In order to avoid this kind of illegal parking, convenient and reliable public transport system is needed for commuting as well as regulatory approach to parking issue.

B: Support to reduction of the total traffic volume during peak hours

If employers enforce employees not to use private vehicles for commuting to avoid this kind of situation, convenient and reliable public transport system should be provided.

C: Support to reducing the traffic volume on roads

Since continuing of this increase trend in registered vehicles is inevitable, reducing the number of traffic volume on roads is necessary to alleviate traffic congestion on roads by expanding convenient and reliable public transport system.

D: Promotion of converting private vehicle use to public transport use

The most fundamental matter for establishing convenient public transport system including paratransit is to provide efficient functional road network.

E: Support to socio-economic activities

Judging from the vehicle registration trend, future rapid traffic demand is highly expected.

Increase in road carrying capacity to accommodate the future rapid traffic demand is basic matter required for not hampering socio-economic activities by alleviating serious traffic congestion in harmony with future land use plan.

F: Reducing the number of vehicles driven by amateur and undisciplined drivers

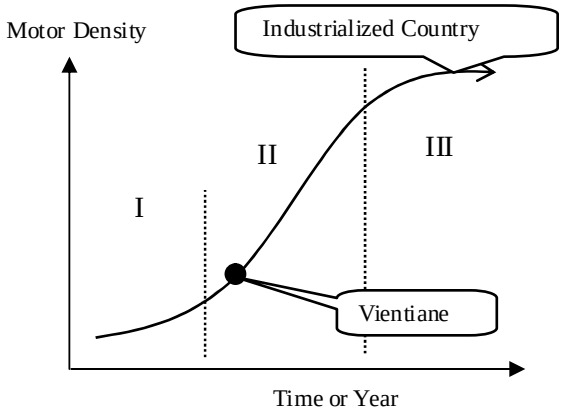
Reducing the total number of private vehicles on roads by shifting them to public transport will lead to reducing the number of traffic accidents because drivers of public transport are well disciplined, professional drivers.

G: Reducing loads to environment

Extensive use of public transport can certainly reduce the total number of vehicles on roads, which results in reducing air pollution and mitigating traffic noise and vibration.

Figure 16.4-3 Basic Policy for Urban Transport Issue

***Note**



Typical Curve of Developing of Motorization

In many industrialized countries the number of cars per capita has gone through a development of an S-shaped curve as shown in the figure.

Stage I: Developing Motorization
: Economy requires higher priority than safety.

Stage II: Exploding Motorization
: Traffic safety a growing concern.

Stage III: Saturating Motorization
: Traffic safety to compete with the environment.

(2) Measures of Urban Transport Plan

Measures for the urban transport plan are as follows:

- Improving transport facilities (Supply side) (shown in Table 16.4-1)
- Rectifying transport demand (Demand side) (shown in Table 16.4-1)
- Improving Environment and traffic safety (shown in Table 16.4-2)

(3) Measures for Encouraging Conversion of Private Vehicle Usage to Public Transport Usage

Table 16.4-1 Components of Measures for Master Plan Alternatives

Improving Transport Facilities	Rectifying Transport Demand
(1) Existing Roads	(1) Traffic Demand Control
-Improvement of road surface conditions	-Guiding desired land use
-Improvement of drainage facilities	-Guiding desired urban structure/function
-Improvement of intersections	-Clustering high-density housing near transit station stops
-Providing appropriate and uniform road surface markings/motorcycle lanes	-Concentrating jobs in big clusters in areas of new growth
-Reconstruction of deteriorated bridges	-Adopting local growth limits
(2) Road Network	-Building regulation
-Completion of the missing links	-Establishment of efficient logistics system
-Establishment of basic road network including access to the planned development zones	-Encouraging people to work at home
-Construction of intra-/inter-city expressway	-Preparing work laws that encourage working at home
-Construction of high standard roads	-Introduction of ride sharing
-Control of through traffic	-Introduction of color coding. road pricing, park/kiss and ride
(3) Road Traffic Management System	-Introduction of staggering working hours
-Improvement of traffic control/signal system	-Concentrating jobs in big cluster in areas of new growth
-Improvement of regulation on on-/off- street parking	
-Improvement of traffic management system	
-Adding HOV lanes	
-Rapidly removing accidents	

Improving Transport Facilities	Rectifying Transport Demand
(4) Public Transport System -Improvement of existing public transport modes -Improvement of operation system of existing public transport modes -Improvement of bus services including such facilities as bus terminals and stops -Introduction of high-speed bus system -Introduction of bus rapid transit system -Introduction of trolley bus system -Introduction of rail-type public transport system (5) Bicycle/Pedestrian and Other Facilities -Construction of bicycle lanes/roads -Construction of pedestrian bridges -Construction of truck terminals	(2) Management of Vehicle Ownership -Improvement of vehicle tax system -Improvement of drivers' license system -Increasing vehicle license fees -Improvement of vehicle inspection system -Improvement of import tax system (3) Control of Vehicle Usage -Improvement of fuel tax system -Introduction of road-user tax system -Charging fees for the usage of all the public parking facilities (4) Rectification of Public Transport -Introduction of appropriate fare system -Introduction of monetary benefit system for commuters -Promoting coexisting system between mass transit and paratransit

Table 16.4-2 Measures for Improving Environment and Traffic Safety

Improvement of Environment	Traffic Safety*
(1) Emission Source -Improvement of vehicle mechanism -Introduction of low-emission/eco-friendly vehicles including private vehicles, trucks and buses -Improvement of bus transport system -Introduction of rail-type public transport system -Encouraging use of non-motorized vehicles (2) Traffic Flow -Create orderly traffic flow (Appropriate road surface markings and enforcement) -Guiding vehicles to functional class of road suitable to the type of vehicle -Regulation on operation of trucks in designated zones (3) Road Facilities -Improvement of road surface conditions -Installation of environmental buffer zone -Installation of noise barrier -Providing pedestrian zones -Securing sufficient road spaces as fire-shuttering zones -Securing sufficient road spaces in densely populated areas (4) Road Side Area -Promotion of appropriate roadside land use -Regulation on roadside buildings	(1) Traffic Safety Facilities -Segregation among pedestrians, motorcycles and cars -Construction/improvement of bicycle lane/road and sidewalks -Improvement of traffic safety facilities at black spots including appropriate road surface markings (2) Motor Cycles -Establishment of encouragement measures for converting motorcycle usage to public transport usage -Providing motorcycle lane (3) Traffic Safety Education -Continuous implementation of traffic safety education -Implementation of traffic education campaign -Implementation of "Intensive Traffic Safety Week" or "Intensive Traffic Safety Month" (further strengthening of traffic enforcement for these periods than usual) (4) Traffic Enforcement -Improvement of traffic enforcement methodology -Strengthening of institutional organization for traffic enforcement

*: This Study needs coordination with the National Level Road Safety Action Plan formulated by MCTPC.

With respect to encouraging conversion of private vehicle usage, especially motorcycle usage, to public transport usage, the following approaches shall be considered in implementing.

The Market-Based Approach (Voluntary Market Forces)

Market-based measures assign monetary value to different types of travel behavior and then rely on travelers to choose among them. Their goal is to achieve more efficient use of scarce resources, usually by making the prices of different travel options more nearly equal to their social costs so that marginal benefits will equal or exceed marginal costs. Factors for deciding their choices can be listed as follows.

- Convenient and punctual public transport services with reasonable fares with diverse service routes provided.
- Providing monetary benefits to commuters including both workers and students.
  - Employers pay each worker travel allowance but charge parking fee for providing their parking spaces. This encourages workers to use public transport or to share rides.
  - Employers give each worker a commuter pass in cooperation with public transport companies but charge parking fee for providing their parking spaces to private vehicle users. This provides considerably large monetary benefits to commuters, and since public transport companies can gain stable income, they could afford to offer discounted fare for the commuter pass.
  - Public transport companies provide special discounted commuter pass to students in order not only to encourage to shift motorcycle usage to public transport usage but also to mitigate families' expenses for their education, resulting in gaining stable income for the companies and reducing such social costs as traffic accidents.
  - All the public parking spaces shall be charged.
  - Such other measures as introduction of road pricing for private vehicle users.

The Regulatory Approach (Compulsory Administrative Regulation)

Regulation mandates certain behaviors or prohibits others. It does not attach varying prices to different behaviors, nor does it leave the choice up to individual travelers. Instead it prohibits or limits by government fiat the behaviors it wants to discourage and permits or requires those it wants encourage.

- Prohibiting students' commuting by private vehicles mainly including motorcycles.
  - Providing such compensating measures as school bus and convenient and safe bus service for commuting is necessary.
- Introduction of color-coding system
  - Prohibiting automobiles with license plates ending in a particular digit number from

driving on specific days, and those ending in other digits from driving on other specific days.

- Introduction of three in one
  - One car shall be occupied during peak hours by three or more persons including a driver.

The latter two items, color-coding system and three in one, are not so important at present in terms of reducing motorcycle usage that they shall be studied in case that serious traffic congestion appears during peak hours in the future.

16.4.3 Consideration on Environmentally Sustainable Transport

With rapidly growing concern over global warming or climate change, it is a worldwide movement to reduce use of private motorized vehicles. This movement is accelerated by soaring of fuel price in the past one year or so.

Lao PDR, with Vientiane, has been one of the active members of the Environmentally Sustainable Transport (EST) Forum supported by United Nations Centre for Regional Development (UNCRD) and other multi-lateral and bilateral international organizations. This Forum is promoting development of transport system which minimizes emission of greenhouse gas and other pollutants. Currently, the Government of Lao PDR is preparing EST Action Plan.

In view of the above, this Study proposes encouragement of non-motorized vehicles (NMV), such as bicycles, in addition to the strengthening of public transport.

Use of NMV is also encouraged in tourist zones and city centers where high-speed is not feasible or necessary. Examples of such zones include the zone enclosed by Samsenthai Rd. and Fa Ngum Rd. (City Center), zone along Mekong River and zone around Victory Monument. Commuting by bicycles also should be encouraged to students and workers.

The measures for encouraging use of NMV include the following:

(i) Provision of bicycle lanes, segregated from motorized vehicles as much as possible
(ii) Provision of bicycle parking at strategic locations
(iii) Encouragement of commuting by bicycles at schools and offices

16.5 FORMULATION OF MASTER PLAN ALTERNATIVES

16.5.1 Urban Transport Development Policy

(1) Establishment of Urban Transport System

In order to achieve the vision set forth in the Study and to meet the objectives and policy on "the National Strategy and Action Plan on Environmentally Sustainable Transport" (EST Policy) of the Government of Lao PDR, the public transport needs to be extensively integrated into the urban transport system, especially for commuting to/from work and school and for transporting disadvantaged people.

Figure 16.5-1 illustrates the conceptual diagram of the roles of public transport in the desirable urban transport system. From this figure, it is learned that for efficiently and effectively connecting the generation and attraction points, establishment of road functional hierarchy and clarification of the roles of mass public transit and paratransit using those roads are of great importance.

(2) Functional Road Network to Support Urban Transport System

Roads in Vientiane are categorized only from such administrative view point as national roads, provincial roads and district roads. Functional hierarchy system needs to be introduced and established for the formulation of the master plan alternatives on the urban transport system centering on the public transport. From this present situation, the basic matters on the road functions are first to be discussed, applying them as practically as possible to the future road network in the Study.

Functional System and Classification

The classification of roads into different operational systems, functional classes or geometric types is necessary for communication among engineers, administrators, and general public. Different classification schemes have been applied for different purposes in rural and urban regions. Classification of roads by design types based on the major geometric features such as arterial and collector roads is the most helpful one for road location and design procedures. Classification by route numbering is the most helpful for traffic operations. Administrative classification such as national and provincial roads is used to denote the levels of government responsible for, and the method of financing, road facilities. Functional classification, the grouping of roads by the character of service they provide, was developed for transport planning purposes. Comprehensive transport planning, which is an integral part of total economic and social development, uses functional classification as important planning tool.

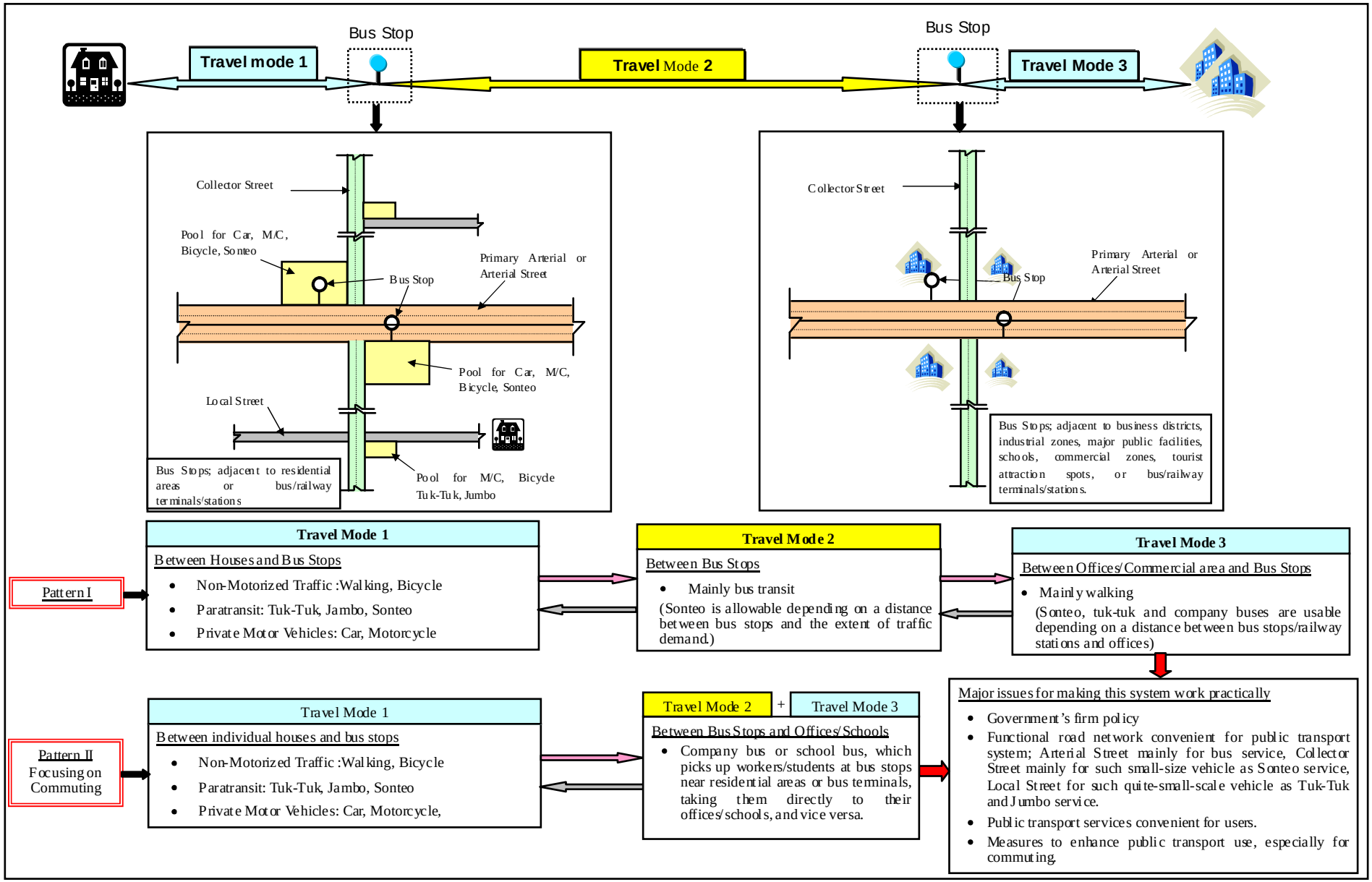


Figure 16.5-1 Basic Concept of Urban Transport System Centering on Public Transport

A complete functional design system provides a series of distinct travel movements, namely the following six (6) stages in most trips include; main movement, transition, distribution, collection, access and termination.

Under the functional design system above, roads are basically classified into three (3) types with respect to their functions; the arterial road, collector road and local road. Arterial roads are main roads with the highest standard and cater to large volume of traffic with longer trip length and higher travel speed. Collector roads connect arterial roads and local roads. Local roads connect houses, shops and other facilities directly with collector roads or arterial roads. An example of the ideal road network representing the above relationship is illustrated in Figure 16.5-2.

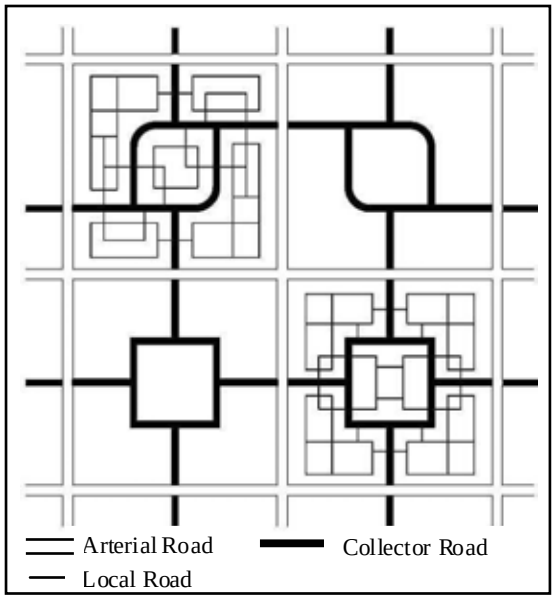


Figure 16.5-2 An Example of Road Network Limiting Trough Traffic to Access

Application of Road Network Pattern

Arterial roads are generally categorized into four (4) patterns as shown in Figure 16.5-3; spider-wave pattern system, grid pattern system, ladder pattern system and slant-line pattern system. In the core city area of Vientiane, road network is principally formulated with the grid pattern system, while some major roads in suburban area are developed in the radial pattern from the core city area.

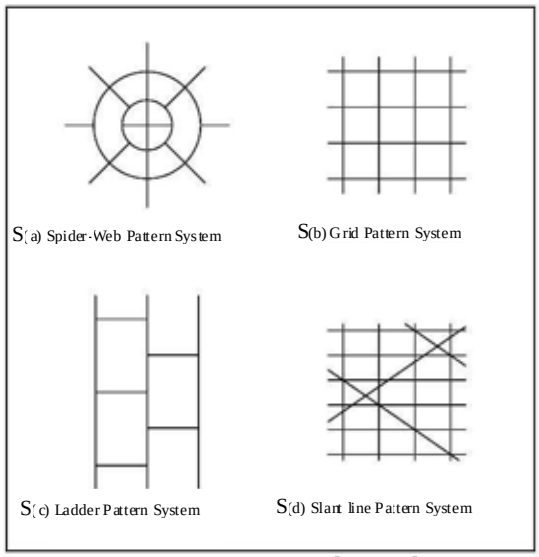
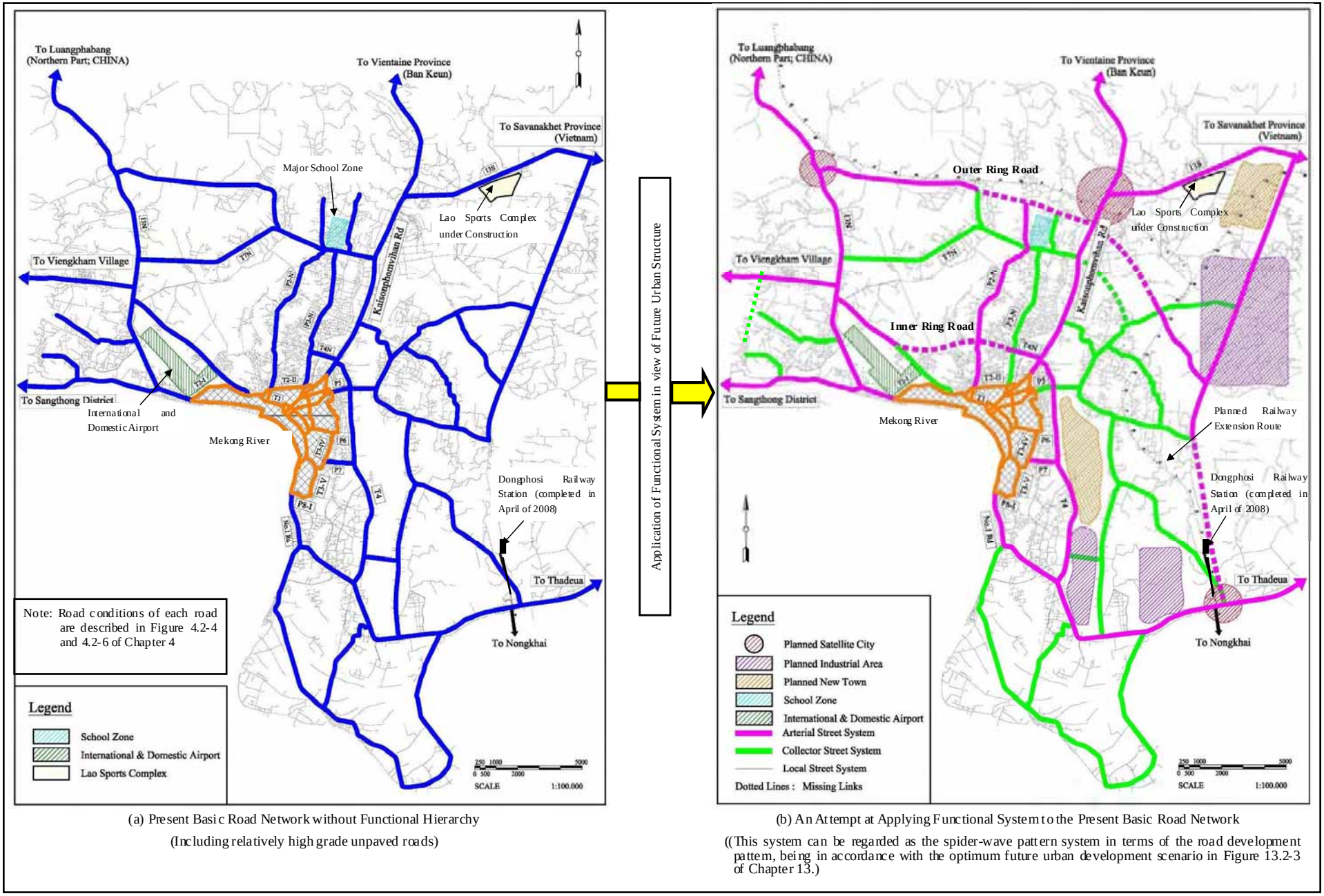


Figure 16.5-3 Basic Road Development Pattern (——— ; Arterial Street)

Figure 16.5-4 shows; (a) is the present basic road network in Vientiane with being developed without functional hierarchy and disorderly; (b) is an attempt at applying the functional road network system to the present basic road network, considering the future urban structure recommended as the optimum future urban development scenario in Figure 13.2-3 of Chapter 13. This road network can be regarded as the spider-wave pattern system in terms of the road development pattern shown in Figure 16.5-3. Through the attempt at applying the functional hierarchy system and the survey results of the existing road conditions described in Chapter 4, the following four (4) items to be addressed are revealed with regard to future road development issues.



(a) Present Basic Road Network without Functional Hierarchy

(Including relatively high grade unpaved roads)

(b) An Attempt at Applying Functional System to the Present Basic Road Network

((This system can be regarded as the spider-wave pattern system in terms of the road development pattern, being in accordance with the optimum future urban development scenario in Figure 13.2-3 of Chapter 13.)

Figure 16.5-4 Application of Road Functional Hierarchy to the Present Road Network

- In view of future urban development scenario, providing the outer ring road connecting the planned satellite cities and major areas to be developed is essential to support and enhance sustainable socio-economic activities through securing the smooth traffic mobility.
- The basic road network has not yet been established. There are several important missing links to be connected for having the road functions efficiently perform, including the inner ring road and outer ring road.
- Taking into account of the present road conditions, the existing road should be so widened and paved as to be correspondent to the geometric standards required to perform each road function.
- The road network shown in Figure 16.5-4 (b) is to be utilized as the basis for the formulation of road development scenarios, along with the survey results of the existing road conditions such as road widths and road surfaces.

It is recommended that the arterial street system be further divided into two (2) systems; primary arterials and arterials. Features and roles of the street systems are as follows:

(a) Primary Arterial Street System

- This system serves the major centers of activity of Vientiane, the highest traffic volume corridors and the longest trip desires.
- This system carries most of the trips entering and leaving the area, as well as the trough movements bypassing the central city.
- This system serves significant intra-area travel, such as between central business districts and outlying residential areas, between major inner-city communities, and between major suburban centers.
- This system carries important intra-urban as well as intercity bus routes.
- Providing frontage roads for this system is recommended to secure high traffic mobility by separating local traffic from main traffic as much as possible as shown in Figure 16.5-5.

(b) Arterial Street System

- This system interconnects with the primary arterial system and accommodates trips of moderate length at a somewhat lower level mobility than primary arterials do.
- This system places more emphasis on land access than the primary arterial system does and provides local bus routes.

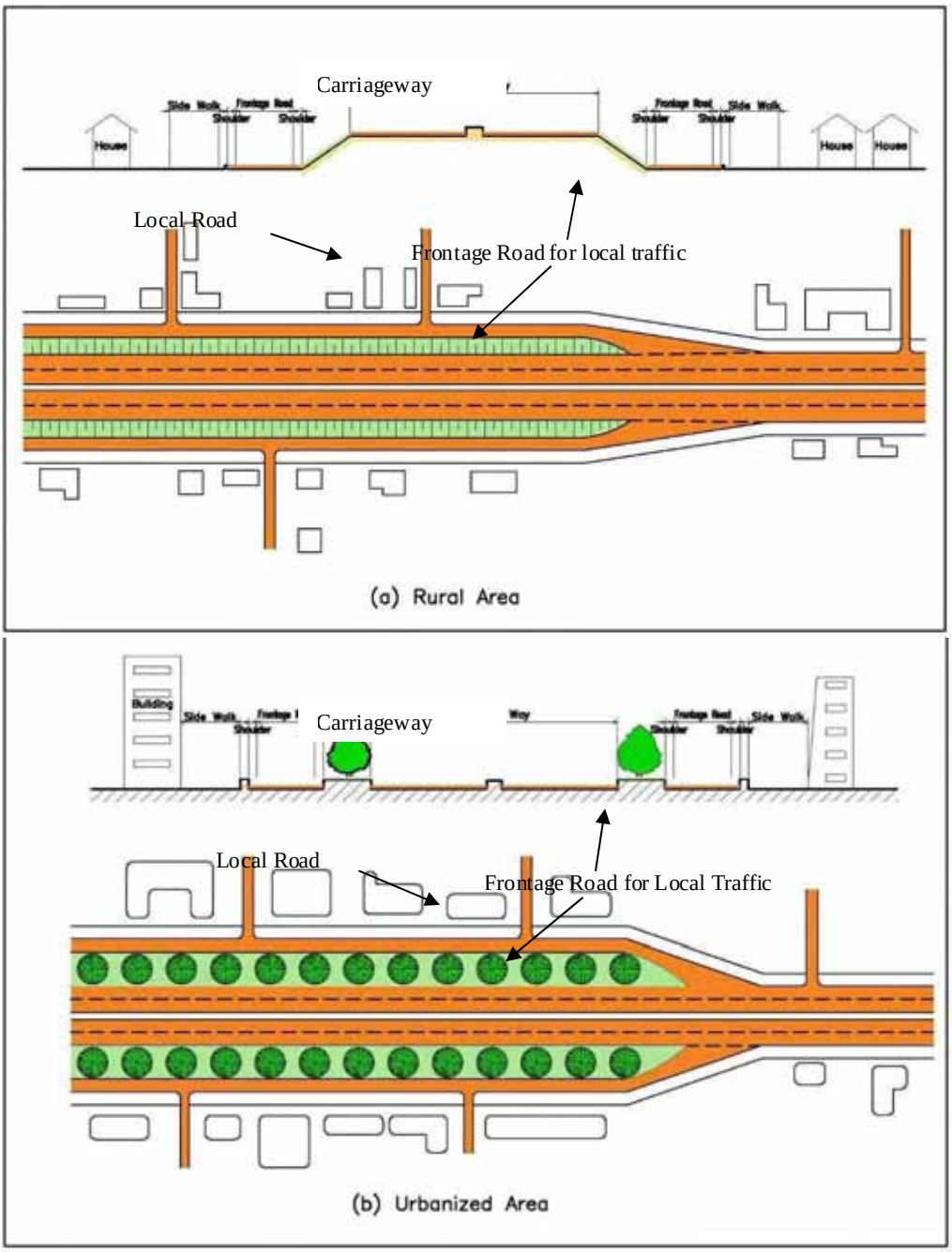
(c) Collector Street System

- This system collects traffic from local streets in residential neighborhoods and channels it into the arterial system.
- This system provides local bus routes as well as the arterial system does.

- In the central business district, this system may include the entire main street network.

(d) Local Street System

- This system primarily permits direct access to abutting lands and connections to the higher order system.
- This system offers the lowest level of mobility and usually includes no bus routes.



- Through partially limiting access to carriageway from local/collector or local/collector streets by offering frontage roads, a relatively high level of traffic mobility can be secured, which leads to reducing traffic congestion and accidents.
- Spaces between carriageway and frontage roads provide green belts, which leads to securing good urban environment and amenities.

Figure 16.5-5 Principal Arterial Street with Frontage Roads

16.5.2 Road Network Development Scenarios

Taking into account of the future traffic demand forecast for Do-Nothing case shown in Figure 15.8-4 and present traffic conditions, the following three (3) scenarios are established.

- Urgent Improvement Scenario
- Missing Link Construction Scenario
- Completion of Road Network Scenario

In addition, the lane widths mentioned below are as follows:

- One lane width is 3.25m
- 0.5-lane width is 2.5m for mortar cycles

(1) Urgent Improvement Scenario (Scenario 1)

This scenario assumes that only urgent road improvement project are implemented, which aims to reduce traffic congestion expected in near future. These improvement projects are listed as follows:

- Extension of the Inner Ring Road up to the north-eastern side of the airport and connect to the road between Nongtengtai Village and Pakthan Village.
- Widening of the existing sections of Inner Ring Road into opposed 4 lanes.
- Widening of the road connecting Dongdok – Saynamngeun – Chommani – Hongseng into opposed 4-lane road from the existing 1.5 lanes in each direction.

Figure 16.5-6 (a) shows the scenario 1 with the number of lanes in one direction for the target roads to be improved.

(2) Missing Link Construction Scenario (Scenario 2)

In addition to the urgent improvement scenario above, the following projects are to be implemented, which aims to complete the basic road network with minimum improvement of existing roads in view of future urban structure proposed in the Study.

- Missing links shown Figure 16.5-5 (b) are to be connected with 2-lane pavement road.
- The unpaved existing roads with 2-lane are to be paved.
- The road sections less than 2-lane width are to be widened to 2-lane width.

Figure 16.5-6 (b) shows the road network of the scenario 2.

(a) Scenario 1

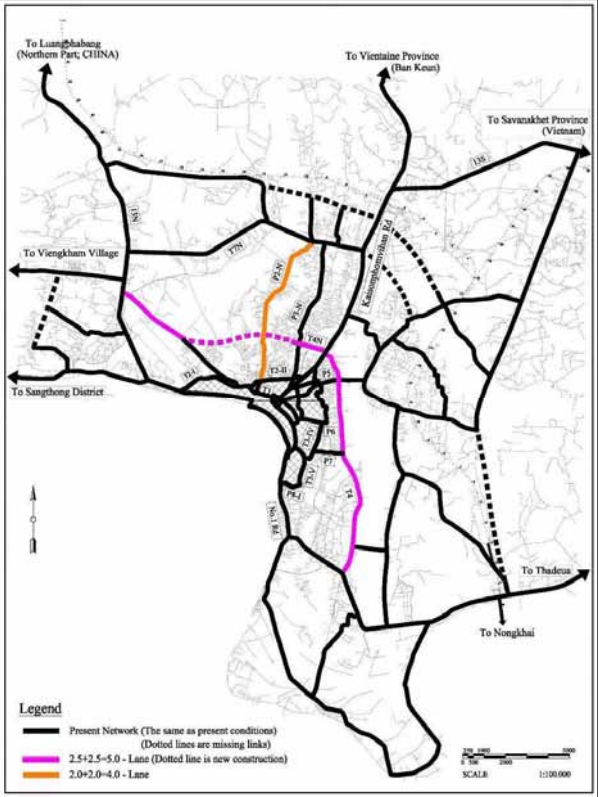


Figure 16.5-6 (a) Urgent Improvement Scenario

(b) Scenario 2

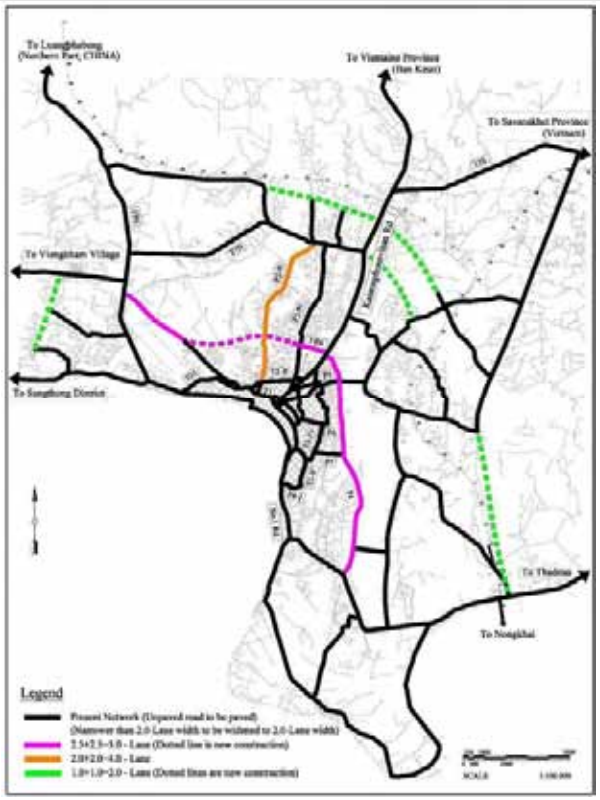


Figure 16.5-6 (b) Missing Link Construction Scenario

(c) Scenario 3

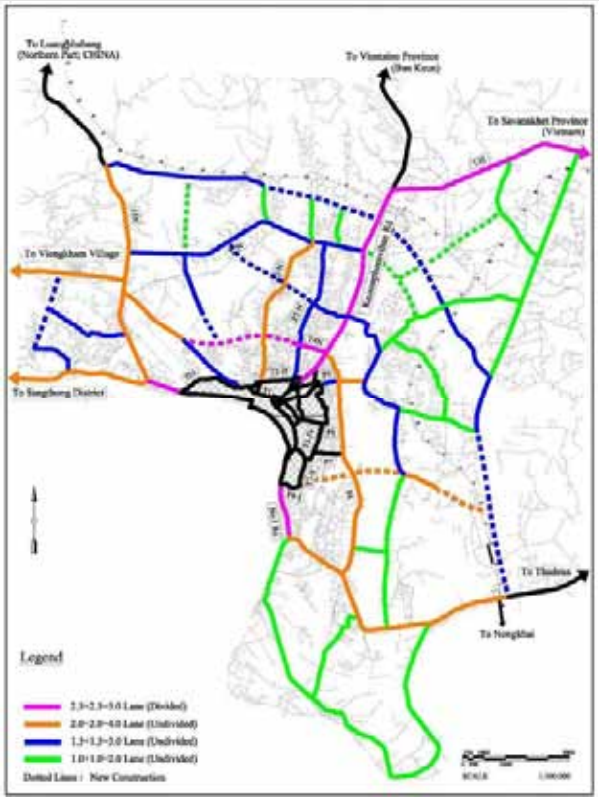


Figure 16.5-6 (c) Completion of Road Network Scenario

Figure 16.5-6 Road Development Scenarios

(3) Completion of Road Network Scenario (Scenario 3)

This scenario assumes that functional road network is to be provided so as to accommodate traffic demand in the target year of 2025 and to apply the road design standards corresponding to the functional street systems described in the preceding section. Local roads are excluded in the traffic assignment of the Study, since the Study is to treat the broad-based traffic flow.

The steps indicated in Figure 16.5-8 were taken to establish the entire road network with functional hierarchy for the scenario 3.

Figure 16.5-6 (c) shows the road network of the scenario 3, and Figure 16.5-7 shows the complete road network with desirable road widths. It is recommended that the Right-Of-Way (ROW) widths described in Chapter 17 be secured in a phase manner because acquiring desirable road widths will require large-scale resettlement and traffic demand in the target year of 2025 will not need desirable road widths. ROW acquisition for desirable road widths is presented here for further future traffic demand beyond the target year of the Study

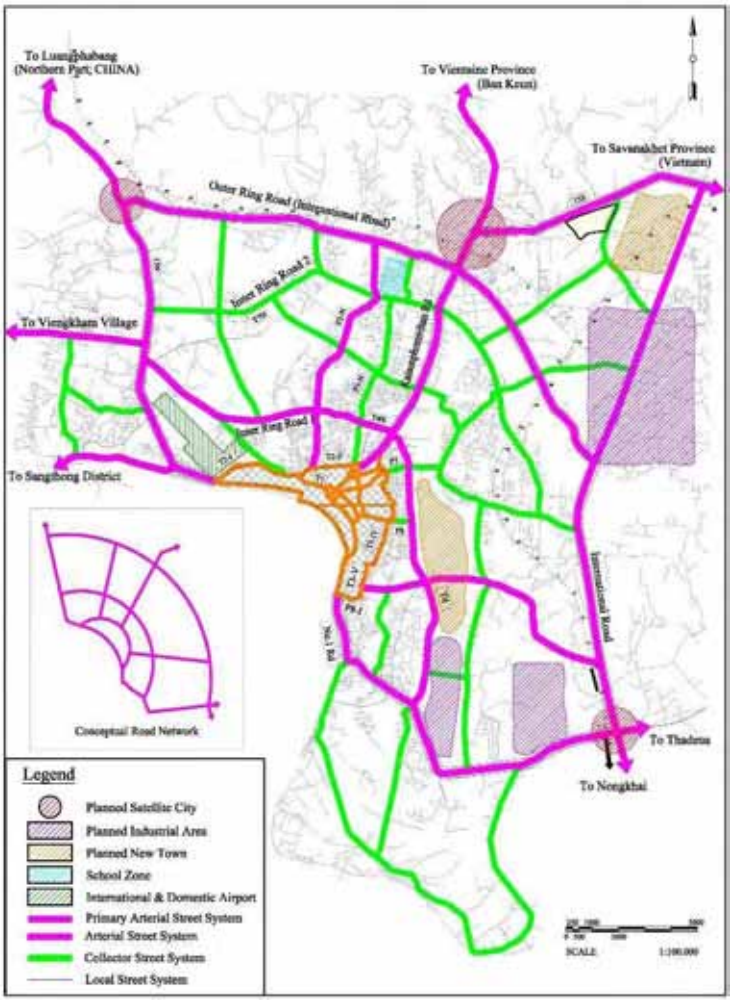


Figure 16.5-7 Complete Road Network with Desirable Road Widths

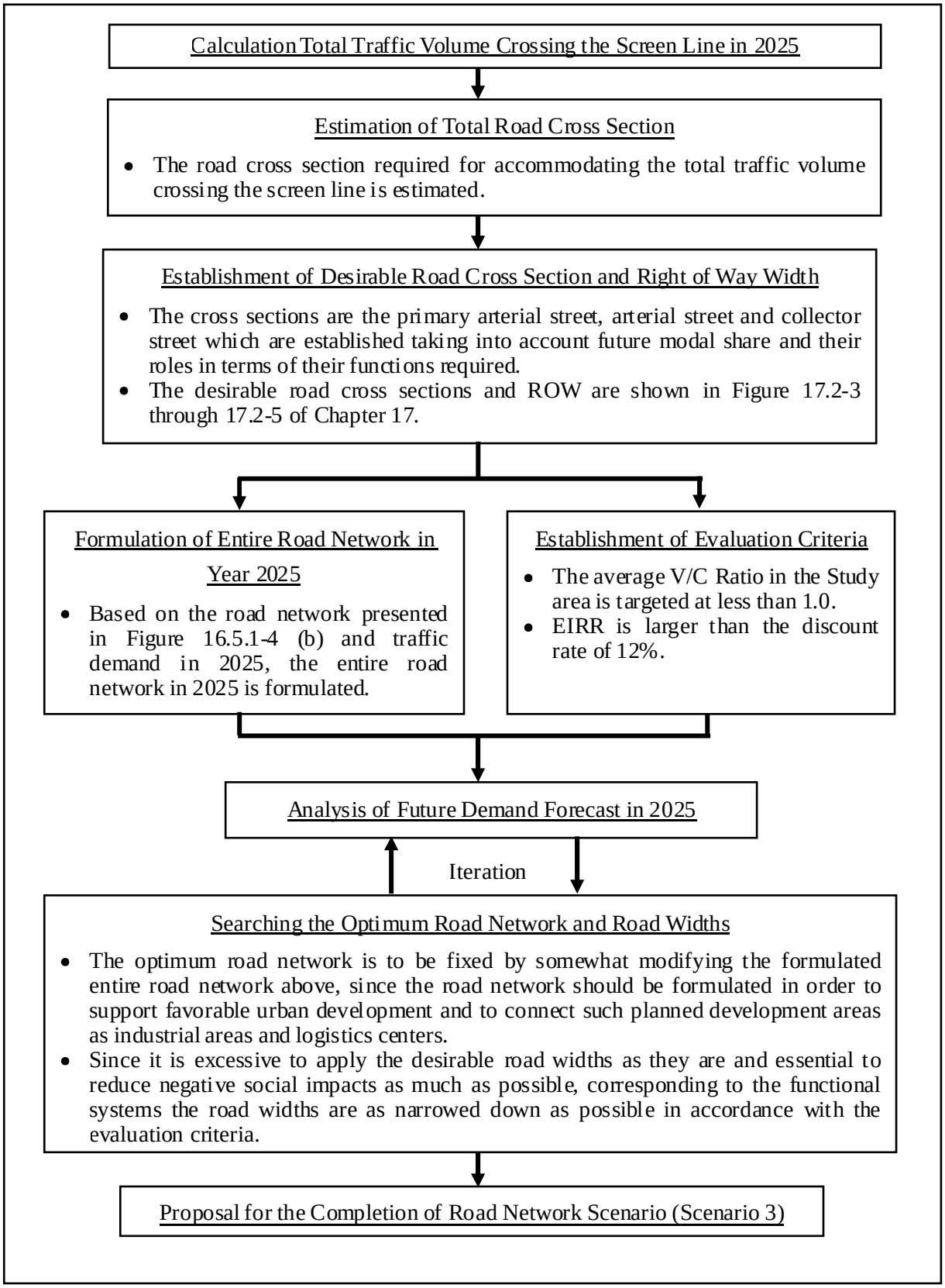


Figure 16.5-8 Procedure for the Establishment of the Scenario 3

(a) Scenario 1	(b) Scenario 2	(c) Scenario 3

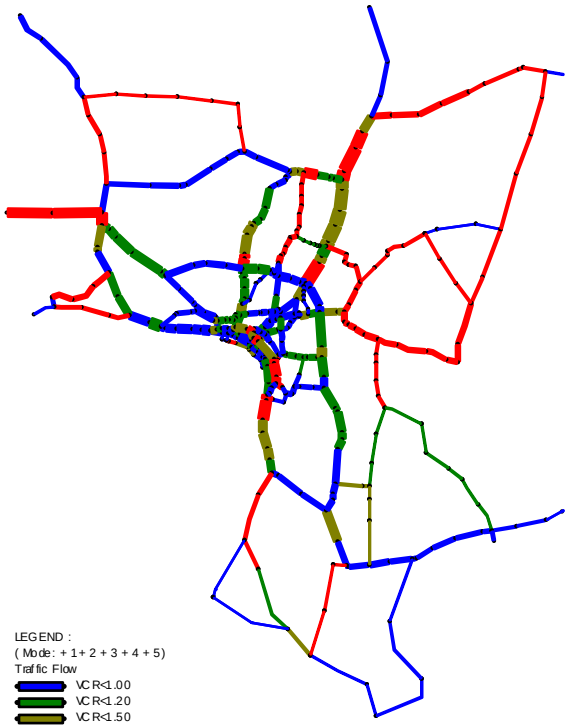
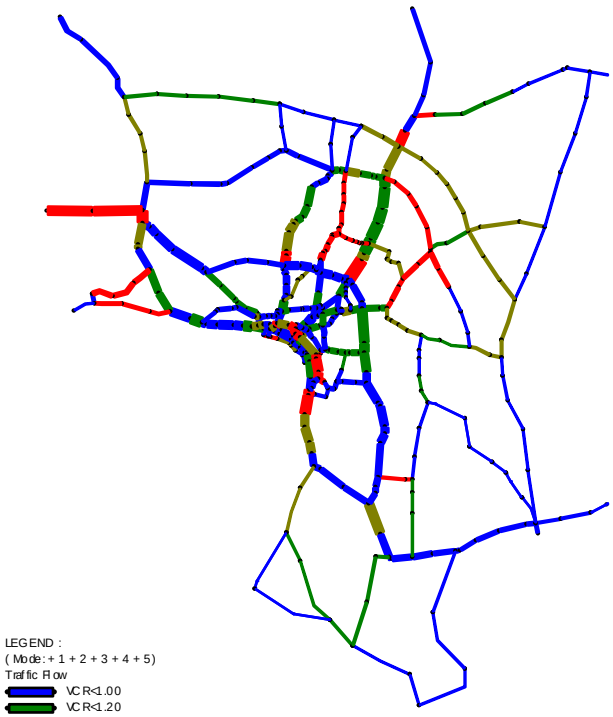
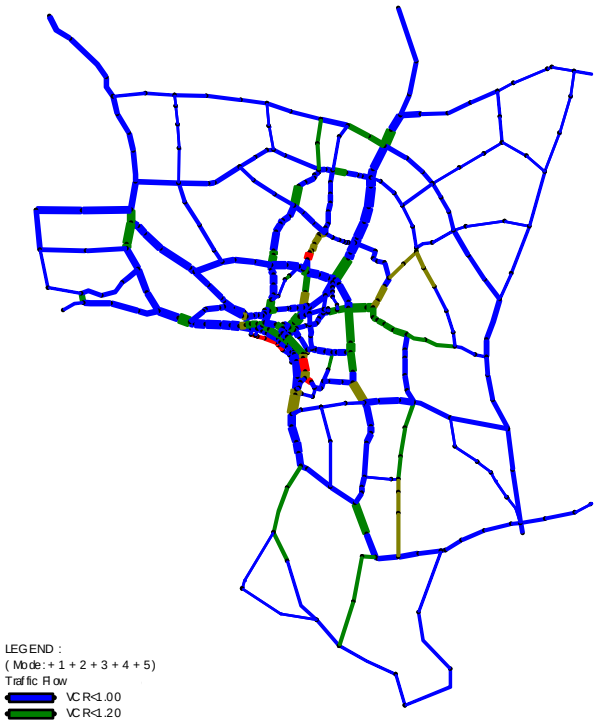

		

Figure 16.5-9 (a) Urgent Improvement Scenario	Figure 16.5-9 (b) Missing Link Construction Scenario	Figure 16.5-9 (c) Completion of Road Network Scenario

Figure 16.5-9 Traffic Assignment and V/C Ratios on Roads in Year 2025

(4) Comparative Study on Proposed Scenarios

Figure 16.5-9 is the projected traffic volume on each road with V/C ratios in 2025. Table 16.5-1 shows the average V/C ratios in the Study area, while Table 16.5-2 shows the difference in the environmental indicators.

Table 16.5-1 Comparison of V/C Ratio

Case	Total PCU-Hrs	Total PCU-km	Average Travel Speed (km/h)	Average V/C Ratio (Urban)	Average V/C Ratio (Suburban)	Average V/C Ratio (Whole)
Do-Nothing	364,006	7,467,732	20.5	1.20	1.45	1.38
Scenario1	320,844	7,324,524	22.8	1.00	1.21	1.15
Scenario2	235,057	7,199,951	30.6	0.98	1.03	1.02
Scenario3	173,273	7,128,592	41.1	0.89	0.67	0.71

Table 16.5-2 Comparison on Environmental Indicators (ton/year)

	HC*1)		CO*1)		NOx*1)	
	Weight	Difference*2) (Reduction Rates (%))	Weight	Difference (Reduction Rates (%))	Weight	Difference (Reduction Rates (%))
Do-Nothing	10,684	-	27,278	-	1,892	-
Scenario1	10,448	-236 (2.2)	26,672	-606 (2.2)	1860	-32 (1.7)
Scenario2	10,281	-403 (3.8)	26,256	-1,022 (3.7)	1809	-83 (4.4)
Scenario3	10,277	-407 (3.8)	26,242	-1,036 (3.8)	1790	-102 (5.4)

Remarks

*1): HC=Hydro Carbon, CO=Carbon Monoxide, NOx=Nitrogen Oxide(s)

Emission Unit (g/km)

	M/C	PC	Sonteo	Bus	Truck
HC	0.50	0.64	0.12	0.17	0.87
CO	2.00	0.64	0.63	2.22	2.22
NOx	0.15	0.72	0.49	2.00	3.38

Source: set by JICA Study Team based on the present emission regulation in Japan

*2) Difference between Do-Nothing case and each scenario. (Minus sign means the extent of improvement to the Do-Nothing case)

Economic Analysis of Scenarios

Economic benefits of the scenarios are to be compared by quantifying their generalized travel cost. Travel Time Cost (TTC) and Vehicle Operation Cost (VOC) were considered to quantify the benefit. Unit rates of TTC and VOC for each vehicle type are shown in Table 16.5-3, the details of which are discussed in Chapter 21.

Table 16.5-3 Unit Cost by Vehicle Type

	M/C	Car	Sonteo	Bus	Truck
TTC(US$/hr)	0.280	0.495	0.861	3.044	3.044
VOC(US$/km)	0.064	0.116	0.207	0.365	0.358
Fixed Cost(US$/hr)	0.063	1.110	1.027	1.094	1.035

Financial and economic costs of the scenarios are estimated as shown in the Table 16.5-4.

Table 16.5-4 Financial and Economic Costs

	Financial Cost (US$1,000)	Economic Cost (US$1,000)
Scenario 1	87,000	78,000
Scenario 2	125,000	112,500
Scenario 3	217,000	195,300

Economic indices of Economic Internal Rate of Return (EIRR), Cost Benefit Ratio (B/C) and Net Present Value (NPV) are shown in Table 16.5-5.

Table 16.5-5 Results of Economic Analysis

	V/C R	Travel Cost (US$1,000)	EIRR (%)	B/C	NPV (US$1,000)
DO-Nothing	1.38	516,172	-	-	-
Scenario 1	1.15	490,877	13.5	1.11	8,429
Scenario 2	1.02	447,068	17.9	1.57	64,631
Scenario 3	0.71	414,736	18.1	1.54	87,237

From the results the Scenario 3 is the most preferable in terms of the economic parameters.

Recommendation of Optimum Scenario

Scenario 3 is recommended as the optimum road development scenario judging from the following aspects of the comparative study results.

- Average V/C ratio in the Study Area is less than 1.0, which satisfies evaluation criteria.
- The extent of improvement in terms of auto emission from vehicles is the biggest comparing to that in the Do-Nothing case.
- Economic internal rate of return (EIRR) is reasonable.

16.5.3 Generation of Master Plan Alternatives

In line with the urban transport development policy, master plan alternatives are formulated as the following, considering the major components for them discussed in Section 16.4.2.

Do-Nothing (Present Road Conditions and Present Traffic Pattern)

: This case is to be used as the base for evaluation of master plan alternatives and selection of the proposed optimum alternative. In this case, both the road conditions and traffic patterns are assumed to be the same as present ones and only future increase in traffic demand is considered.

Alternative 1 (Present Pattern Scenario) (Continuation of Present Traffic Pattern)

: This alternative assumes that neither specific measures nor regulations are taken, except for ordinary management measures. The modal share is to change corresponding to the growth of the households' income levels.

Alternative 2 (Paratransit-Oriented Scenario) (Encouraging Paratransit Service)

: This alternative assumes encouraging paratransit service using such small-scale vehicles as sonteo and tuk-tuk, while the bus service maintaining the present share. The service of sonteo is to be expanded into urbanized area where it is prohibited now. This alternative is proposed to the effect that if bus services cannot be improved/strengthened due to lack of fund, one of the measures to reduce private vehicles usage is to strengthen the services of the existing such paratransit as sonteo. Such situation is possible in view of considerable amount of fund needed for replacing the old buses and purchasing the additional buses.

The advantage of this alternative is that small-scale enterprises or even individuals can participate in this business because large investment is not required to participate. Thus it is easy to promote increase of the vehicles and transport capacity.

On the other hand, the largest drawback of this scenario is that the efficiency of paratransit is generally much less in operating them on major and busy streets than mass transit such as buses. Therefore, reduction in traffic congestion on major streets is not expected much. Another disadvantage of paratransit is that the management/control of the operator tends to impose considerable burden to the government as the number of vehicles/operators become enormous.

Alternative 3 (Bus Favored Scenario) (Encouraging bus services with coexistence of paratransit)

This alternative assumes the existing bus services to be expanded on the arterial roads or high demand routes. Such medium-small-scale public transport as Sonteo and quite small public transport like tuk-tuk and jumbo are allowed to operate mainly on collector roads and local

streets, respectively. This alternative is in accordance with the urban transport policy recommended in section 16.5.1 and largely hinges on the government's traffic policy which requires decisive action by the Government to implement this alternative.

The existing bus services are loosing the passengers due to poor quality of services including long waiting time, unreliable travel time and schedule, and poor bus stop facilities. Therefore, this scenario intends to attract more passengers by improving these problems. Bus services are so common public transport mode adopted in many cities that this scenario can be evidently very realistic.

One of the major problems to be solved for improvement of bus services is financial viability of bus services. In many cities, it is hard for bus services operated by government sector to yield profit. On the other hand, in some cities like Tokyo, for example, there are many bus routes operated by private enterprises and yielding profits. Therefore, diligent study on financial viability is needed.

Another problem for providing good bus services is that it requires favorable traffic environment for good operation. This favorable traffic environment includes smooth flow of general traffic and sufficient road width for smooth and reliable operation which are out of direct control of bus operators. Therefore, the effort of the government on these aspects is required.

Alternative 4 (Bus-Plus-LRT Favored Scenario) (More comprehensive public transport services than alternative 3)
In addition to the alternative 3, introduction of light rail (LRT) along major corridor is considered.

If the number of passengers to be transported exceeds the capacity of bus transport, other mode of mass transit has to be introduced. Such transport mode with a capacity larger than that of bus is LRT. There are various types of LRT practically use in the cities of the world; tram-type trains that run on the same streets with ordinary vehicles, light-weight trains that runs on viaduct above streets and monorail which also runs above streets. LRT becomes one of a few realistic solutions where the capacity of bus transport is not sufficient for the demand.

Introduction of LRT is limited to major corridors of traffic where sufficient demand exists. Therefore, bus services need to be provided along the routes where LRT is not operated.

The relationship between the alternatives and transport development scenarios is shown in Table 16.5-6.

Table 16.5-6 Relationship between Alternatives and Transport Development

Alternatives	Road Development		Development of Transport Measures			
	Existing Network	Proposed Network	Car Plus Motorcycle	Paratransit	Bus	LRT
Do Nothing	○		◎	○	○	
Alternative 1		○	◎	○	○	
Alternative 2		○		◎	○	
Alternative 3		○		○	◎	
Alternative 4		○		○	◎	○
Remarks	◎ : Main transport means Note: Difference between do-nothing case and alternative 1 is road network. : Difference between alternative 2 and 3 is composition of bus transit and paratransit on roads.					

16.6 EVALUATION OF MASTER PLAN ALTERNATIVES

16.6.1 Evaluation Method

(1) Assumption of Modal Share

Setting the modal share of public transport is involved in the target matter of traffic policy of the government or agencies concerned.

Assumptions of the modal share of person trip for alternative 2 through 4, which are shown in Table 16.6-1, are made so as to be in line with the vision set through the Study and the EST policy of the Government of LAO PDR.

In this study, the modal share of public transport is assumed to be 40% taking into account of the public transport shares in the Asian countries shown in Figure 16.6-1. As far as the modal share of public transport is concerned, more detailed and deeper study is needed regarding modal shares among public transport means, cost-benefit, staging plan, optimum public transport service routes, traffic demand management measures and etc. This issue will be studied in Chapter 18 except for alternative1 and 2 which are not recommended for further study in this chapter.

Table 16.6-1 Assumed Modal Share of Person Trip (unit: Percent)

		Private Vehicle		Public Transport			Walking & Bicycle
		Car	Motor-cycle	Para-Transit *2)	Bus	LRT	
Year 2007		11.1	59.8	2.0	1.9	0	25.2
Year 2025	Alternative 1	22.2	57.7	0.1	1.9	0	18.1
	Alternative 2 *1)	17.9	24.0	30.0	10.0	0	18.1
	Alternative 3 *1)	17.9	24.0	10.0	30.0	0	18.1
	Alternative 4 *1)	17.9	24.0	10.0	25.0	5.0	18.1
Remarks		*1): Modal share of public transport (Paratransit + Bus + LRT = 40%) in 2025 are assumed using the following conversion rates in private vehicle, walking and bicycle use. Motorcycle for work : 75% Motorcycle for school : 90% Car for work : 30% The more practical modal shares within public transport use for alternative 3 and 4 will be studied in Chapter 18. *2): Paratransit means such small scale type public transport as sonteo, roles of which are to complement bus and LRT services by serving mainly collector roads and local streets or relatively short distances.					

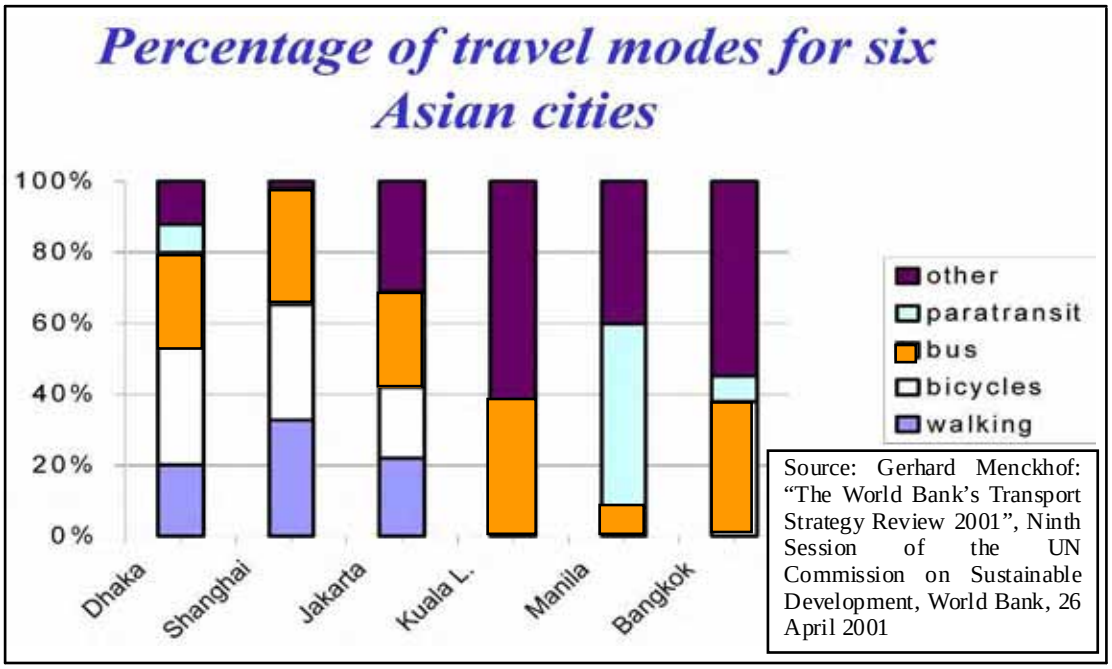


Figure 16.6-1 Modal Shares in Asian Countries

(2) Evaluation Indicators

The proposed alternatives are comparatively evaluated using the following four (4) factors

(i) Traffic Conditions

- Average travel speed : Higher one is better.
- Average VCR[*1] in the Study area: Smaller one is better. (*1: Volume Capacity Ratio)

(ii) System Efficiency

- Travel Length: Figures of the alternatives are compared with each other.
- Travel Time : The same as above.
- Travel Cost : The same as above.

(iii) Environmental Aspects

The air pollution components emitted by each alternative are considered to compare.

- HC : Hydro Carbon
- CO : Carbon Monoxide
- NOx : Nitrogen Oxide(s)
- CO2 : Carbon Dioxide

(iv) Economic Aspects

- EIRR (%): Higher one is preferable.

16.6.2 Comparative Evaluation of Transport System Alternatives

(1) Traffic Assignment Analysis

Traffic assignment analysis of the four (4) alternatives was made on the proposed road network in year 2025, as shown in Figure 16.6-2.

(2) Comparative Analysis of Traffic Parameters

Table 16.6-2 summarizes the results of the comparative study on traffic parameters for the study area in year 2025. Traffic conditions focusing on the average V/C Ratios are remarkably improved by extensively introducing public transport system.

Table 16.6-2 Comparisons of Traffic Parameters

Scenario	Traffic Parameters			
	Travel Length (pcu-km)	Travel Time (pcu-hr)	Ave. Speed*1) (km/h)	Ave.V/C R
Do-Nothing	7,467,732	364,006	20.5	1.38
Alternative1	7,128,592	173,273	41.1	0.71
Alternative2	5,113,107	107,486	47.6	0.51
Alternative3	4,752,757	97,717	48.6	0.47
Alternative4	4,708,633	96,531	48.8	0.47

*1): These average speeds are figures of traffic flow at road sections not considering disturbance at intersections. This means these figures are much different from actual travel speeds affected by traffic congestion at/near intersections. In this table, values of the average V/C Ratios and relative differences of the average speeds should be paid attention to.

(3) Economic Evaluation

The project costs of the alternatives in both financial and economic aspects are estimated as shown in Table 16.6-3. The assumptions of the analysis such as vehicle operation costs are described in Chapter 23.

Table 16.6-3 Financial and Economic Project Cost

	Financial Cost (US$1,000)	Economic Cost (US$1,000)
Alternative 1	217,000	195,300
Alternative 2	271,288	244,159
Alternative 3	269,493	242,544
Alternative 4	305,220	274,698

The evaluated results of economic parameters are shown in Table 16.6-4. All alternatives except Alternative 1 show high economic indices. This demonstrates that expanding public transport as largely as possible is to enjoy high economic benefits.

Table 16.6-4 Evaluation of Economic Parameters

	VCR	Travel Cost (US$1,000)	EIRR (%)	B/C	NPV (US$1,000)
DO-Nothing	1.38	516,172	-	-	-
Alternative 1	0.71	414,736	18.1	1.54	87,237
Alternative 2	0.51	293,565	34.5	3.24	398,309
Alternative 3	0.47	269,815	39.6	4.17	551,257
Alternative 4	0.47	256,605	40.9	4.05	565,138

(4) Environmental Comparison

The air pollution components of HC, CO, NOx and CO2 produced by each alternative are as shown in Table 16.6-5. The discharge rates are assumed as follows:

Table 16.6-5

Unit: g/km

	M/C	PC	Sonteo	Bus	Truck
HC*	0.50	0.64	0.12	0.17	0.87
CO*	2.00	0.64	0.63	2.22	2.22
NOx*	0.15	0.72	0.49	2.00	3.38
CO2	80.00	230.00	340.00	600.00	700.00

Source: Present auto emission regulation in Japan

*HC: Hydro Carbon, CO: Carbon Monoxide, NOx: Nitrogen Oxide(s), CO2: Carbon Dioxide

From the calculated results shown in Table 16.6-6 and Figure 16.6-2, the following are revealed.

- Expanding public transport services are greatly to contribute to a reduction of air pollution emitted by vehicles.
- There show no significant differences in the reduction effects of auto emission among Alternative 2, Alternative 3 and Alternative 4.

Table 16.6-6 Environmental Evaluation in 2025 (unit: kg/year, t/year(CO2))

	HC		CO		NOx		CO2	
Scenario	W	Dif. (R.R. (%))	W	Dif. (R.R. (%))	W	Dif. (R.R. (%))	W	Dif. (R.R. (%))
Do-Nothing	2,562	-	7,784	-	2,054	-	1,909	-
Alternative1	2,456	-105 (4)	7,472	-312 (4.0)	1,946	-108 (5)	1,818	-91(5)
Alternative2	1,365	-1,197 (47)	3,664	-4,120 (53)	1,536	-518 (25)	1,379	-439(23)
Alternative3	1,338	-1,224 (48)	3,583	-4,201 (54)	1,495	-560 (27)	1,266	-643(34)
Alternative4	1,331	-1,231 (48)	3,517	-4,267 (55)	1,438	-616 (30)	1,214	-694(36)

Note: W=Weight, Dif.=Difference, R.R.=Reduction Rate: Difference between Do-Nothing case and each alternative; figures of minus signs mean the extent of improvement to the Do-Nothing case.

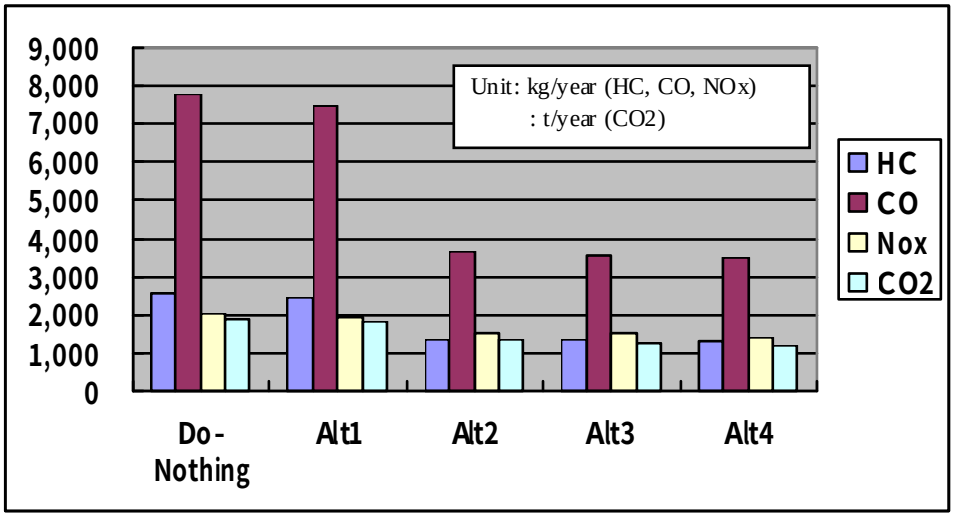


Figure 16.6-2 Comparison of Auto Emission

(5) Comparative Evaluation of Master Plan Alternatives

Table 16.6-7 presents the overall evaluation of four (4) alternatives. From evaluated results, alternative 3 and 4 are recommended as the optimum scenarios. These two optimum scenarios are studied in detail in Chapter 18 in terms of modal shares within public transport means, cost-benefit, staging plan, optimum public transport service routes, traffic demand management and so on.

Table 16.6-7 Evaluation of Proposed Scenarios

Items	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Description	• No special measures against future traffic demand are taken except for road development.	• Paratransit vehicles are encouraged to increase and allowed to operate in the urbanized area.	• Bus services are improved/strengthened to attract more passengers and encourage shift form private vehicles to buses.	• LRT is introduced along major transport corridors where number of passengers exceeds the capacity of bus transport. • Bus services are provided together with LRT.
Advantages	• Only concentrating on road development is needed.	• Small-scale enterprises or individuals can participate.	• VBSC and other entities have sufficient experience of bus operation. Thus, it can be easily implemented if proper plan and preparation are made. • Socially acceptable.	• Large transport capacity can be provided. • Effective to reduce air pollution. • Suitable for modern city.
Disadvantages	• Urban amenities will be deteriorated due to heavily crowded traffic, air pollution and traffic noise. • Future traffic situations are not fit for the objectives and policy on the National Strategy and Action plan on EST.	• Less efficient in transport capacity and less effective in reducing traffic volume. • Large effort needed to control large number of paratransit vehicles.	• There is possibility that bus services are not financially viable. • Needs improvement of roads for bus routes. • Establishment of “exclusive bus lane” may be needed.	• Large amount of initial investment is needed. • High demand is needed to be financially viable.
Difficulty for Implementation	• Easy.	• Relatively easy.	• Easy if properly prepared (with necessary improvement of road network).	• Possible where sufficient road width is secured.
Evaluation	• Not recommended in terms of running counter to EST policy of the Government of LAO PDR.	• Not recommended in view of low efficiency, little contribution to improvement of air pollution.	• Most realistic scenario in that bus services exist.	• Needs further study depending on the demand for public transport.

CHAPTER 17

ROAD DEVELOPMENT PLAN

CHAPTER 17 ROAD DEVELOPMENT PLAN

17.1 PLANNING CONCEPT

In view of the rapidly growing traffic, the road network in Vientiane needs to be strengthened in the future. Also, urbanized area of Vientiane is anticipated to expand in the future towards the present suburban area, as described in Chapter 13. Strengthening of the existing road network is necessary to support the sound urban development. Further, sufficient road width and/or right of way are prerequisite for smooth operation of public transport as discussed in Chapter 18.

As discussed in Chapter 4, the existing road network of Vientiane has the following major problems:

- Ambiguity in functional hierarchy,
- Incomplete circular road system,
- Lack of some road links needed to support future urban development as proposed in Chapter 13, and
- Insufficient road width and poor surface condition on some road links to support smooth operation of the public transport.

The objective of the road development plan is to complete the road network which can accommodate the increased traffic demand of the future as well as to provide the environment suitable for smooth operation of public transport. The development strategy and scenario to achieve this objective is discussed in Chapter 16 of this Report. The concept for the planning of road development plan is shown below.

- Introduction of functional road hierarchy on the future road network, consisting of arterial street system, collector street system and local street
- Establishment of arterial system network integrated with the Corridor Network Development Plan including the hierarchy of principal arterial as the corridor of the highest grade
- Development of the missing links to complete the network, in particular the proposed Inner Ring Road and Outer Ring Road for the reinforcement of circumferential system on the future road network
- Full utilization of existing streets/roads to develop the collector system network
- Application of the standard cross section by functional classification, as much as possible
- Adoption of stage construction considering such factors as estimated traffic volume, existing right of way (ROW), difficulty/easiness of land acquisition

- Acquisition of necessary ROW for future widening to realize the desirable sectional composition
- Preservation of the existing central city are with urban development control to maintain the desirable urban landscape and historical/cultural heritage which attract the foreign tourists
- Prioritization of the urgent issues on the traffic safety environment such as the improvement of traffic accident prone intersection

17.2 PROPOSED ROAD NETWORK

17.2.1 Establishment of Road Network

The proposed road network is formulated by the procedure as shown in Figure 17.2-1.

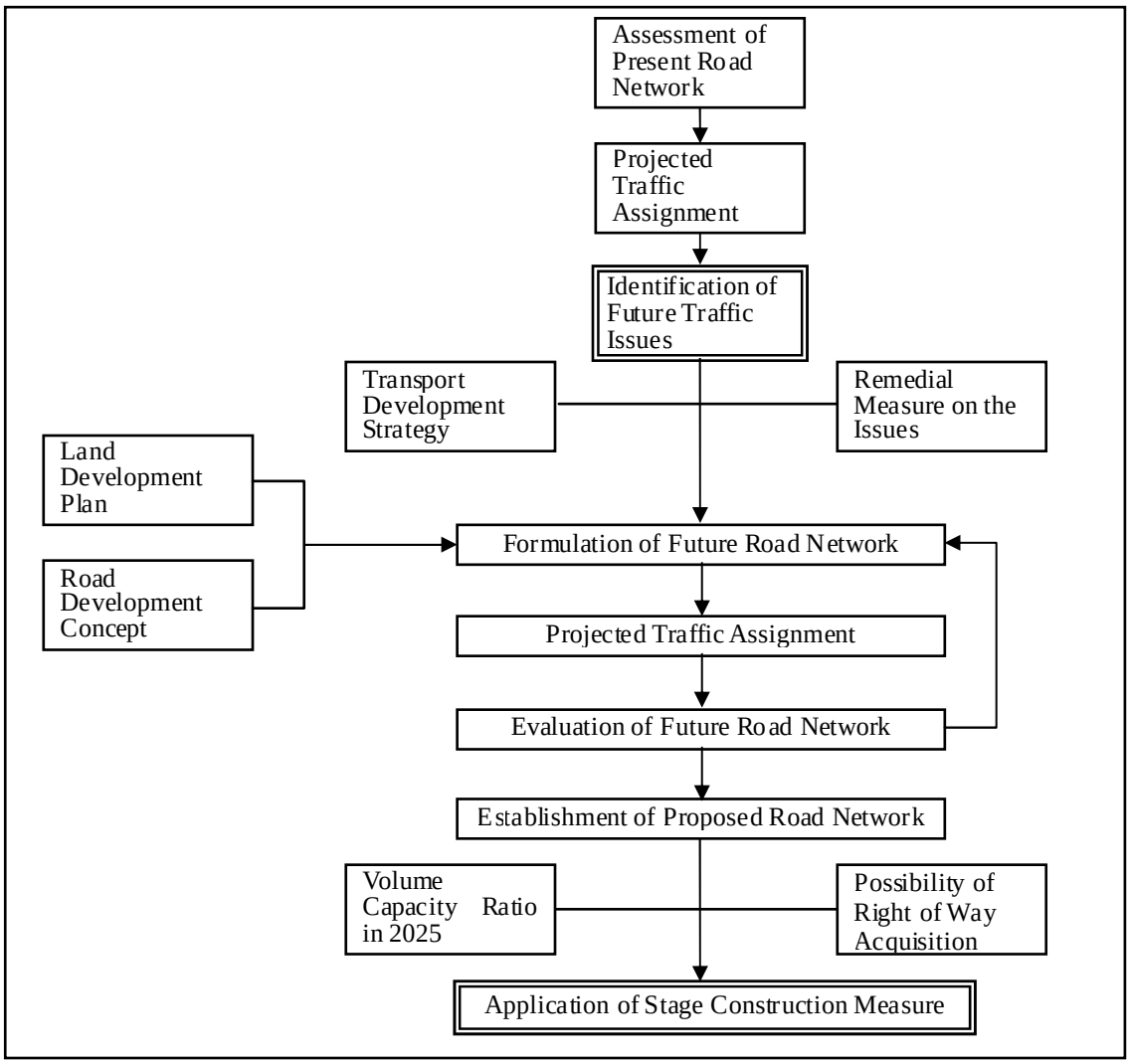


Figure 17.2-1 Procedure of Formulation of Proposed Road Network

First Step: Assessment of Present Road Network

- The future traffic issues are identified through the traffic assignment on the present road network. The predictable issues are studied in line with the direction of transport development strategy and the remedial measure on the identified issues.

Second Step: Formulation of Future Road Network

- Based on the land development plan and road development concept, present road network is modified with the consideration of road functional hierarchy. The formulation of future road network shall be reflected the direction of development and remedial measure for the identified issues.

Third Step: Evaluation of Future Road Network

- The result of traffic assignment on the future road network is examined to evaluate the traffic efficiency of the proposed network. If the result of the evaluation shows that the proposed network does not satisfy the requirement, the network is reviewed and revised. The trial-and-error is carried out to find out the effective network which fulfills the requirements.

Fourth Step: Establishment of Proposed Road Network

- The network which satisfies the requirement is adopted as the proposed road network in this Master Plan. The factors of each link included in the proposed road network, such as functional classification and cross-sectional composition, are specified.

Fifth Step: Adoption of Stage Construction

- Sectional composition of each road section on the proposed road network is reviewed whether the number of lanes and road width are suitable for the projected traffic volume and/or present roadside environment. Stage construction is adopted if the forecasted traffic volume and/or other conditions indicate that widening to the complete cross-section is not necessary for considerable period. In this case, the road section is widened to the width which is sufficient to accommodate the planned traffic volume.

Through the several trial and errors on the above procedure, the proposed road network is established as shown in Figure 17.2-2.

Basic network formed by the Primary Arterial System is to cover the planned development areas. Newly proposed Outer Ring Road (ORR) is a circumferential Primary Arterial Road connecting Friendship Bridge, 13 South Rd and No.13 North Rd as the international transport corridor for the through traffic. The western end of the ORR is No.13 North Rd, which is a

radial Primary Arterial Road for the traffic from city center to the northern part of the country. The southern end of the ORR is Thadeua Rd., which is the access to the Friendship Bridge from city center. The busiest Kaisonephomvihane Rd. is the central corridor from city center to the newly developed industrial zone near Km 21 of No.13 South Rd.

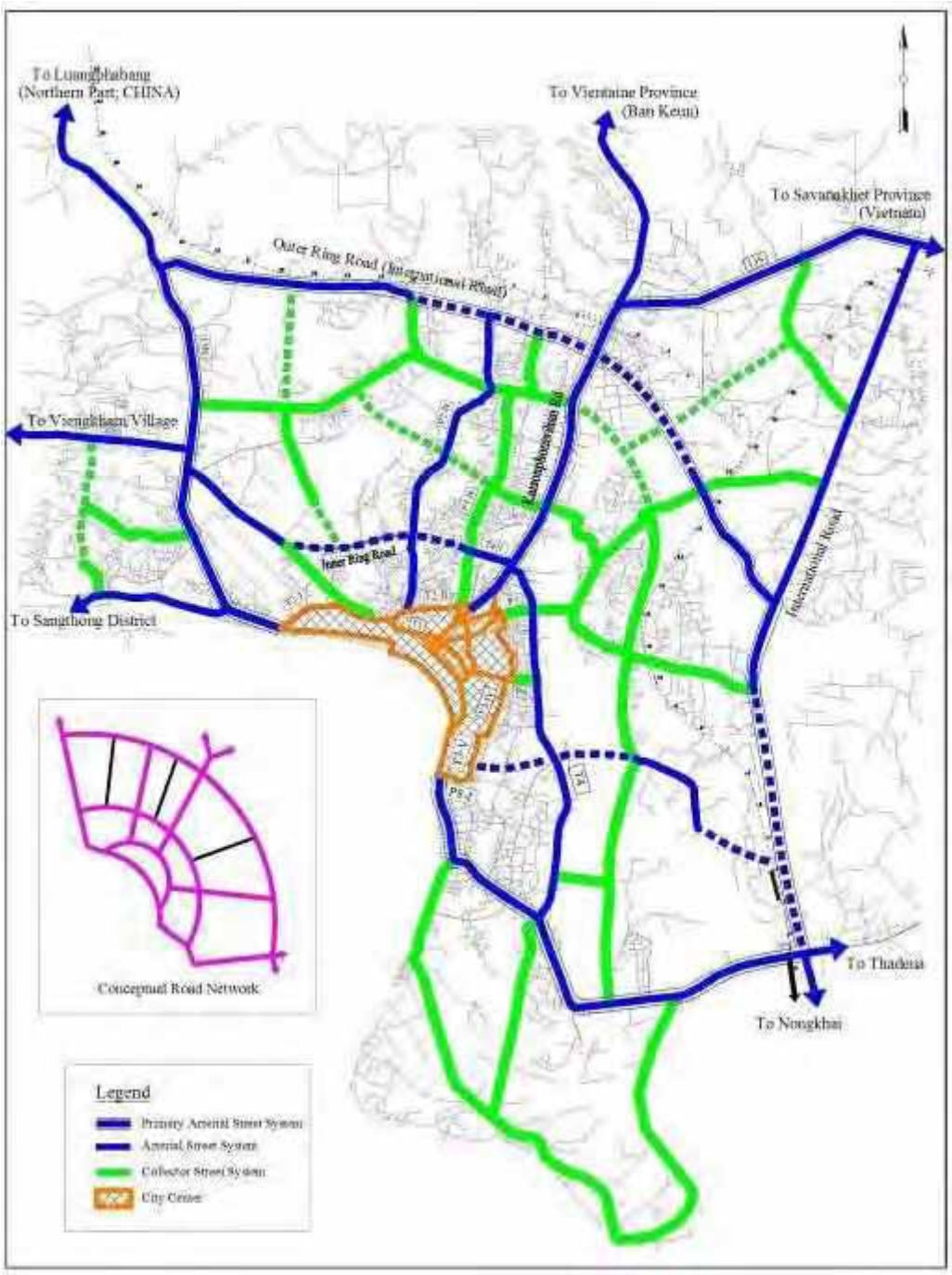


Figure 17.2-2 Proposed Road Network

Arterial Street System also is to cater for the major flow of traffic, but to less degree than the Primary Arterial System. The Inner Ring Road (IRR) is the circumferential road and distributes the traffic to the radial primary arterial roads. As the IRR will be completed, the

traffic which is now passing through the congested city center to travel from north to south, or vice versa, will be able to detour the city center, resulting in the reduction of the congestion in the city center as well as smoother travel of the traffic between the north and the south. To reinforce the congesting radial system, two roads are to be the arterial street. One is the P2, present Dong Palep Rd., supporting the central corridor and the other is the P8, newly developed east-west link, connecting between Thanaleng railway station and city center.

Collector Street System is to collect/distribute the traffic to/from the principal arterial and arterial streets. Collector Streets cover the area surrounded by arterial streets with full utilization of existing road asset. However some newly developed collector street linkage is proposed to strengthen the present road network where the existing collector streets are not sufficient.

17.2.2 Cross-Sectional Composition

Cross-sectional composition for each functional classification proposed here is to provide sufficient capacity and safe traffic environment for the forecasted future traffic, as well as desirable urban environment. Existing roadside lane use, however, may not allow land acquisition for the widening of the road to such cross-section in a short period. Thus, stage construction with a cross-section narrower than "desirable" one, which can be constructed within existing ROW, is proposed. The cross-section for such stage construction is selected to provide sufficient capacity for the forecasted traffic volume.

(1) Primary Arterial Street System

Primary arterial street shall be the main corridor of Vientiane and high speed through traffic shall be separated from local traffic. Relating on the roadside circumstances, several type of vehicle and non motorized traffic are mixed on the road. The frontage road is one of the solutions to separate the through traffic and local traffic on the same street. Favorable access for commercial and residential usage is secured with the frontage road and the local traffic which have specific purpose on that roadside facility can use it. Paratransit system is able to continue the service safely along the same street while the through traffic with higher speed travel the main lane. Therefore, primary arterial street shall be composed of main traveled way and frontage road. Figure 17.2-3 compares the present road section of Kaysonepomvihane Rd., or National Road No.13 South as an example and desirable cross section of Primary Arterial Street. It also shows the cross sections for stage construction. The necessary ROW for the Primary Arterial Street shall be at least 40m (preferably 50m) in width.

Stage construction type 1, case with median, shall be applied on national road 13 North from 3 junctions with T2 on Luang Phabang Rd. to km 16, No.13 South from Km 0 to Km 21 and

A12 from 3 junctions with Sokpaluang Rd. on Thadeua Rd. to Friendship bridge. Other primary arterial streets shall have similar cross section with stage construction type 2. In unurbanized area, sidewalk is not provided and the width of outer vehicle lane is reduced to be used as bike lane where projected traffic assignment shows low capacity ratio.

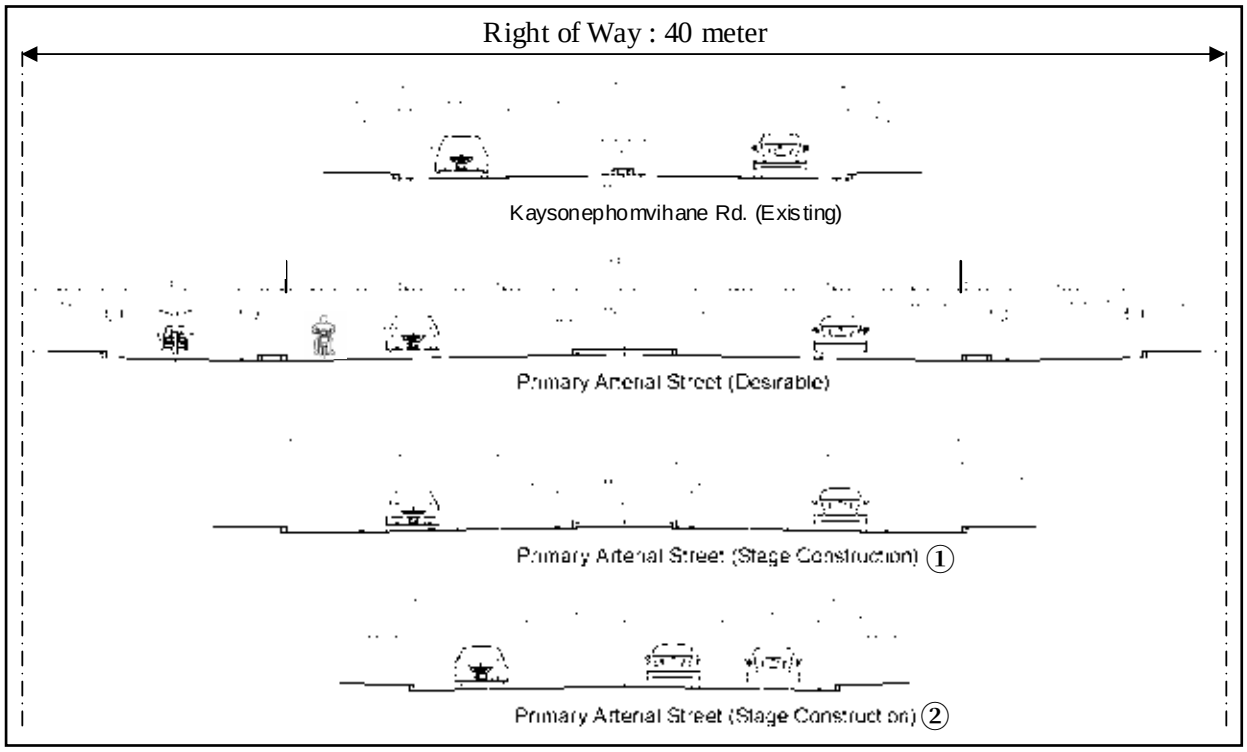


Figure 17.2-3 Standard Cross Section of Primary Arterial Street

Regarding the public transport, several scenarios were discussed in the previous chapter. In case that mass transit system is introduced, primary arterial street shall be the prioritized route for the introduction of such system. Mass transit system needs the space for exclusive use by the mass transit vehicles to secure the rapid and stable operation. There are several ideas of the placement of those facilities on the road. The most basic and economical method is the construction at grade within ROW. Vehicle size of Bus Rapid Transit; BRT or Light Rail Transit; LRT is approximately 2.5 meter in width and total width including safety side margin become at least 7.0 meter. In addition a platform for passengers shall be provided at appropriate place. Preliminary the required space for the introduction of mass transit system is compared with present cross section of Kaysonephomvihane Rd., National Road No.13 South, in the Figure 17.2-4. However, wider space shall be required at the intersection of the road to provide left-turn lane and at the station of new public transport system to construct a platform.

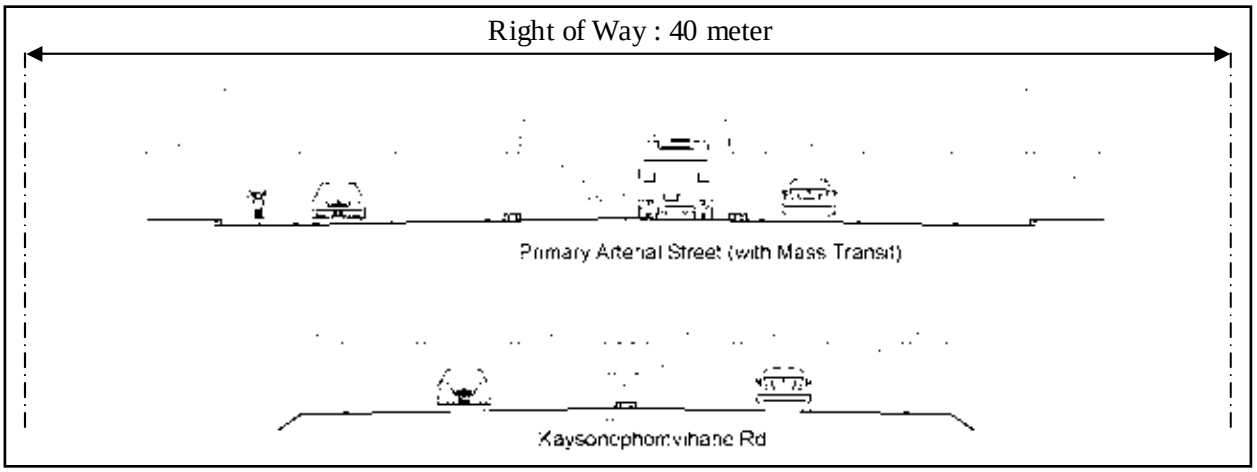


Figure 17.2-4 Sample of Cross Section with Mass Transit System

(2) Arterial Street System

Arterial street is regarded to have the similar function with primary arterial street for handling the trip of large number of vehicles. Basically the cross-sectional composition with divided 4 lane road and mounted sidewalk is proposed. An additional lane for the slow moving motorcycles shall be provided as the outer lane to secure the smooth and safe traffic flow. A median shall be provided to separate opposing traffic, allow space for storage of left-turning and U-turning vehicles, minimize headlight glare and provide a refuge area for pedestrians crossing the street. Also the stage construction measure is considered depending on the roadside environment. Figure 17.2-5 shows the desirable standard cross section and stage construction for the arterial street. For example of widening, present cross section of Dong Palep Rd. is shown in the same figure. The cross section of stage construction shall be widened at busy intersection to provide the additional lane for left-turning vehicles. The necessary ROW for the arterial street shall be at least 30m in width

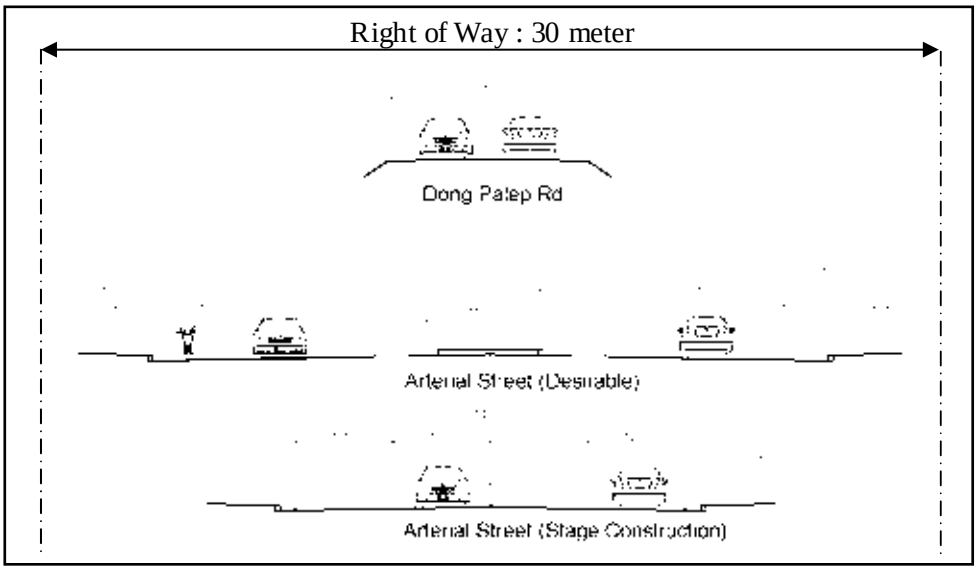


Figure 17.2-5 Standard Cross Section of Arterial Street

(3) Collector Street System

The concept of the development of collector street is mentioned in section 17.1 as full utilization of existing streets. At present, the most of the major roads in Vientiane are undivided 2 lane road with additional narrow space for the slow speed traffic. Therefore this master plan proposes the similar sectional composition with existing condition as the evaluation of volume/capacity ratio with the projected traffic assignment is within an allowable value. Basically the sectional composition is undivided 2 lanes with additional outer lane for the slow moving vehicles including motorcycles. Depending on the roadside land use, mounted sidewalk shall be provided. Figure 17.2-6 shows the desirable standard cross section compared with present cross section of Sivilai Rd., and cross-section of stage construction for the collector street. The necessary ROW for the collector street shall be at least 20m in width.

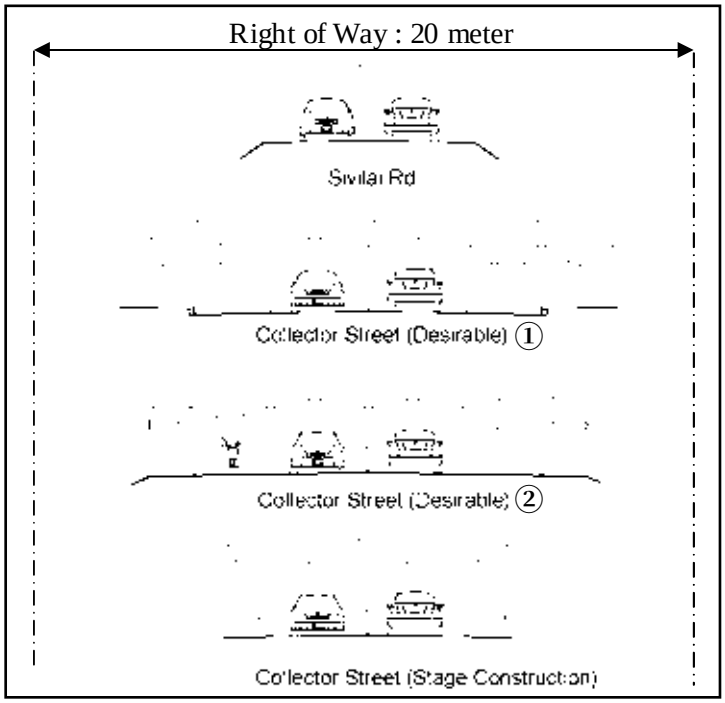


Figure 17.2-6 Standard Cross Section of Collector Street

17.3 PROPOSED ROAD PROJECTS

17.3.1 Road Project

In accordance with the road network proposed in this Master Plan, necessary construction, improvement, or rehabilitation were examined on each road section with the consideration of stage construction measure. Compared with future traffic demand, the most of the existing roads on the proposed network need widening to provide additional lanes. All surface of the road shall be covered by asphalt concrete (AC) to support the heavy traffic load for proper period. Rehabilitation of the existing AC pavement shall be considered by overlay method in view of economical life cycle on the pavement management. Proposed road projects are listed in Table 17.3-1 together with existing condition. The project numbers shown in Figure 17.3-1 should be referred for the locations of projects.

Most of the roads within the city center have been almost improved under several projects administered by VUDAA. As mentioned in Section 17.1 “Planning Concept”, central city should be preserved with deliberate urban development control for the urban landscape and historical/cultural heritage. It means that the scope of work for the roads inside city center is mainly maintenance and repair. Therefore road projects in the city center are not planned in this Master Plan.

Table 17.3-1 Proposed Road Projects

No.	Road Section	Distance (km)	Present Conditon			Proposed Project			Road Code
			width (m)	lane (bike)	surface type	width (m)	lane (bike)	scope of work	
	Primary Arterial								
1	Jct. Sikhay - 13N Km16	10.6	11.0	2+(2)	DBST	19.0	4+(0)	w, o, s	National13N
2	Luang Phabang Rd.	1.6	19.5	4+(2)	AC	27.5	4+(2)	o, L	National13N
3	Thadeua Rd.	3.5	14.9	4+(0)	AC	27.5	4+(2)	w, s	NationalA12
	Thadeua Rd.	12.9	14.9	4+(0)	AC	19.0	4+(0)	o, L	NationalA12
4	Friendship Br. - B.Nakhouay	7.9	N/A	N/A	N/A	14.5	2+(2)	n	
5	B.Nakhouay - B.Dong Kang	2.7	6.0	2+(0)	Gravel	14.5	2+(2)	w, c	District108
6	B.Dong Kang - B.Xok Noy	4.1	6.0	2+(0)	Gravel	14.5	2+(2)	w, c	District148
7	B.Xok Noy - 13S Km10	5.1	N/A	N/A	N/A	14.5	2+(2)	n	
8	13S Km10 - B.Dongxiangdi	6.6	N/A	N/A	N/A	14.5	2+(2)	n	
9	B.Dongxiangdi - 13N Km16	6.4	6.0	2+(0)	Gravel	14.5	2+(2)	w, c	District172
10	Kaysonephomvihane Rd.	10.0	17.0-23.5	4+(2)	AC	27.5	4+(2)	o, L	National13S
11	Jct. Don Noun - 13S Km21	9.0	11.0	2+(0)	DBST	27.5	4+(2)	w, o, s	National13S
	Arterial								
12	N11 Rd. (Jct. Sikhay - B.Nongda)	4.2	7.5	2+(0)	DBST	19.0	4+(0)	w, o, s	National11
	N11 Rd. (B.Nongda -)	0.8	6.0	2+(0)	Gravel	19.0	4+(0)	w, c, s	National11
13	Nong Duag Rd. (13S - Inner ring)	3.8	12.5	2+(2)	DBST	19.0	4+(0)	w, o, s	
14	B.Pakthang - B.Phontong	4.2	N/A	N/A	N/A	27.5	4+(2)	n, s	
15	Phonphanou Rd.	1.8	6.5 - 9.0	2+(0)	DBST	27.5	4+(2)	w, o, s	T4N
16	Blvd. Kamphengmeuang	4.9	15.0-16.0	2+(2)	AC	19.0	4+(0)	w, s	T4N
	Blvd. Kamphengmeuang	6.0	13.0	2+(2)	AC	19.0	4+(0)	w, s	T4N
17	Savang Rd.	0.5	17.2	4+(0)	DBST	19.0	4+(0)	o, L	P2N
18	Dong Palep Rd.	2.3	12.4	2+(2)	DBST	19.0	4+(0)	w, o, s	P2N
	Dong Palep Rd.	4.7	6.7	2+(0)	DBST	19.0	4+(0)	w, o, s	P2N
19	Dong Palep Rd. - outer ring Rd.	2.1	7.0	2+(0)	DBST	9.5	2+(0)	w, o	
20	B.Sokpaluang - B.Xiangda	4.7	N/A	N/A	N/A	19.0	4+(0)	n, s	P8
21	B.Xiangda - B.Khoumhin	1.8	6.5	2+(0)	Gravel	19.0	4+(0)	w, c, s	District109
22	B.Khoumhin - outer ring Rd.	2.0	N/A	N/A	N/A	19.0	4+(0)	n, s	
23	B.Dong Kand - 13S Km21	11.2	6.0	2+(0)	Gravel	9.5	2+(0)	w, c	Ditrict108
24	13N Km11 - B.Viangkham	5.0	8.0	2+(0)	DBST	19.0	4+(0)	w, o, s	Provincial106
	Collector								
25	B.Nonkhilek - Provincial Rd. 106	3.6	N/A	N/A	N/A	14.5	2+(2)	n	
26	B.Nonkhilek - N11 Rd.	2.0	8.0	2+(0)	DBST	14.5	2+(2)	w, o	
27	13N Km8 - B.Phosomboun	1.8	7.0	2+(0)	DBST	14.5	2+(2)	w, o	
	13N Km8 - B.Phosomboun	2.4	6.0	2+(0)	Gravel	14.5	2+(2)	w, c	
28	Nong Duag Rd. (Inner ring - T2)	3.2	12.5	2+(2)	DBST	16.5	2+(2)	o, L	
29	Dongdok Rd.(T7N)	11.7	12.0	2+(2)	DBST	16.5	2+(2)	o, s	Provincial107
30	B.Phonkeo - B.Dongkalao(T7N.)	3.6	N/A	N/A	N/A	9.5	2+(0)	n	
31	B.Dongkalao(T7N) - Inner ring Rd.	4.6	2.0 - 4.0	1+(0)	Earth	14.5	2+(2)	n	
32	B.Dongxiangdi - B.Nongphagna	1.6	6.0	2+(0)	Gravel	9.5	2+(0)	w, c	District172
33	B.Nongphagna - B.Phonsavang	5.1	N/A	N/A	N/A	14.5	2+(2)	n	
34	Sivilai Rd. (P3N - N13S)	1.5	7.0	2+(0)	DBST	16.5	2+(2)	w, o, s	T5N
35	B.Dongdok - new outer ring Rd.	1.9	6.0 - 9.0	2+(0)	Gravel	9.5	2+(0)	w, c	
36	Sivilai Rd. (B.Phonsavang - T4N)	3.0	7.0	2+(0)	DBST	16.5	2+(2)	w, o, s	P3N
37	Pul Thong Rd.	2.2	7.0	2+(0)	DBST	16.5	2+(2)	w, o, s	P3N
38	New Hong Kai Keo Rd.	1.7	14.0	2+(2)	DBST	16.5	2+(2)	o, L	P3N
39	13S Km6 - B.Xiangda	10.0	7.0	2+(0)	DBST	14.5	2+(2)	w, o	Provincial109
40	B.Singda - Thadeua Rd.	3.6	7.0	2+(0)	DBST	9.5	2+(0)	w, o	District152
	B.Singda - Thadeua Rd.	3.4	6.5	2+(0)	Gravel	9.5	2+(0)	c	District152
41	That Luang Rd.	0.9	13.6	4+(0)	AC	19.0	4+(0)	o, s	Urban112
42	B.Dongkhamxang - Inner ring Rd.	1.5	6.5	2+(0)	DBST	9.5	2+(0)	w, o	
43	Jct.SaNamMar(cd109) - Jct.B.Mai	2.2	6.0	2+(0)	DBST	9.5	2+(0)	w, o	District155
	Jct.SaNamMar(cd109) - Jct.B.Mai	6.2	6.7	2+(0)	Gravel	9.5	2+(0)	c	District155
44	B.Nonkho(cd109) - B.Nakhouay	3.2	8.0	2+(0)	DBST	9.5	2+(0)	o	
45	B.Vangxay(cd109) - B.Khamngoy	3.4	4.0 - 6.0	2+(0)	Earth	9.5	2+(0)	n	
46	B.Khamngoy - 13S Km9	6.0	N/A	N/A	N/A	9.5	2+(0)	n	
47	13S Km18 - B.Konk Gnai	5.2	5.0 - 7.0	2+(0)	Gravel	9.5	2+(0)	w, c	
48	B.Khok Noy - Hong Beng	5.4	N/A	N/A	N/A	9.5	2+(0)	n	
49	Jct.Ji Nie Mo(A12) - B.Thakhek	22.5	6.0 - 7.0	2+(0)	DBST	9.5	2+(0)	w, o	District123
50	B.SaLaKham(A12) - B.SaVang	4.8	4.5	1+(0)	Earth	9.5	2+(0)	n	District187

Scope of work) n:new construction, c:new pavement, o:overlay, w:widening, s:sidewalk&drain, L:land acquisition

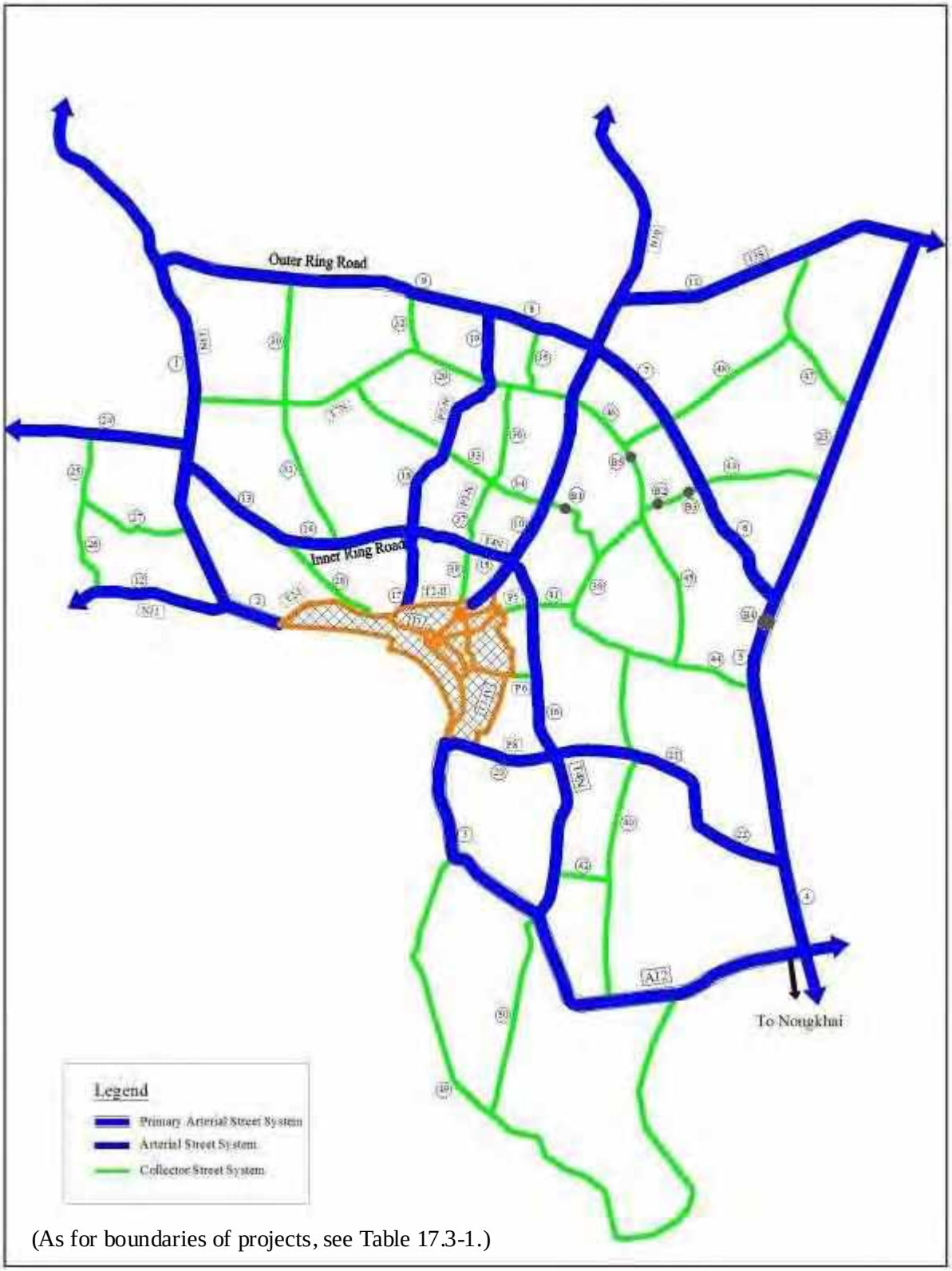


Figure 17.3-1 Location of Proposed Projects

17.3.2 Bridge Project

There are 4 existing bridges crossing the Hong Beng stream on the proposed road network. As mentioned in Chapter 4, all of those bridges are structurally unstable and have insufficient load capacity. The bridge widths are only for one lane even they are placed on two lane road. Thus the replacement of those 4 bridges is urgent issue to secure the stable road traffic.

In the course of the development of the proposed road network, the new collector link between Ban Kamngoy and No.13 South Rd. Km 9 will be constructed and one new bridge will be required for crossing the Hong Beng stream. The location of this new bridge is downstream of B1 and upstream of B2 & B3.

As mentioned in the section of road projects, stage construction shall be considered for the road construction/improvement. Thus the sectional composition of the bridges also shall be adjusted with approaching road section. The bridge length is decided based on the site condition of the stream around the existing bridge and comparison of the river flow with the neighboring crossings. Table 17.3-2 shows the list of proposed bridge projects. The bridge locations are shown in Figure 17.3-1.

Table 17.3-2 Proposed Bridge Projects

No.	Road Section	Present Condition			Proposed Project				Road Code
		Bridge Type	length (m)	width (m)	Bridge Type	lane (bike)	length (m)	width (m)	
B1	13S Km6 - B.Xiangda	Bailey	30.3	4.0	PC I-girder	2+(2)	45.0	14.5	Provincial 109
B2	Jct.SaNamMar - Jct.B.Mai	Steel girder	22.0	2.9	PC I-girder	2+(0)	30.0	10.5	District 155
B3	Jct.SaNamMar - Jct.B.Mai	Bailey	18.3	4.0	PC I-girder	2+(0)	20.0	10.5	District 155
B4	B.Nakhouay - B.Dong Kang	Bailey	24.3	4.0	PC I-girder	2+(2)	50.0	17.0	District 108
B5	B.Khamngoy - 13S Km9	N/A	N/A	N/A	PC I-girder	2+(0)	45.0	10.5	
	N11 Rd.	Bailey	30.3	4.0	-	-	-	-	National 11

In addition, one old Bailey bridge is located on National Road No.11 at approximately 7 kilometer from Sikhay Intersection. This bridge has the same problems with other Bailey bridges of structural stability. The large number of heavy dump trucks loaded with sand or gravel is using this road section. Therefore the existing bridge needs to be reconstructed urgently. But this bridge location is out of the Study Area and it is not included in the project list.

Regarding the operation of the Friendship Bridge, the existing bridge is to be used by the train and enforced closure of vehicle traffic for few hours is anticipated to occur frequently in the future. As a result of the development of central corridor of GMS, rapidly increasing trading cargo may cross the bridge. The necessity of widening of the existing or construction of second bridge shall be discussed in the future.

17.3.3 Intersection Project

(1) Consideration on capacity and traffic volume

Together with the road development, the intersections need to be improved in order to secure the smooth traffic flow. Grade-separated intersections are often proposed in road network plan. From the viewpoint of capacity of intersection and traffic volume, all the intersections in the Study Area can cater for the forecasted traffic volume in year 2025, if left-/right-turning lanes are properly provided.

For example, the intersection with largest forecasted traffic volumes is Phonephanao Intersection (intersection of Phonkheng Rd. with T4 or Inner Ring Road). The forecasted traffic volumes in year 2025 are 65,000 pcu on Phonkheng Rd. (both direction) and 53,000 pcu on T4 or Inner Ring Road (both direction). These volumes can be accommodated by providing 4 to 5 lanes in one direction, including left- and/or right-turning lane(s) on all the legs of the intersection. (Another problem of this intersection is discussed later.)

On the other hand, grade separated structure is desirable for the intersection of Primary Arterial Roads from the viewpoint of smooth flow of long-trip through traffic. A good example of such intersection is the intersection of No.13 South Rd with the proposed Outer Ring Road. Although the volume of the traffic is forecasted to be within the range which can be handled by at-grade intersection, it is desirable to construct grade-separated intersection here.

However, the largest drawback of fly-over is a negative impact to the urban view. (Under-pass is should be avoided in Vientiane in view of the high groundwater level and frequent heavy rain in the rainy season.)

Considering the above factors, at-grade intersections are recommended in this Master Plan.

Still another consideration is that there are some accident prone intersections in city center. The improvement of those black spots is an urgent issue and the improvement for the emergency countermeasures on those places is proposed in Chapter 19. The substantial improvement shall be designed with the connecting road improvement work. The project list of intersection projects, which are emergent remediation to prevent the accident, is shown in Table 17.3-3 and location of the intersection is shown in Figure 17.3-2.

Table 17.3-3 Proposed Intersection Projects

No.	Intersection	Present Condition			Proposed Project	related road
		type	mark	leg	improvement	
X1	Odeon Intersection	signal	ex	5	median & access limt.	T2 & local
X2	Circus Intersection	median	ex	4	marking & signal	Dong Palep & Savang
X5	Phonephanao Intersection	uncontrol	none	4	relocation & signal	13S & T4
X6	That Luang Neua Intersection	uncontrol	none	4	marking & rumble strip	That Luag & local
X7	Phonetong Intersection	uncontrol	none	3	guiding & rumble strip	Phonphanou & Savang
X13	Thongkhankham Intersection	signal	ex	4	marking	17 & T2
X15	That Luang roundabout	roundabout	ex	4	realign & marking	That Luag & local

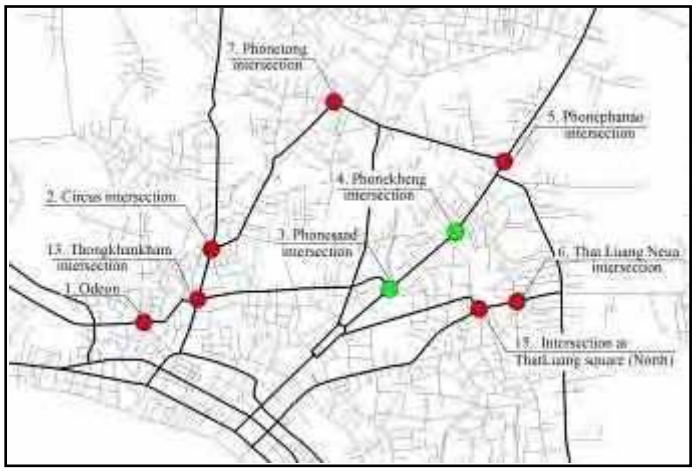


Figure 17.3-2 Location of Intersection Projects

The more details of the intersections of the project is discussed in Chapter 19 and the proposed design for the improvement of each intersection projects is attached in the Appendix 17 in the separate volume of the report.

Project No. X5 : Improvement of Staggered Intersection

Present Phonephanao Intersection has “Staggered” configuration.

This alignment hinders continuous traffic flow and hampers the function as an arterial street. Therefore, this intersection needs to be improved into regular-shaped, A-leg intersection with future Inner Ring Road. Figure 17.3-2 shows the aerial photo of the intersection and the proposed new alignment.

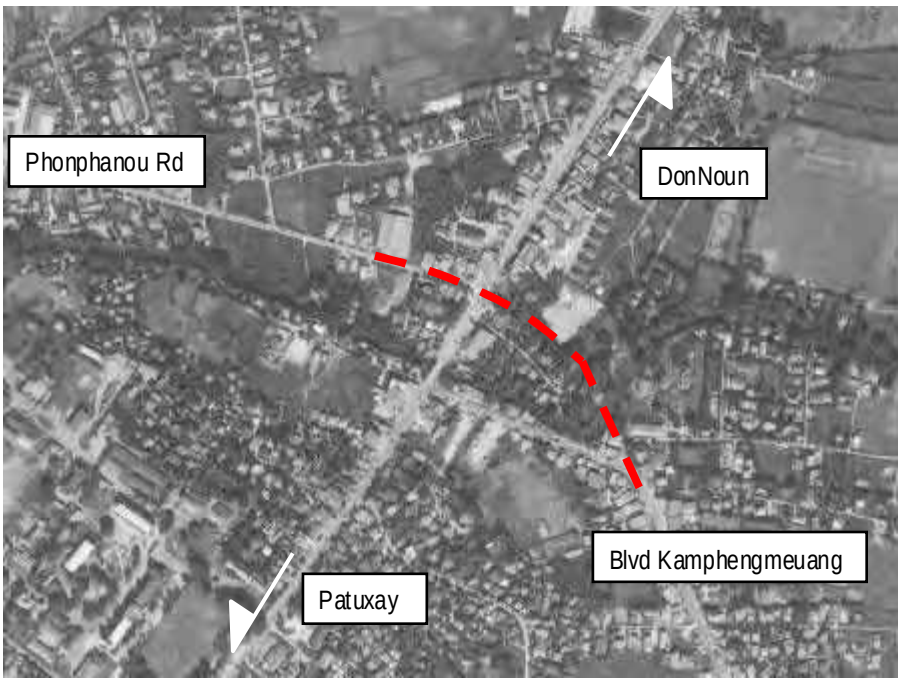


Figure 17.3-3 Intersection with 13 South, Blvd. Kamphengmeuang & Phonphanou Rd.

17.4 COST ESTIMATION

Compared with recent construction projects in Vientiane, each unit price used in the preliminary cost estimation was decided as shown in Table 17.4-1. In estimating these unit costs, the global trend of rise in the price of oil and other materials was considered.

Table 17.4-1 Unit Price of Work Item Used in Cost Estimation (US$)

	Work Item	Unit	Unit Price
Earth Work	Clearing & Grubbing including top soil	sq.m	1.29
	Common embankment	cu.m	4.21
	Common excavation	cu.m	6.43
	Replacement of unstable material	cu.m	19.38
	Slope treatment	sq.m	2.44
Pavement	Subgrade preparation	sq.m	0.35
	Subbase course, t=20cm	sq.m	5.59
	Base course, t=15cm	sq.m	5.94
	Prime coat & Binder course, t=5cm	sq.m	9.61
	Surface course, t=5cm	sq.m	9.56
Miscellaneous	Sidewalk pavement	sq.m	25.07
	Edge block placement	m	6.01
	Mounted median, w=3.0m	m	32.79
	Road Marking, white & yellow	sq.m	11.90
	Road sign, single board	no.	129.53
	Street light, single bulb	no.	2,055.73
	Traffic signal, 4 leg Jct.	set	52,078.28
	Roadside ditch, L-gutter	m	29.69
	Drainage pipe line, D=400mm	m	65.78

Based on these unit prices, the cost of each construction type was calculated. The cost of each road project was estimated based on the width of construction and the quantity of the work. Also the cost of sidewalk, drainage and other facility were added if required. The basic cost of a linear kilometer is summarized in Table 17.4-2 and estimated project cost of proposed each road project is shown in Table 17.4-3.

Table 17.4-2 The Cost of Construction per linear kilometer (US$)

Construction Type	Cost	Remarks
New road construction for 1m in width	34,438.00	include cross drainage
Pavement construction for 1m in width	31,050.00	for present gravel/earth road
Overlay of pavement for 1m in width	19,170.00	for present AC/DBST road
Widening of road for 1m in width	34,306.00	include earth work
Sidewalk & drainage line for both sides	353,986.00	include earth work
Shoulder construction for both sides	87,076.00	include earth work

Table 17.4-3 Estimated Road Project Cost

No.	Road Section	Distance (km)	road width (m)	no. of lane (bike lane)	scope of work	Cost (million)
	Primary Arterial				sub total	$71.46
1	Jct. Sikhay - 13N Km16	10.6	19.0	4+(0)	widening, overlay, sidewalk	$11.92
2	Luang Phabang Rd.	1.6	27.5	4+(2)	overlay, land acquisition	$1.02
3	Thadeua Rd.	3.5	27.5	4+(2)	widening, sidewalk	$3.63
	Thadeua Rd.	12.9	19.0	4+(0)	overlay, land acquisition	$5.92
4	Friendship Br. - B.Nakhouay	7.9	14.5	2+(2)	new construction	$6.45
5	B.Nakhouay - B.Dong Kang	2.7	14.5	2+(2)	widening, pavement	$3.31
6	B.Dong Kang - B.Xok Noy	4.1	14.5	2+(2)	widening, pavement	$3.21
7	B.Xok Noy - 13S Km10	5.1	14.5	2+(2)	new construction	$4.17
8	13S Km10 - B.Dongxiangdi	6.6	14.5	2+(2)	new construction	$5.39
9	B.Dongxiangdi - 13N Km16	6.4	14.5	2+(2)	widening, pavement	$5.00
10	Kaysonephomvihane Rd.	10.0	27.5	4+(2)	overlay, land acquisition	$6.03
11	Jct. Don Noun - 13S Km21	9.0	27.5	4+(2)	widening, overlay, sidewalk	$15.41
	Arterial				sub total	$62.25
12	N11 Rd. (Jct. Sikhay - B.Nongda)	4.2	19.0	4+(0)	widening, overlay, sidewalk	$5.10
	N11 Rd. (B.Nongda -)	0.8	19.0	4+(0)	widening, pavement, sidewalk	$1.10
13	Nong Duag Rd. (13S - Inner ring)	3.8	19.0	4+(0)	widening, overlay, sidewalk	$4.37
14	B.Pakthang - B.Phontong	4.2	27.5	4+(2)	new construction, sidewalk	$7.95
15	Phonphanou Rd.	1.8	27.5	4+(2)	widening, overlay, sidewalk	$3.10
16	Blvd. Kamphengmeuang	4.9	19.0	4+(0)	widening, sidewalk	$3.51
	Blvd. Kamphengmeuang	6.0	19.0	4+(0)	widening, sidewalk	$3.95
17	Savang Rd.	0.5	19.0	4+(0)	overlay, land acquisition	$0.23
18	Dong Palep Rd.	2.3	19.0	4+(0)	widening, overlay, sidewalk	$2.65
	Dong Palep Rd.	4.7	19.0	4+(0)	widening, overlay, sidewalk	$5.80
19	Dong Palep Rd. - outer ring Rd.	2.1	9.5	2+(0)	widening, overlay	$0.84
20	B.Sokpaluang - B.Xiangda	4.7	19.0	4+(0)	new construction, sidewalk	$6.61
21	B.Xiangda - B.Khoumhin	1.8	19.0	4+(0)	widening, pavement, sidewalk	$2.46
22	B.Khoumhin - outer ring Rd.	2.0	19.0	4+(0)	new construction, sidewalk	$2.81
23	B.Dong Kand - 13S Km21	11.2	9.5	2+(0)	widening, pavement	$5.52
24	13N Km11 - B.Viangkham	5.0	19.0	4+(0)	widening, overlay, sidewalk	$6.25
	Collector				sub total	$76.54
25	B.Nonkhilek - Provincial Rd. 106	3.6	14.5	2+(2)	new construction	$2.94
26	B.Nonkhilek - N11 Rd.	2.0	14.5	2+(2)	widening, overlay	$1.33
27	13N Km8 - B.Phosomboun	1.8	14.5	2+(2)	widening, overlay	$1.19
	13N Km8 - B.Phosomboun	2.4	14.5	2+(2)	widening, pavement	$1.88
28	Nong Duag Rd. (Inner ring - T2)	3.2	16.5	2+(2)	overlay, land acquisition	$1.19
29	Dongdok Rd.(T7N)	11.7	16.5	2+(2)	overlay, sidewalk	$11.27
30	B.Phonkeo - B.Dongkalao(T7N.)	3.6	9.5	2+(0)	new construction	$1.90
31	B.Dongkalao(T7N) - Inner ring Rd.	4.6	14.5	2+(2)	new construction	$3.76
32	B.Dongxiangdi - B.Nongphagna	1.6	9.5	2+(0)	widening, pavement	$0.79
33	B.Nongphagna - B.Phonsavang	5.1	14.5	2+(2)	new construction	$4.17
34	Sivilai Rd. (P3N - N13S)	1.5	16.5	2+(2)	widening, overlay, sidewalk	$1.62
35	B.Dongdok - new outer ring Rd.	1.9	9.5	2+(0)	widening, pavement	$0.94
36	Sivilai Rd. (B.Phonsavang - T4N)	3.0	16.5	2+(2)	widening, overlay, sidewalk	$3.23
37	Pul Thong Rd.	2.2	16.5	2+(2)	widening, overlay, sidewalk	$2.37
38	New Hong Kai Keo Rd.	1.7	16.5	2+(2)	overlay, land acquisition	$0.63
39	13S Km6 - B.Xiangda	10.0	14.5	2+(2)	widening, overlay	$6.63
40	B.Singda - Thadeua Rd.	3.6	9.5	2+(0)	widening, overlay	$1.35
	B.Singda - Thadeua Rd.	3.4	9.5	2+(0)	pavement	$1.67
41	That Luang Rd.	0.9	19.0	4+(0)	overlay, sidewalk	$0.93
42	B.Dongkhamxang - Inner ring Rd.	1.5	9.5	2+(0)	widening, overlay	$0.58
43	Jct.SaNamMar(cd109) - Jct.B.Mai	2.2	9.5	2+(0)	widening, overlay	$0.82
	Jct.SaNamMar(cd109) - Jct.B.Mai	6.2	9.5	2+(0)	pavement	$3.04
44	B.Nonkho(cd109) - B.Nakhouay	3.2	9.5	2+(0)	overlay	$1.16
45	B.Vangxay(cd109) - B.Khamngoy	3.4	9.5	2+(0)	new construction	$1.79
46	B.Khamngoy - 13S Km9	6.0	9.5	2+(0)	new construction	$3.16
47	13S Km18 - B.Konk Gnai	5.2	9.5	2+(0)	widening, pavement	$2.40
48	B.Khok Noy - Hong Beng	5.4	9.5	2+(0)	new construction	$2.85
49	Jct.Ji Nie Mo(A12) - B.Thakhek	22.5	9.5	2+(0)	widening, overlay	$8.42
50	B.SaLaKham(A12) - B.SaVang	4.8	9.5	2+(0)	new construction	$2.53

Regarding the bridge project, the experience of several bridge projects were examined and basic unit cost for the construction of PC bridge was estimated at 2,350.00 U.S. dollar per square meter including all miscellaneous cost and expenses. Table 17.4-4 shows the cost of each bridge project.

Table 17.4-4 Estimated Bridge Project Cost

No.	Road Section	Bridge Type	span	length (m)	width (m)	no.of lane (bike)	cost (million)	related road project no.
B1	13S Km6 - B.Xiangda	PC I-girder	2 span	45.0	14.5	2+(2)	US$1.53	39
B2	Jct.SaNamMar - Jct.B.Mai	PC I-girder	1 span	30.0	10.5	2+(0)	US$0.74	43
B3	Jct.SaNamMar - Jct.B.Mai	PC I-girder	1 span	20.0	10.5	2+(0)	US$0.49	43
B4	B.Nakhouay - B.Dong Kang	PC I-girder	2 span	50.0	17.0	2+(2)	US$2.00	5
B5	B.Khamngoy - 13S Km9	PC I-girder	2 span	45.0	10.5	2+(0)	US$1.11	46

The cost estimation of the intersection project is difficult to set up the basic unit cost by type of improvement. Actually it is necessary to calculate quantities of each work for the cost estimation of intersection such as improved area, number of leg, crossing road width and necessary facilities which are different by each case. For example, That Luang Neua intersection project; project number X6, which is the most simple case, is examined and project cost was roughly estimated at approximately forty three thousand U.S. dollar (US$ 43,000.00). For the appropriate project evaluation, each project cost for intersection projects shall be estimated with design drawing in pre-feasibility study.

17.5 STAGING PLAN

In view of the large number and cost of the proposed projects, it is proposed that the projects be implemented in stages. In this section, staging plan is discussed to classify all the projects into 3 phases; Short Term, up to year 2013, Medium Term, from year 2014 to 2018; and Long Term, from year 2019 to 2025.

17.5.1 Prioritization Criteria

Priority of each proposed road project is evaluated based on the criteria described in this section. The criteria are composed of four (4) aspects which, in turn, consist of twelve (12) factors showing below.

Planning Aspect

- Compatibility with Development Plans : Relation with Vientiane's development plans
- Impact on Socio-economic Activity / Basic Human Needs : number of public facilities, commercial area and tourism resources
- Multifunction of Road : Utilization of the road for daily life purpose

Technical Aspect

- Urgency (degree and scale of problems) : Present service level of the road section and status of new land development
- Role in Road Network : Functional classification of the road
- Technical Difficulty : Required type of work

Environmental Aspect

- Social Impact : Land acquisition and resettlement of the people to secure Right of Way
- Natural Impact : Impact on natural environment
- Social Acceptance : Degree of acceptance

Benefit Aspect

- Traffic Demand : Traffic volume in 2025
- Project Cost : Scale of estimated project cost
- Benefit Scale : Relative benefit scale

Each aspect of the project is examined and 1 (low advantage) to 3 (high advantage) points are given. Perfect score of a project become 12 point and the lowest score is 4 point. During the scoring of each road projects, much attention was paid for the completion of the linkage of the road to avoid the exclusion of a stretch from the implementation of the same link. Table 17.5-1 shows the criteria of the evaluation.

Table 17.5-1 Criteria for the Prioritization of the Projects

Advantage / Factor	High (3 point)	Medium (2 point)	Low (1 point)
Planning Aspect			
Compatibility with development plans	essential	supporting	relational
Impact on socio-economic activity / BHN	many	some	none
Importance of multifunction of road	much	common	little
Technical Aspect			
Urgency of implementation	urgent	early	subsequent
Importance of role in road network	primary	arterial	collector
Technical difficulty	common	rare method	new method
Environmental Aspect			
Scale of negative social impact	limited	intermediate	extensive
Scale of negative natural impact	small	middle	large
Degree of social acceptance	very high	high	low
Benefit Aspect			
Traffic demand in year 2025	high	middle	low
Estimated Project cost	little	middle	much
Benefit scale by the project	large	middle	small

The result of the evaluation is shown in Table 17.5-2. Considering with score of all projects, the priority is classified into 3 category; high priority with score of 10~12 point, medium priority with score of 8~9 point and low priority with score of 4~7 point.

Table 17.5-2 The Result of Evaluation of Road Projects

No.	Road Section	Criteria				Score	Priority
		Planning	Technical	Environment	Benefit		
1	Jct. Sikhay - 13N Km16	2	2	3	2	9	Medium
2	Luang Phabang Rd.	2	1	3	1	7	Low
3	Thadeua Rd.	2	2	1	2	7	Low
4	Friendship Br. - B.Nakhouay	3	3	2	2	10	High
5	B.Nakhouay - B.Dong Kang	3	2	3	3	11	High
6	B.Dong Kang - B.Xok Noy	3	3	2	2	10	High
7	B.Xok Noy - 13S Km10	3	2	2	2	9	Medium
8	13S Km10 - B.Dongxiangdi	3	2	2	2	9	Medium
9	B.Dongxiangdi - 13N Km16	2	2	3	2	9	Medium
10	Kaysonephomvihane Rd.	2	1	3	1	7	Low
11	Jct. Don Noun - 13S Km21	3	3	3	1	10	High
12	N11 Rd.	2	3	1	3	9	Medium
13	Nong Duag Rd. (13S - Inner ring)	2	1	2	2	7	Low
14	B.Pakthang - B.Phontong	3	3	1	3	10	High
15	Phonphanou Rd.	3	3	1	3	10	High
16	Blvd. Kamphengmeuang	3	2	2	2	9	Medium
17	Savang Rd.	2	1	3	1	7	Low
18	Dong Palep Rd.	3	3	1	3	10	High
19	Dong Palep Rd. - outer ring Rd.	2	1	3	1	7	Low
20	B.Sokpaluang - B.Xiangda	3	2	1	3	9	Medium
21	B.Xiangda - B.Khoumhin	3	2	2	2	9	Medium
22	B.Khoumhin - outer ring Rd.	3	2	2	2	9	Medium
23	B.Dong Kand - 13S Km21	3	2	3	2	10	High
24	13N Km11 - B.Viangkham	2	2	2	2	8	Medium
25	B.Nonkhilek - Provincial Rd. 106	2	2	2	1	7	Low
26	B.Nonkhilek - N11 Rd.	2	1	2	1	6	Low
27	13N Km8 - B.Phosomboun	2	1	2	1	6	Low
28	Nong Duag Rd. (Inner ring - T2)	2	1	3	1	7	Low
29	Dongdok Rd.(T7N)	2	1	3	1	7	Low
30	B.Phonkeo - B.Dongkalao(T7N.)	1	2	2	1	6	Low
31	B.Dongkalao(T7N) - Inner ring Rd.	1	2	2	2	7	Low
32	B.Dongxiangdi - B.Nongphagna	1	2	3	1	7	Low
33	B.Nongphagna - B.Phonsavang	2	2	2	2	8	Medium
34	Sivilai Rd. (P3N - N13S)	3	2	2	3	10	High
35	B.Dongdok - new outer ring Rd.	2	2	3	2	9	Medium
36	Sivilai Rd. (B.Phonsavang - T4N)	2	3	2	3	10	High
37	Pul Thong Rd.	2	3	2	3	10	High
38	New Hong Kai Keo Rd.	2	1	3	1	7	Low
39	13S Km6 - B.Xiangda	3	3	2	3	11	High
40	B.Singda - Thadeua Rd.	3	2	3	2	10	High
41	That Luang Rd.	2	1	3	1	7	Low
42	B.Dongkhamxang - Inner ring Rd.	1	1	3	1	6	Low
43	Jct.SaNamMar(cd109) - Jct.B.Mai	3	2	3	2	10	High
44	B.Nonkho(cd109) - B.Nakhouay	2	1	3	1	7	Low
45	B.Vangxay(cd109) - B.Khamngoy	2	2	1	2	7	Low
46	B.Khamngoy - 13S Km9	1	2	2	2	7	Low
47	13S Km18 - B.Konk Gnai	3	1	3	2	9	Medium
48	B.Khok Noy - Hong Beng	1	2	2	1	6	Low
49	Jct.Ji Nie Mo(A12) - B.Thakhek	2	2	3	1	8	Medium
50	B.SaLaKham(A12) - B.SaVang	2	2	2	1	7	Low

Basically the priority of bridge projects shall be the same with the road project where proposed bridge is located. However existing four bridges, Project Number B1~B4, should be

replaced urgently due to their condition and those projects were classified into high priority. Remaining new proposed bridge project, Project Number B5, should be constructed at the same time with the road section and the priority is judged to be same with the road project, Project Number 46, which was classified into low priority.

17.5.2 Staging Plan

Basically, the staging plan for the implementation of the proposed projects shall be prepared based on the priority evaluated in the previous section. Target year of each phase is year 2013, 2018 and 2025 respectively. The Short Term projects include the measures to solve urgent issues and problems in the near future. To secure the realization of short term projects, it is necessary to start the preparation of project implementation immediately. The projects classified into Short Term implementation is listed in Table 17.5-3 and estimated total cost for Short Term is approximately 78.9 million U.S. dollar.

Table 17.5-3 Proposed projects in Short Term

No.	Road Section	Classification	Distance (km)	Width (m)	Cost (million $)	Remarks
Short Term (year 2008~2013)						
4	Friendship Br. - B.Nakhouay	Primary Arterial	7.9	14.5	6.45	outer ring road
5	B.Nakhouay - B.Dong Kang	Primary Arterial	2.7	14.5	3.31	outer ring road
6	B.Dong Kang - B.Xok Noy	Primary Arterial	4.1	14.5	3.21	outer ring road
11	Jct. Don Noun - 13S Km21	Primary Arterial	9.0	27.5	15.41	national network
14	B.Pakthang - B.Phontong	Arterial	4.2	27.5	7.95	inner ring road
15	Phonphanou Rd.	Arterial	1.8	27.5	3.10	inner ring road
18	Dong Palep Rd.	Arterial	7.0	19.0	8.45	center-north link
23	B.Dong Kand - 13S Km21	Arterial	11.2	9.5	5.52	eastern corridor
34	Sivilai Rd. (P3N - N13S)	Collector	1.5	16.5	1.62	east-west sub-link
36	Sivilai Rd. (B.Phonsavang - T4N)	Collector	3.0	16.5	3.23	center-north sub-link
37	Pul Thong Rd.	Collector	2.2	16.5	2.37	center-north sub-link
39	13S Km6 - B.Xiangda	Collector	10.0	14.5	6.63	north-south sub-link
40	B.Singda - Thadeua Rd.	Collector	7.0	9.5	3.02	north-south sub-link
43	Jct.SaNamMar(cd109) - Jct.B.Mai	Collector	8.4	9.5	3.86	connector
B1	13S Km6 - B.Xiangda	Collector	0.045	14.5	1.53	on project 39
B2	Jct.SaNamMar - Jct.B.Mai	Collector	0.030	10.5	0.74	on project 43
B3	Jct.SaNamMar - Jct.B.Mai	Collector	0.020	10.5	0.49	on project 43
B4	B.Nakhouay - B.Dong Kang	Primary Arterial	0.050	17.0	2.00	on project 5
				sub-total	78.89	

Proposed intersection projects, except Project Number X5 shall be classified into the phase of Short Term because of its emergent nature. However the problems, measures, design and cost estimation will be discussed in Chapter 19, and the above list dose not include proposed intersection projects.

Considering the amount of necessary fund, classification of priority and the linkage of road stretch, remaining proposed projects are classified into the phases of Medium Term and Long Term. Attention is paid to balance the total cost of each phase for the realizable fund arrangement. Proposed projects listed in the Medium Term and Long Term are shown in Table 17.5-4. Total costs of the projects in the Medium Term and Long Term are estimated at

approximately 75.3 million U.S. dollar and 63.0 million U.S. dollar, respectively.

Table 17.5-4 Proposed Projects in Medium Term and Long Term

No.	Road Section	Classification	Distance (km)	Width (m)	Cost (million $)	Remarks
Medium Term (2014~2018)						
1	Jct. Sikhay - 13N Km16	Primary Arterial	10.6	19.0	11.92	western corridor
7	B.Xok Noy - 13S Km10	Primary Arterial	5.1	14.5	4.17	outer ring road
8	13S Km10 - B.Dongxiangdi	Primary Arterial	6.6	14.5	5.39	outer ring road
9	B.Dongxiangdi - 13N Km16	Primary Arterial	6.4	14.5	5.00	outer ring road
12	N11 Rd.	Arterial	5.0	19.0	6.20	national network
16	Blvd. Kamphengmeuang	Arterial	10.9	19.0	7.46	inner ring road
20	B.Sokpaluang - B.Xiangda	Arterial	4.7	19.0	6.61	new east - west link
21	B.Xiangda - B.Khoumhin	Arterial	1.8	19.0	2.46	new east - west link
22	B.Khoumhin - outer ring Rd.	Arterial	2.0	19.0	2.81	new east - west link
24	13N Km11 - B. Viangkham	Arterial	5.0	19.0	6.25	provincial network
33	B.Nongphagna - B. Phonsavang	Collector	5.1	14.5	4.17	east-west sub-link
35	B.Dongdok - new outer ring Rd.	Collector	1.9	9.5	0.94	center-north sub-link
47	13S Km18 - B.Konk Gnai	Collector	5.2	9.5	2.40	connector
49	Jct.Ji Nie Mo(A12) - B.Thakhek	Collector	22.5	9.5	8.42	southern ring road
X5	Phonephanao Intersection	Intersection	-	-	1.10	with project 16
				sub-total	75.30	
Long Term Project (2019~2025)						
2	Luang Phabang Rd.	Primary Arterial	1.6	27.5	1.02	southern corridor
3	Thadeua Rd.	Primary Arterial	16.4	27.5-19.0	9.55	southern corridor
10	Kaysonephomvihane Rd.	Primary Arterial	10.0	27.5	6.03	central corridor
13	Nong Duag Rd. (13S - Inner ring)	Arterial	3.8	19.0	4.37	inner ring road
17	Savang Rd.	Arterial	0.5	19.0	0.23	center-north link
19	Dong Palep Rd. - outer ring Rd.	Arterial	2.1	9.5	0.84	center-north link
25	B.Nonkhilek - Provincial Rd. 106	Collector	3.6	14.5	2.94	connector
26	B.Nonkhilek - N11 Rd.	Collector	2.0	14.5	1.33	connector
27	13N Km8 - B.Phosomboun	Collector	4.2	14.5	3.07	connector
28	Nong Duag Rd. (Inner ring - T2)	Collector	3.2	16.5	1.19	connector
29	Dongdok Rd.(T7N)	Collector	11.7	16.5	11.27	east-west link
30	B.Phonkeo - B.Dongkalao(T7N.)	Collector	3.6	9.5	1.90	connector
31	B.Dongkalao(T7N) - Inner ring Rd.	Collector	4.6	14.5	3.76	connector
32	B.Dongxiangdi - B.Nongphagna	Collector	1.6	9.5	0.79	connector
38	New Hong Kai Keo Rd.	Collector	1.7	16.5	0.63	center-north sub-link
41	That Luang Rd.	Collector	0.9	19.0	0.93	center-east link
42	B.Dongkhamxang - Inner ring Rd.	Collector	1.5	9.5	0.58	connector
44	B.Nonkho(cd109) - B.Nakhouay	Collector	3.2	9.5	1.16	center-east link
45	B.Vangxay(cd109) - B.Khamngoy	Collector	3.4	9.5	1.79	east-west link
46	B.Khamngoy - 13S Km9	Collector	6.0	9.5	3.16	east-west link
48	B.Khok Noy - Hong Beng	Collector	5.4	9.5	2.85	connector
50	B.SaLaKham(A12) - B.SaVang	Collector	4.8	9.5	2.53	connector
B5	B.Khamngoy - 13S Km9	Collector	0.045	10.5	1.11	on project 46
				sub-total	63.03	

Total cost of all proposed road projects and bridge project was estimated at 217.22 million U.S. dollar. It should be noted that the estimated cost as listed in Table 17.5-4 does not include the cost for design, construction supervision and other costs associated with implementation of the project.

Figure 17.5-1 shows the projects in the three phases.

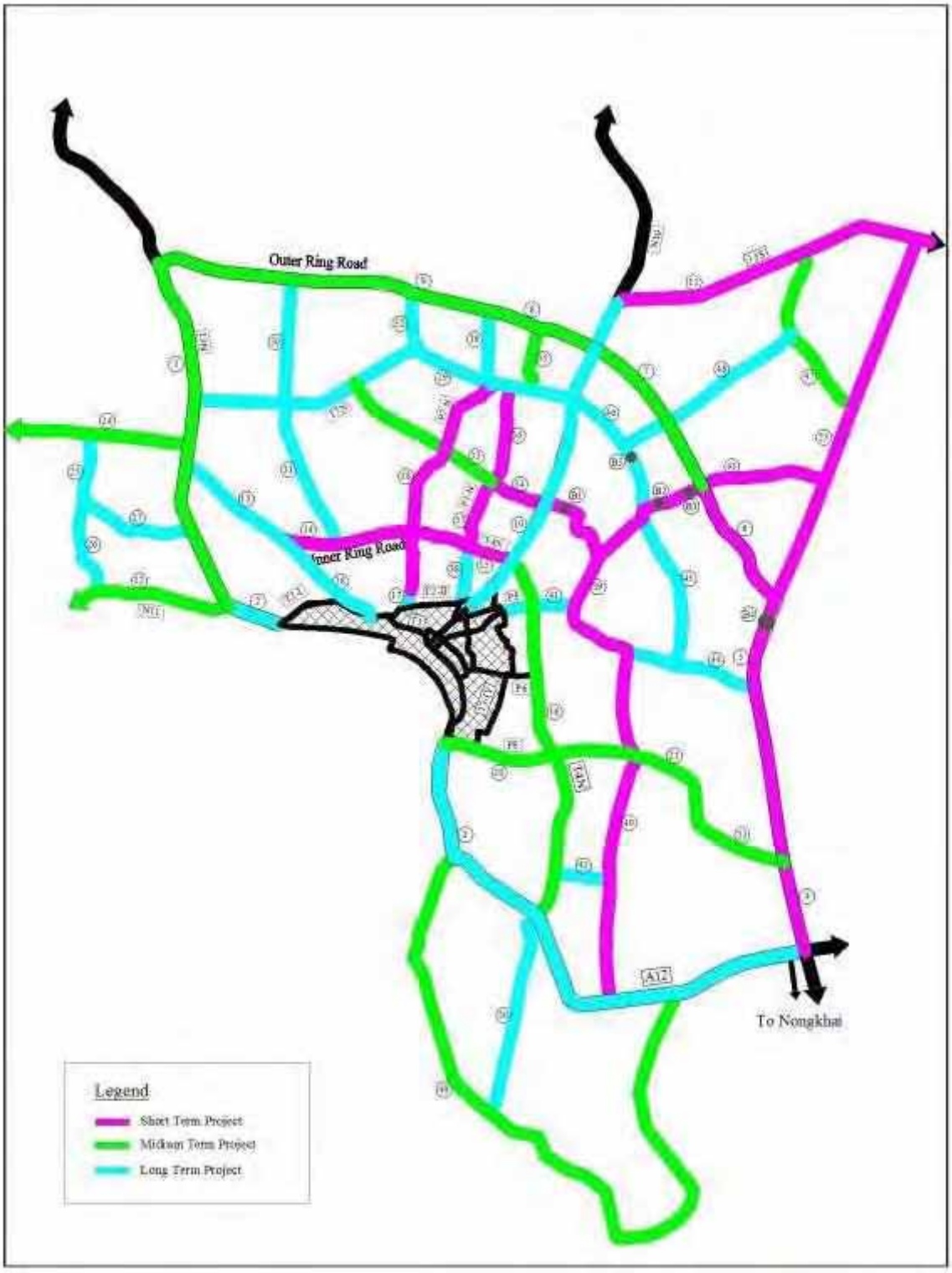


Figure 17.5-1 Phase of Project Implementation

The acquisition of ROW is very sensitive issue and it has to proceed with careful attention through the appropriate coordination with related stakeholders. It may take long years to secure the stretch of Right of Way for the development of each road. Thus this Master Plan proposes the stage construction measure instead of desirable sectional composition.

17.6 A CASE STUDY ON CONSTRUCTION OF MISSING LINK OF INNER RING ROAD

17.6.1 INTRODUCTION

The Inner Ring Road (IRR) is to be the main route for the traffic in circular direction in the urbanized area of Vientiane. The eastern section of IRR is Boulevard Kamphengmeuang running in the north-south direction. Boulevard Kamphengmeuang end at its intersection with Kaysonephomviane Road and Phonphanou Road is functioning as IRR from Kaysonephomviane Road to west. Phonphanou Road ends at the intersection with Savang Road and there is no existing road which functions as IRR.

The lack of the west-end section (the missing link) of IRR results in concentration of the traffic from the area in the west of the airport to the city center and increase of the congestion there. Thus construction of this section is urgent and expected to greatly contribute to improvement of traffic condition in the city center as well as western periphery of the city.

For this urgency, the Study Team conducted a case study on construction of missing link of IRR (between Dong Palaep Road and Nong Duag Road) for planning and implementing the project. This case study consists of following.

- Preliminary design
- Construction plan
- Cost estimate
- Economic evaluation
- Pre-EIA

17.6.2 Selection of the Section for the Case Study

In addition to the lack of the west-most section, there are a few problems in the current situation of the Inner Ring Road:

(i) The configuration of the intersection with National Rd. No. 13 South is staggered. (See Chapter 17; Subsection 17.3.3 Intersection Project)

(ii) The widths of existing sections are insufficient; especially the existing width of Phonphanou Rd (between National Rd. No. 13 South and Savang Rd.) is not sufficient even as an opposed 2-lane road.

(iii) The section between Savang Rd. and Dong Palep Rd. is practically non-existent and the traffic are forced to detour to the merging point of Savang Rd. and Dong Palep Rd., located about 2km south of the ending point of Phonphanou Rd.

Relocation of considerable number of houses is foreseen if the improvement works of the above problems are to be implemented in a short period. Thus, diligent study and plan/preparation are required before for these works are implemented. Therefore, it is strongly recommended that the Government start the study the improvement of these problems as soon as possible.

In spite of these problems, construction of the missing link section on the west end of the Inner Ring Road (between Dong Palep Rd and Nong Duag Rd.) is expected to greatly contribute to the mitigation of traffic congestion in the city center and yield good economic return, as explained later. Although ROW for this project needs to be acquired for the entire section, relocation of houses is relatively limited and the majority of the land to be acquired is mainly rice pad and other agricultural land. Thus, implementation is expected not to be difficult. For this reason and the urgency/benfit, this section of IRR is selected for the Case Study.

Although the detailed studies on the above problems are not conducted in this Study, one of the possible improvement plan for the problem (i) above is discussed in Page 17-14, Subsection 17.3.3: Intersection Project.

In addition, possible alternative routes for the problem are discussed in the following subsection, together with the alternative routes of the Case Study Section. Also, a very preliminary study was conducted. Preliminary cost estimate, economic parameters and other information are presented in Appendix 17-7.

17.6.3 PRELIMINARY DESIGN

(1) Road Alignment Selection

1) Basic Policy on Road Alignment Selection

The alignment of the Project Road is selected considering the factors as described bellows:

(i) Location of beginning point of Project Road

The project alignment of the Inner Ring Road, a circumferential road located at about 4 to 6km from the city center of Vientiane, will connect Boulevard Kamphengmeuang and Phonphanou Road with Nong Duag Road. The Project Road alignment, passing through the north-western suburbs of Vientiane, is about 4.7km in length between Dong Palep Road and Nong Duag Road. However the alignment between Phonphanou Road and Dong Palep Road is not yet fixed. Therefore the alignment of this section needs to be considered in selecting the location of the beginning point for the Project Road.

(ii) Minimizing adverse social impact:

It is necessary to minimize the number of affected peoples and resettlement in order to reduce negative social impact as well as to reduce of Project by the time for relocation.

(iii) Drainage channel

The selection of route alignment should be consider and avoid the Hong Wattay Channel Improvement accomplished on February 2008.

These factors for route selection are illustrated in the proposed road network is formulated by the procedure as shown in Figure 17.6-1.

Figure 17.6-1 Procedure of Formulation of Proposed Road Network

2) Evaluation Criteria for Alternative Routes

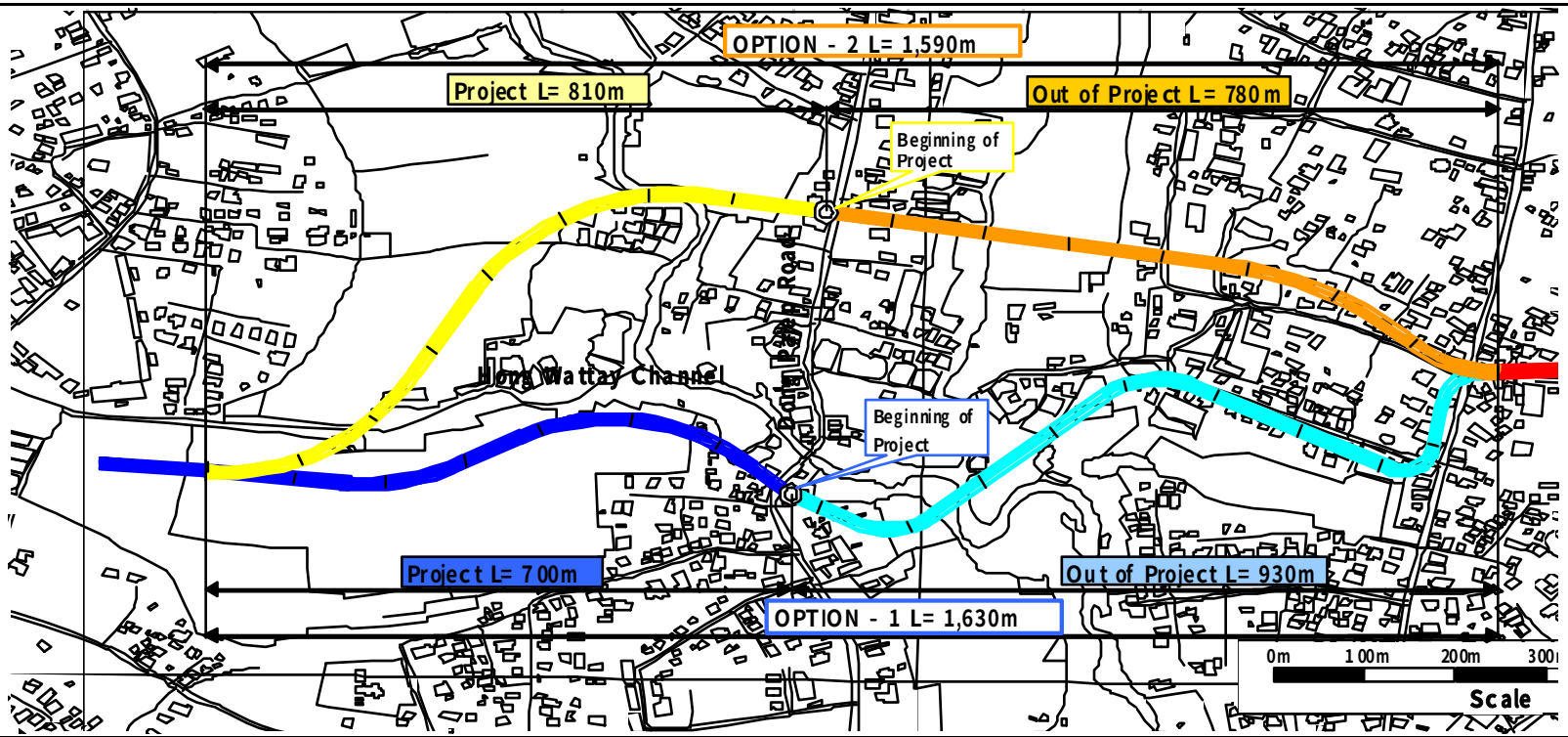
Location of the beginning point of the Project Road and the alternative routes are evaluated using the criteria presented in Table 17.6-1.

Table 17.6-1 Criteria for Route Selection

Item	Evaluation Weight	Assessment Points
1) Road Alignment	2	• Good……2 • Normal ……1 • Not Bad……0
2) Construction Cost	5	• Cheapest……5 • Average ……3 • Expensive……1
3) Construction Method	2	• Easy……2 • Average ……1 • Difficult……0
4) No. of Affected Houses	6	• Few……6 • High ……3 • Very High……1
5) Right-of-way Acquisition	5	• Easy……5 • Average ……3 • Difficult……1
Total	20	

The results of comparative route alternative selection are shown in Table 17.6-2.

Table 17.6-2 Alternative Route Selection for Beginning Point of Project Road on Dong Palep Road

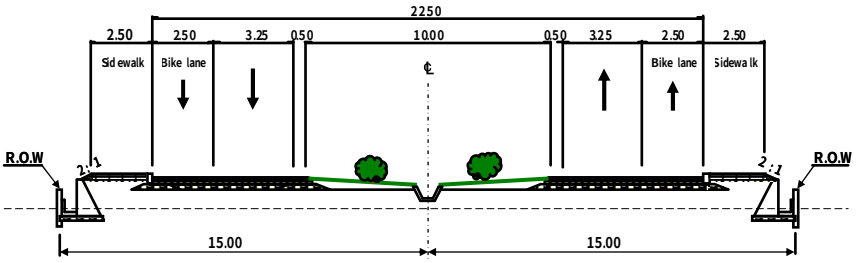
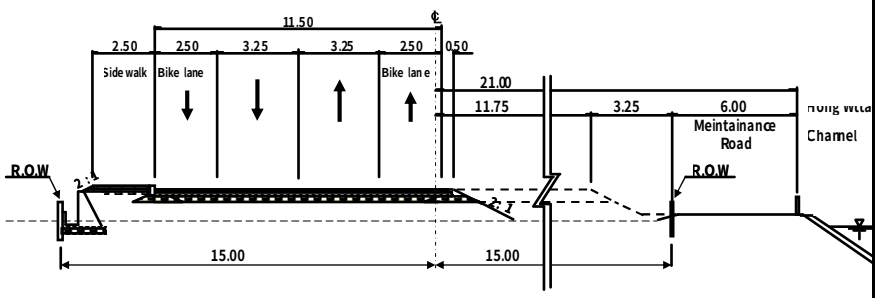
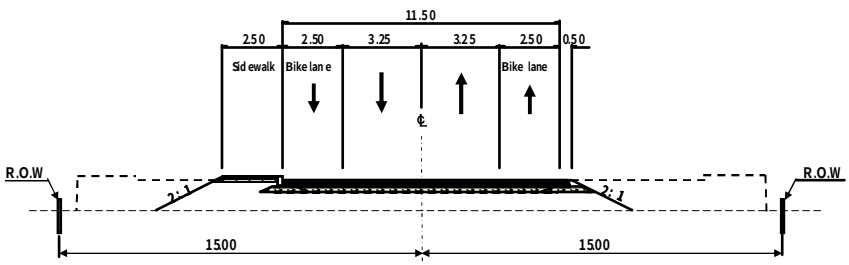
Plan							
Option	Option 1			Option 2			
Length	Total Length =1,630m	Road Length =1,585m	Bridge Length = 45m	Total Length =1,590m	Road Length =1,519m	Bridge Length = 71m	
Criteria	Evaluation Point			Evaluation Point			
Road Alignment	Min. Hor. Radius = 30m	Min. Vert. Grade =0.30%	0	Min. Hor. Radius =250m	Min. Vert. Grade=0.30%	2	
Const. Cost	2.384 M.US$ (1.46 M.US$ /km)		3	3.038 M.US$ (1.91 M.US$ /km)		1	
Const. Method	Possible to utilize existing roads as access to construction site		2	Alignment involves 2 bridges - need to provide about 800m access road and Temporary Bridge during construction.		0	
Affected Houses	3 one-storied houses		3	3 tow-storied houses + 1 one-storied house		1	
ROW	Pass through rice paddies and residential areas; less affected house.		3	Pass through rice paddies and residential areas; more affected house.		1	
Evaluation	Adopted in this Pre-F/S		11	To be adopted in the future plan/design		5	

(2) Cross-Sectional Composition

1) Cross section for the initial construction stage

Since the Inner Ring Road is classified as an Arterial Street, cross section is studied based on Figure 17.2-5. Also, stage construction measure is considered depending on the roadside environment/development. Three alternatives of cross sections for the initial construction are compared in Table 17.6-3.

Table 17.6-3 Alternatives of Cross Section for Initial Construction

Cross Section	Features
Alt.-1 	● Suitable when the development quickly occurs along the road. ● Easy construction and no re-construction work. ● Initial construction cost is the most expensive.
Alt.-2 	● Suitable when the development along the road occurs on one side only. ● Construction of completed cross section is easier with less scrapping of constructed works. ● Initial construction cost is less.
Alt.-3 	● Unsuitable when the development along a road occurs quickly. ● Construction of completed cross section is difficult involves many scrapping of constructed works and many re-construction works. ● Initial construction cost is the lowest.

Considering the factors listed in the column of 'Features', and the conditions of the site, Alternative - 3 is adapted to minimize the initial construction cost.

2) Cross section for the final construction stage

Cross Section for final construction is shown Figure 17.6-2.

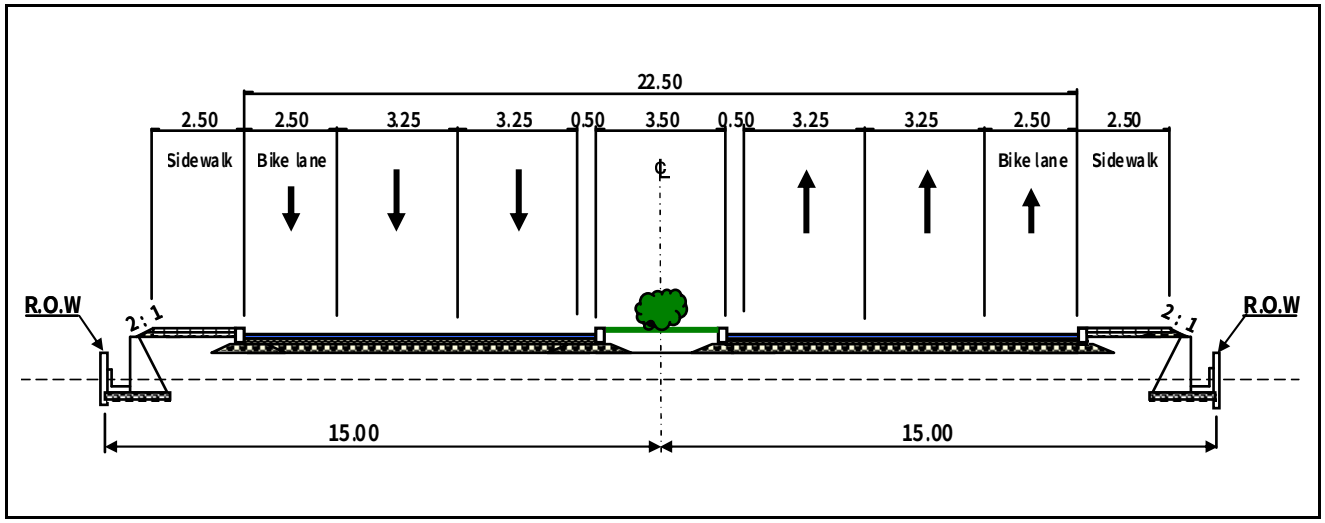


Figure 17.6-2 Cross Section for Final Construction

Consideration on Mass Transit system

Alternative -1 can accommodate Mass Transit System if necessary in the future, as illustrated in Figure 17.6-3.

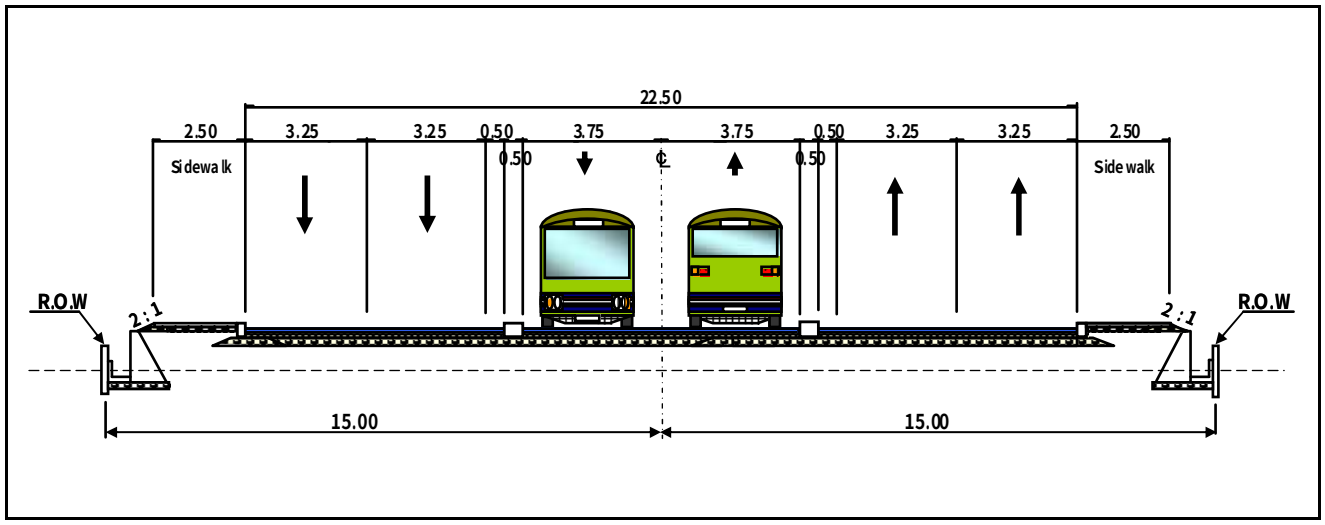


Figure 17.6-3 Accommodation of Mass Transit System

(3) Structure Design

1) Proposed Cross Section for Bridge

The details of proposed bridge cross section are shown in Table 17.6-4.

Table 17.6-4 Cross Section Dimensions of Bridge

Item	Unit	Cross Section Element	
		Initial Stage	Completed Stage
Width of Bridge	m.	14.00	12.00+12.00
Number of Lanes	No.	2+2(Bike lane)	4+2(Bike lane)
Lane width	m.	3.25, 2.50(Bike lane)	3.25, 2.50(Bike lane)
Carriageway	m.	11.50	9.50 x 2 =19.00
Sidewalk	m.	2.50	2.50 x 2= 5.00
Vertical Clearance	m.	Vertical clearance is 10~20cm from top of Channel bank to lowest structure member	

After consulting with counterpart member, 'the Standard Drawings for Highway Construction', Department of Highway, Ministry of Transport and Communications, Kingdom of Thailand is adopted as the basic design criteria.

The proposed design for bridge is as follows:

Hong Wattay Channel Bridge

- Bridge Length : L= 16.00m
- Bridge Width : W= 14.00m (Initial), W= 24.00m (Completed)
- Superstructure : RC-Multi Beam Type
- Foundation Type : RC Pile
- Pavement : Asphalt Concrete t=5cm

Design of the bridge is shown in Figure 17.6-4.

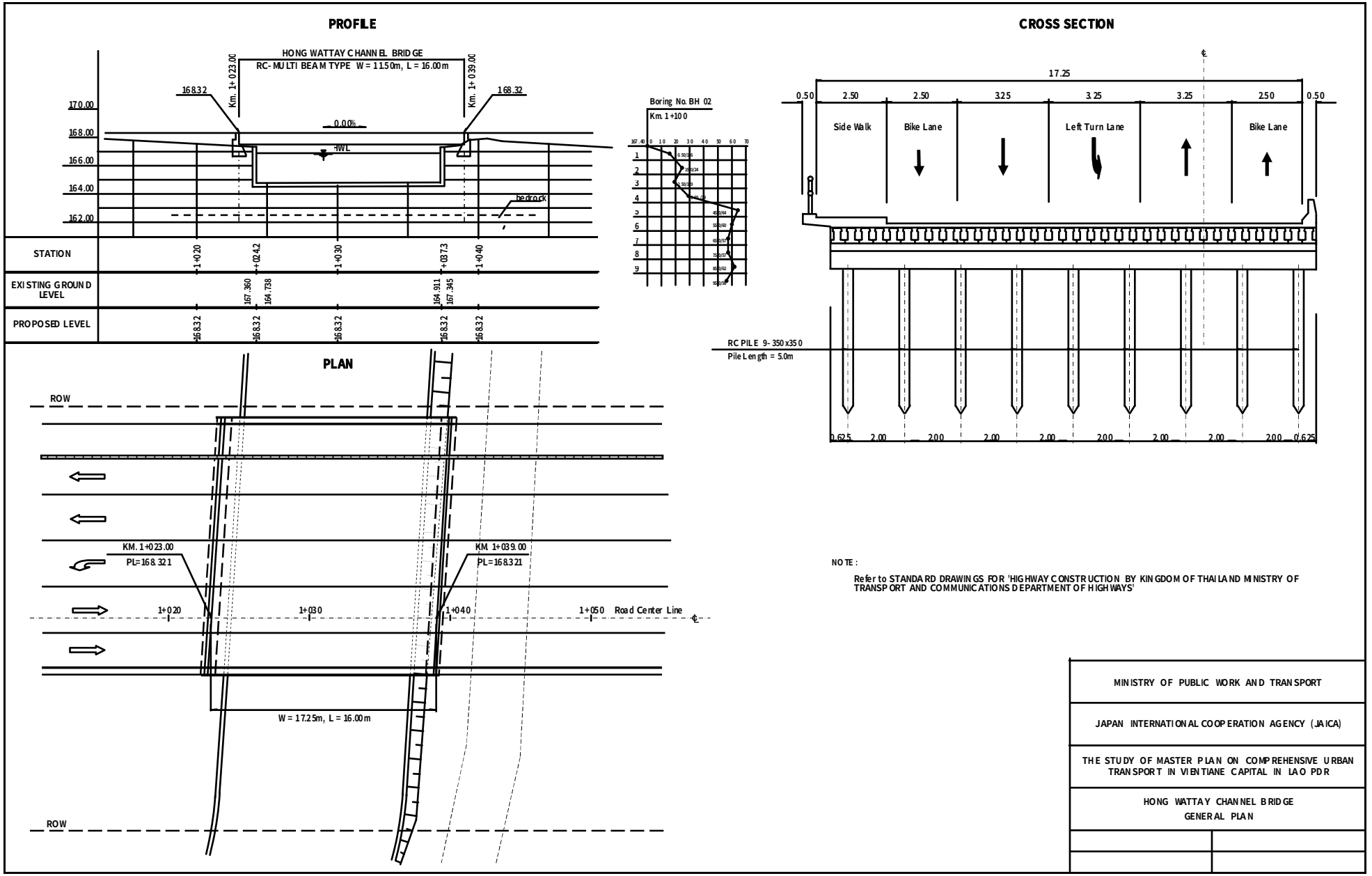


Figure 17.6-4 General Plan of Hong Wattay Channel Bridge

(4) Pavement Design

1) General

The primary purpose of the pavement design for the road section is to select the most economical combinations of pavement materials and layer thickness of base and sub-base course that will provide sufficient durability to last over the design life of the pavement with only routine maintenance.

Two main factors are considered in the pavement design of this Study:

(i) The total traffic volume and axle load distribution that will pass the road over the design life of asphalt concrete pavement is 10 years.
(ii) The preliminary design needs to assume a value of the sub-grade by reviewing the existing material report on the CBR, because a detailed survey is to be carried out at the detailed design stage.

2) Design Formula

The design analysis of the pavement structure was made in accordance with the *Design Guidelines Criteria and Standards* and the *AASHTO Guide for the Design of Pavement Structures* (1993). Details of pavement design are presented in Appendix 17-2.

3) Proposed Pavement Structure

As a result of calculation as presented in Appendix 17-2 the following pavement is proposed:

Asphalt concrete: 10cm (Surface Course: 5cm, Binder Course: 5cm)
Aggregate Base Course: 15cm
Granular Subbase Course: 20cm

(5) Drainage Design

The different structures applied to drainage system including line ditches, pipe culverts and box culverts, as presented in the Table 17.6-5.

Table 17.6-5 Drainage System

Line Ditches	Applied as toe of road slope and median strip	U-Type concrete ditch 0.50m x 0.50m
Pipe Culverts	Applied as undercrossings for creeks and openings in small creeks and irrigation in rice paddy.	RCPC-φ0.60m ~ φ1.00m
Box Culverts	Applied as undercrossings for creeks and openings in small creeks and streams.	RCBC- 1.5~3.0 x 1.0~2.0 m

(6) Intersection Design

The main intersections in this project are as listed in Table 17.6-6.

Table 17.6-6 Main Intersection

Number	Station	Crossing Road	Intersection Type	Remarks
①	0+000	Dong Palep Road	T Type	4-Leg in future
②	0+980	Nong Bouathong Road	4-Leg	
③	4+500	Nong Duag Road	Y Type	

In designing the above intersections, Ring Road is regarded as the priority road and the crossing road are regarded as the miner roads with one stop control. It is proposed that Intersections ① and ③ are constructed with the completed cross section at initial stage so that the completed stage can be constructed easily.

Plan of each Intersectional Type is shown in Figure 17.6-5.

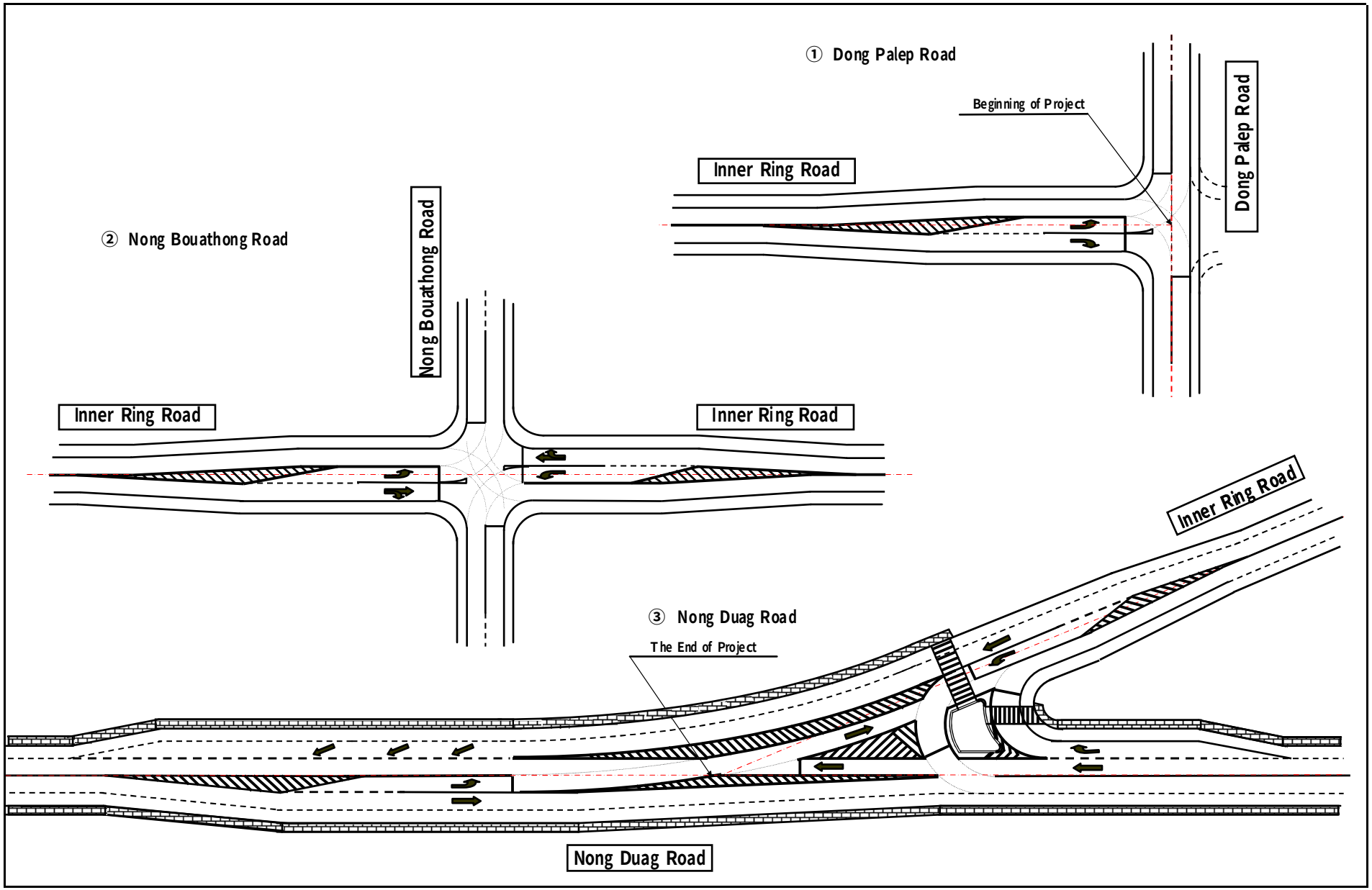


Figure 17.6-5 Intersection Type

17.6.4 CONSTRUCTION PLAN

(1) Implementation Schedule

1) Detailed Design and Tender Preparation

Detailed design and tender of the contractor including procurement of the Consultant will take one (1) year after financing is confirmed.

2) Construction

Table 17.6-7 presents the construction schedule. The construction period is estimated to be two years.

Table 17.6-7 Construction Schedule

Year	1st Year												2nd Year												Remarks
Major Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1. Mobilization																									
2. Earthwork																									
3. Slope Protection																									
4. Pavement																									
5. Drainage 1) Longitudinal Drainage																									
2) Cross Drainage																									
6. Bridge 1) Foundation																									
2) Super structure																									
7 Road Facilities																									
8 Demobilization																									

3) Project Implementation Schedule

Project implementation schedule is shown in Table 17.6-8.

Table 17.6-8 Project Implementation Schedule

Major Work	Cost (M.US$)	Year (Cal.)	2008	2009	2010	2011	2012	2013
Fund Preparation								
Consultant Selection								
Detailed Design								
Tendering								
Land Acquisition								
Construction								
Construction supervision								
Total								

17.6.5 COST ESTIMATE

(1) Calculation of Construction Quantities

In the calculation of construction quantities, the Items established Initial Stage and Final Stage.

The quantities are classified into six (6) Items as follows;

1) Earth Work
2) Slope protection
3) Pavement
4) Drainage
5) Bridge
6) Road Facilities

(2) Condition of Cost Estimation

The following Conditions are taken into consideration for the cost estimation.

1) Unit price was determined based on Table 17.4-1 in Chapter 17 and other unit prices collected from similar construction project in Lao.
2) Foreign exchange rate is US$ 1 = Kip 9,628 = Japanese Yen110.
3) Land Acquisition without compensation (resettlement) cost is estimated according to provided by Department of Land.
4) Engineering services and construction management cost are assumed to be 6% for detailed engineering and 4% for local administration of the Construction Cost.
5) Physical contingency is estimate to be 10% of the total construction cost.
6) Sales Tax is estimated to be 10% of 'C. Sub-total'.
7) Cost of removal of the existing public works is taken into consideration 100,000 US$. (Electricity, water service, road infrastructure, etc.)

Estimation Sheets of Construction Cost are presented in Appendix 17-3.

Summary of Inner Ring Road Construction Cost by item is shown in Table 17.6-9. See Appendix 17-4 for Final Construction Stage Cost.

Table 17.6-9 Construction Cost of Inner Ring Road

Item	Unit	Unit Price (USD)	Quantity	Construction Cost (USD)	Remarks
1 Earthwork					
1.1 Clearing & Graving	ha	12,900	7.9	102,150	
1.2 Embankment From Road Excavation	m^3	19.38	804.0	15,582	
1.3 Embankment From Borrow	m^3	4.21	68,069.0	286,570	
2 Slope Protection					
2.1 Slope Protection on Embankment Slope (Sodding)	m^2	2.44	16,980.0	41,431	
2.2 Masonry Retaining Wall	m^3	103.5	0.0	0	
3 Pavement					
3.1 Subgrade Preparation	m^2	0.35	62,297.2	21,804	
3.2 Granular Sub-base Course (t=20cm)	m^3	5.59	12,084.7	67,554	
3.3 Aggregate Base Course (t=15cm)	m^3	5.94	8,501.5	50,499	
3.4 Bituminous Concrete Binder Course (t=5cm)	m^2	9.61	54,100.2	519,903	
3.5 Bituminous Concrete Surface Course (t=5cm)	m^2	9.56	53,866.0	514,959	
3.6 Prime Coat	L.	1.66	65,201.3	108,234	
3.7 Tack Coat	L.	1	2,810.4	2,810	
4 Drainage					
4.1 Longitudinal Drainage	m	106	9,400.0	996,400	
4.2 Excavation for RCPC & RCBC	m^3	15.8	383.7	6,062	
4.3 Cross Drainage (RCPC φ0.600)	m	101.67	441.2	44,857	
Cross Drainage (RCPC φ1.000)	m	213.7	18.1	3,868	
4.4 Concrete for RCPC & RCBC	m^3	235.7	286.2	67,467	
4.5 Re-bar for RCPC & RCBC	ton	1,010.87	13.1	13,209	
5 Bridge					
5.1 RC Multi-Beam	m^2	2,300.00	240.0	552,000	
6 Public Utility Relocation/Protection					
6.1 Public Utility Relocation/Protection	L.S.	1	100,000	100,000	
7 Miscellaneous					
7.1 Sidewalk w=2.5m	m	82	4,684.0	384,088	
7.2 Traffic Sign each100m ×2	No.	129.53	94	12,176	
7.3 Guide Sign 4 Intersection	No.	259.36	13	3,372	
7.4 Pavement Marking	m^2	11.9	2,810.4	33,444	
7.5 Km. Post	No.	60.4	5	302	
7.6 Guard Rail	m	150	40.0	6,000	
7.7 Road Lighting	set	2,055.73	95	195,294	per km
A. Sub-total (1 t0 7)				4,150,035	882,986
8 Engineer's Facility					
8.1 Engineer's Facility (1% of A)	L.S.		1	41,500	
9 Mobilization/Demobilization					
9.1 Mobilization/Demobilization (0.5% of A)	L.S.		1	20,750	
10 Contingency					
10.1 Contingency (10% of A)	L.S.		1	415,004	
B. Construction Cost Total (A + 8 to 10)				4,627,289	
11 Management Fee					
11.1 Engineering and Construction Management (6% of B)	L.S.		1	277,637	
11.2 Local Administration (4% of B)	L.S.		1	185,092	
C. Construction Cost Total (B + 11)				5,090,018	
12 Land Acquisition and Compensation					
12.1 Land Acquisition residential	m^2	256	4,000	1,024,000	
agricultural	m^2	63	90,000	5,670,000	
D. Sub-total (C + 12)				11,784,018	
13 Sales Tax (10% of C)				1,178,402	
E. Project Cost				12,962,420	

17.6.6 ECONOMIC EVALUATION

(1) Methodology of Economic Evaluation

The methodology of economic evaluation of the project road for pre-feasibility study is same as the master plan study mentioned in Chapter 22. The costs and benefit are obtained in the basis of economic values being converted from financial values deducting tax and land acquisition cost. The assumption and criteria applied for the economic evaluation are summarized in Table 17.6-10.

Table 17.6-10 Condition of Economic Evaluation

	Base year	The year 2010
	Opening year	The year 2013
	Economic Life	25 years after open to traffic
	Exchange rate (Oct. 2007)	US$ 1=9628 Kip, = 110 JP¥
	Tax rate	10% of commercial value
	Capital Opportunity Cost	12% per annum

A traffic assignment work by the method same as that mentioned in Chapter 15 is carried out, assuming the opening year to be 2013; assignments are for the year of 2013, 2018 and 2025, for both with and without case. The result is summarized in Table 17.6-11.

1) Economic Benefits

Among the various benefits from the project road, the following factors are counted as the economic benefits as mentioned in Chapter 21.

a) Saving in vehicle operating costs
b) Saving in travel time costs

i) Saving in vehicle operating costs (VOC)

Saving in VOC due to the completion of the project road is obtained by comparing total vehicle-kilometer and vehicle–hour for the study area of with and without network. With network is so called do-nothing network and with network is the network in which only the project road is added to the without network.

In the short term Scenario several road projects are listed, the project road being one of them. However, for the economic evaluation, in order to evaluate only effect of the project road, the other road projects are not included in the with network. The unit VOC is same as what was obtained in the Chapter 21.

Table 17.6-11 Future Traffic Estimation

Case	Year	Vehicle-km (1/1000)					
		M/C	Car	Sonteo	Bus	Truck	Total
Present	2007	2,897	687	29	99	113	3,824
Do-nothing	2013	5,669	1,137	35	121	177	7,139
	2018	7,223	1,889	40	137	265	9,554
	2025	8,901	3,332	43	148	466	12,891
Do-nothing + Bypass	2013	5,614	1,128	36	120	175	7,073
	2018	7,164	1,875	40	137	265	9,482
	2025	8,887	3,323	44	148	467	12,868
Case	Year	Vehicle-hour					
		M/C	Car	Sonteo	Bus	Truck	Total
Present	2007	69,299	16,075	572	2,198	2,783	90,926
Do-nothing	2013	164,946	32,936	810	3,165	5,486	207,344
	2018	257,427	67,297	1,093	4,267	10,518	340,601
	2025	430,184	160,944	1,519	5,931	25,342	623,921
Do-nothing + Bypass	2013	161,716	32,382	812	3,122	5,423	203,455
	2018	253,113	66,312	1,099	4,225	10,415	335,164
	2025	423,213	158,340	1,528	5,874	25,195	614,149

ii) Saving in travel time costs (TTC)

Saving in TTC due to the completion of the project road is obtained by comparing the with and the without case by the same manner as the VOC. In this case, only vehicle-hour is compared. The unit TTC obtained in the Chapter 21 is used.

iii) Economic Costs

The estimated costs for the project road are financial cost using market price. In order to convert it to economic cost, tax is excluded. In Lao PDR tax rate is 10% for all the construction materials. So, 90% of the financial cost is considered as economic cost.

Maintenance cost is estimated to be 5% of the construction cost. And design and construction supervision cost is estimated to be 10% of the project cost.

(2) Economic Evaluation

The economic indices considered in this economic evaluation are EIRR, B/C and NPV. The evaluation period is 30 years same as economic life after the opening of the project road. Cash flow analysis is shown in Table 17.6-12. And economic indices are presented in Table 17.6-13.

If evaluate economic indices with “Out of Project” section, figures are much smaller than Table 17.6-13 as shown in Appendix 17-7.

Table 17.6-12 Cash Flow Analysis

EIRR= 18.49% B/C ratio= 1.57 NPV= 6,813

	year	Costs				Benefit				
		Const'on Cost	OM Cost	Total Cost	discount rate :12%	VOC	TTC	Total Benefit	discount rate :12%	Benefit - Cost
0	2010	7,156		7,156	7,156					-7,156
1	2011	2,106		2,106	1,880			0	0	-2,106
2	2012	2,106		2,106	1,679			0	0	-2,106
3	2013		211	211	150	2,162	524	2,686	1,912	2,476
4	2014		211	211	134	2,206	563	2,769	1,760	2,558
5	2015		211	211	120	2,249	604	2,853	1,619	2,642
6	2016		211	211	107	2,289	648	2,937	1,488	2,727
7	2017		211	211	95	2,328	695	3,023	1,368	2,813
8	2018		211	211	85	2,364	745	3,109	1,256	2,899
9	2019		211	211	76	2,300	811	3,111	1,122	2,900
10	2020		211	211	68	2,232	882	3,113	1,002	2,903
11	2021		211	211	61	2,158	959	3,117	896	2,906
12	2022		211	211	54	2,078	1,044	3,123	802	2,912
13	2023		211	211	48	1,994	1,137	3,131	718	2,921
14	2024		211	211	43	1,904	1,239	3,144	643	2,933
15	2025		211	211	38	1,810	1,350	3,160	577	2,950
16	2026		211	211	34	1,810	1,336	3,145	513	2,935
17	2027		211	211	31	1,810	1,336	3,145	458	2,935
18	2028		211	211	27	1,810	1,336	3,145	409	2,935
19	2029		211	211	24	1,810	1,336	3,145	365	2,935
20	2030		211	211	22	1,810	1,336	3,145	326	2,935
21	2031		211	211	19	1,810	1,336	3,145	291	2,935
22	2032		211	211	17	1,810	1,336	3,145	260	2,935
23	2033		211	211	16	1,810	1,336	3,145	232	2,935
24	2034		211	211	14	1,810	1,336	3,145	207	2,935
25	2035		211	211	12	1,810	1,336	3,145	185	2,935
26	2036		211	211	11	1,810	1,336	3,145	165	2,935
27	2037		211	211	10	1,810	1,336	3,145	148	2,935
28	2038		211	211	9	1,810	1,336	3,145	132	2,935
	Total	11,368	5,476	16,844	12,041	51,599	28,569	80,168	18,853	63,324

Table 17.6-13 Economic Index

Index	Value
EIRR	18.5%
B/C ratio	1.57
NPV (1,000US$)	6,813

(3) Sensitivity Analysis

To examine how these indices are affected by the variation of the cost and benefit is purpose of sensitivity analysis. It is same as the analysis undertaken for the master plan study in Chapter 21. Table 17.6-14 shows the result of the sensitivity analysis thus obtained.

Table 17.6-14 Result of Sensitivity Analysis

			Cost		
			-10%	0%	10%
Benefit	10%	EIRR	21.9%	20.1%	18.5%
		B/C	1.91	1.72	1.57
		NVP	9,902	8,698	7,494
	0%	EIRR	20.2%	18.5%	17.0%
		B/C	1.74	1.57	1.42
		NVP	8,017	6,813	5,609
	-10%	EIRR	18.5%	16.8%	15.4%
		B/C	1.57	1.41	1.28
		NVP	6,131	4,927	3,723

17.6.7 PRE-EIA

Pre-EIA is conducted to evaluate environmental and social impacts that the priority project for pre-F/S are likely to have, analyze alternative plans and prepare adequate mitigation measures and monitoring plans in accordance with regulation on Environmental Assessment in the Lao PDR and JICA guidelines.

According to "Regulation on Environmental Impact Assessment of Road Projects in Lao PDR (2004)", provided with guidance for environmental assessment requirements and procedures, regulation for assessing a project in road sector, EIA is required by projects involving the following activities;

1) New construction or major rehabilitation within the ROW.
2) New construction or construction outside the original ROW.
3) Construction in Environmentally sensitive areas such as: human settlement, protected forest areas, areas of historical and cultural heritage preservation, etc.

Therefore, the project requires EIA because of new construction and passing through human settlement area.

(1) Baseline Survey

1) Purpose of baseline survey

To identify adverse impact on natural and social environments caused by project activities, the details of baseline surveys of affected lands, houses, shops and other structures, air quality (including dust and pollutants), noise, flora and fauna, and others are required.

Table 17.6-15 shows baseline survey required for the pre-EIA study.

Table 17.6-15 Baseline Survey for the Pre-EIA Study

Type of Survey	Item	Location	Method
Air Quality*	TSP, PM10, NOx, CO, weather condition data * Refer to "Air quality and Noise Survey in Vientiane Capital city by MIH and STEA in 2002-2003"	3 points along the new road alignment 4.5Km: beginning, middle and the end.	Installation of air quality measurement equipment
Noise	dB[A] (Leq8, Leq24 and Lmax)	Ditto (3 points)	Installation of noise level measurement equipment
Hydraulics	Hydraulic condition Quantity water flood	3 points along the new road alignment 4.5 Km	Hydraulic Survey
Water Quality	pH, BOD, COD, TSS, DO, Fecal coliform	3 points in rivers and marshes	Sampling and chemical analysis
Flora & Fauna	Diversity of wildlife and their habitat. Number of ancient or mature trees possibly cleared.	Forests and marshes (including That Luang Marsh)	Field survey and data collection from relating agencies
Social Impact	Relocation of about 10 households and acquisition of right of way	Along the new road 4.5 Km	Interview and Data collection from relating agencies

2) Results of baseline survey

i) Air Quality

At present, there is no official standard for controlling air quality in Lao PDR. However, the international standard has been used for comparison. All the parameters as shown in Table 17.6-16 are within the standards.

Table 17.6-16 Air Quality Survey along the New Road

Parameter	Beginning (Ban Dongpaleb)	Middle (Ban Phonkham)	End (Ban Pakthang)	International Standard	Japanese Standard
TSP (mg/m3)	0.120	0.063	0.137	0.330**	-
PM10 (mg/m3)	0.061	0.052	0.088	0.10*	0.10
SO2 (ppb)	5.1	2.3	3.0	-	40
NO2 (ppb)	5.1	6.3	6.5	273*	40 - 60
CO (ppm)	1.1	0.5	0.4	35**	10

*World Bank, **US-EPA

ii) Noise

The same as air issue, there is no official standard for controlling noise in Lao PDR. In 2006 MCTPC issued the Ministerial Agreement on Technique and sign of Transport Vehicle to control noise, however only horn issue has been determined. Noise source in Vientiane are almost generated from motorcycle driving. The noise levels at the end and middle points

exceed Japanese standards (Table 17.6-17). Leq24 at the end point exceeds US-EPA 70dB.

Table 17.6-17 Noise Level Survey along the New Road

Unit: dB

Parameter		Beginning (Ban Dongpaleb)	End (BanPakthang)	Japanese standard*1	Middle (Ban Phonkham)	Japanese standard*2
Leq	Daytime	67	80	70	60	60
	Nighttime	62	88	65	55	50

*1 Area facing the road
*2 Area category C: for commerce and industry as well as for a significant number of residences

iii) Hydraulics

The study area for drainage system is along the road alignment which starts from the junction of Hong Xeng and Hong Wattay 2 westward to the Sithong road. More than 70% of the area is paddy field with flat area which normally submerged during the monsoon. The majority of storm water in the study area will be drained to the Nong Ping Marsh by crossing the road and small amount of storm water, to the Hong Wattay2. The overflow of water from Nong Ping marsh will be drained to Hong Nong Ping; the Hong Nong Ping and Hong Wattay 2 both will be drained to Hong Xeng and finally flow out to Thatluang Marsh. Figure 17.6-6 shows Existing Channel in the Study Area.

22 numbers of drainage block divide area were determined for discharge and approximate design of drainage system of the road. Runoff computation shows that 4.9 % of total discharge flows into Hong Wattay 2, 95.1 % into Nong Ping Marsh.

Figure 17.6-6 Existing Channel in the Study Area

iv) Water Quality

The result of water quality analysis is shown in Table 17.6-18. COD value in That Luang marsh exceeds Japan's environmental quality standard, showing abnormal increase in water pollution. TSS values of both rivers and the marsh are within the standards. BOD values of both rivers are within the standard. All the pH values are also within the standards.

Table 17.6-18 Water Quality

Sampling date	24-Jun-08	24-Jun-08	24-Jun-08	Japanese Standard (river classD*)	Japanese Standard (lake class B**)
Station	St.1	St.2	St.3		
Place	Don-Deng Bridge (Beginning of the project)	Pak Tang (End of the project)	That Luang marsh		
COD (mg/l)	28	14	106	-	5
TSS (mg/l)	44	16	4	100	15
BOD (mg/l)	5	5	10	8	-
PH	6.6	6.6	6.6	6.0-8.5	6.5-8.5
Fecal Coliform (MPN/100ml)	300	400	800	-	-

* Industrial water class 2, agricultural water, and uses listed in E

** Fishery class 3, industrial water class 1, agricultural water, and uses listed in C

v) Flora & Fauna

The site is not included in the area designated as National or Provincial Protected Area. No endangered species has been recorded within urban area of Vientiane, particularly in the site. The most common floras are the mature indigenous hardwood trees lining major streets. Other trees are mostly ornamental and shady trees planted along roadsides and public gardens. Affected trees by the project are mango, coconut, bamboo, etc. The fauna occurring in the site are primarily grazing animals (cattle, goats and horses) and domestic animals (chickens, ducks, dogs, cats and reptiles). In addition, pets such as rodents and insects which typically thrive on wastes in urban environments are commonly found in the site.

vi) Social Impact

There are 9 households to be resettled for the alternative 1 road, 10 households for the alternative 2 road. They are one or two story houses whose gardens are planted with some trees such as mango and coconut. The beginning part (700m) of alternative 1 road passes through residential blocks and along the road for channel control, and the beginning part (810m) of alternative 2 road passes in the middle of residential area and paddy field.

(2) Alternatives of the Project

Table 17.6-19 shows project description for alternatives 1, 2 and do-nothing.

Table 17.6-19 Project Description of Alternatives 1, 2 and Do-Nothing

Project	Alternative 1	Alternative 2	Do Nothing
Description	South route Total length: 4.7km ROW: 30m Bridge: none Earth fill: 1-2m high Beginning part (700m): passing through residential blocks and along the road for channel control.	North route Total length: 4.81km ROW: 30m Bridge: two Earth fill: 1-2m high Beginning part (810m): passing in the middle of residential area and paddy field.	Would lead to traffic congestion when existing roads are overloaded and public transport is not sufficiently served

(3) Quantitative Analyses of Environmental Items by Implementation of the Project

Air quality and noise levels were predicted quantitatively for the service period, considering future traffic volume. The results are shown in Table 17.6-20. Most predicted values for air quality are within the limits specified by the WHO guideline and standards from World Bank and Japan. Considering the predicted values, it can be assumed that emission levels of NO2 and PM10 from vehicles are much smaller compared with the background concentration. All the predicted values for noise are within the limits specified by the standard from Japan.

Table 17.6-20 (1) NO_2 Concentration

Unit: mg/m3

Year	Background	Contribution	Annual average	WHO Guideline	World Bank	Daily average	World Bank	Japanese standard
2013	0.015	0.004	0.019	0.04-0.05	0.1	0.019	0.5	0.11
2018	0.015	0.007	0.022			0.022		
2025	0.015	0.012	0.027			0.027		

Conditions of prediction;
Daily traffic volume:

Year	Motorcycle	Car	Heavy vehicle
2013	8,721	1,339	461
2018	11,473	2,254	873
2025	15,618	4,824	1,609

Speed: 50km/hour Model: Puff-plume model

Table 17.6-20 (2) PM10 Concentration

Unit: mg/m3

Year	Background	Contribution	Annual average	World Bank	Daily average	Japanese standard
2013	**0.068**	**0.0003**	0.068	0.1	0.089	0.1
2018	**0.068**	**0.0004**	0.068		0.090	
2025	**0.068**	**0.0007**	0.069		0.090	
Conditions of prediction: Same as the above table.						

Table 17.6-20 (3) CO Concentration

Unit: mg/m3

Year	Background	Contribution	Annual average	Daily average	US-EPA Standard	Japanese standard
2013	0.671	0.0118	0.683	1.366	42	11.6
2018	0.671	0.0169	0.688	1.376		
2025	0.671	0.0260	0.697	1.394		
Conditions of prediction: Same as the above table.						

Table 17.6-20 (4) Noise Level

Unit: dB

Year		Space adjacent to the road	Japanese standard	Area facing the road	Japanese standard
2013	Daytime	65	70	61	65
	Nighttime	60	65	55	60
2018	Daytime	67	70	62	65
	Nighttime	61	65	57	60
2025	Daytime	68	70	64	65
	Nighttime	63	65	59	60
Conditions of prediction: Daily traffic volume; Same as Table (1) Speed; 50km/hour Model; ASJ Model 2003					

(4) Scoping for Pre-EIA

A comparison of potential impacts of the three alternatives is shown in Table 17.6-21.

Table 17.6-21 Scoping of the Environment and Social Considerations

CONSTRUCTION OF MISSING LINK OF INNER RING ROAD

	Aspect of environment	Alternative-1 (South)		Alternative-2 (North)		Without Project	
		Rating*	Explanation	Rating*		Rating*	Explanation
Social environment	1. Involuntary Resettlement	B	9 households are to be relocated. Paddy field is acquired.	B	10 households are to be relocated. Paddy field is acquired.		No resettlement is involved.
	2. Local economy such as employment and livelihood, etc.	+	Economic development will be induced along the new road.	+	Economic development will be induced along the new road.	B	Regional economy may suffer from congested roads in the surroundings.
	3. Land use and utilization of local resources	B	Construction materials need to be acquired.	B	Construction materials need to be acquired.		Not applicable.
	4. Social institutions such as social infrastructure and local decision-making institutions	+	Accessibility to social infrastructure and local institute will be improved.	+	Accessibility to social infrastructure and local institute will be improved.	B	Traffic congestion should prevail in the surroundings.
	5. Existing social infrastructures and services such as transport and life facilities	++	New facilities will be generated along the road.	++	New facilities will be generated along the road.	B	Traffic congestion should prevail in the surroundings.
	6. The poor, indigenous and ethnic people	B	Construction of the road may affect the poor such as farmers who will lose their productive land to the project.	B	Construction of the road may affect the poor such as farmers who will lose their productive land to the project.		Not applicable.
	7. Misdistribution of benefit and damage	C	The project may cause misdistribution of benefit and damage of farmers and the local residents.	C	The project may cause misdistribution of benefit and damage of farmers and the local residents.		Not applicable.
	8. Cultural heritage		There are no cultural properties such as old temple and stupa along the proposed road.		There are no cultural properties such as old temple and stupa along the proposed road.		Not applicable.
	9. Local conflict of interests	C	Conflict among the local people on future land use may occur.	C	Conflict among the local people on future land use may occur.		Not applicable.
	10. Water Usage or Water Rights and Rights of Common		The watercourse of existing channels is not changed.		The watercourse of existing channels is not changed.		Not applicable.
	11. Sanitation	+	The new road facilitated with drainage system will improve health and sanitation conditions of local people.	+	The new road facilitated with drainage system will improve health and sanitation conditions of local people.		Not applicable.
	12. Hazards (Risk) Infectious diseases such as HIV/AIDS	C	Infectious diseases such as HIV/AIDS due to inflow of construction workers.	C	Infectious diseases such as HIV/AIDS due to inflow of construction workers.		Not applicable.
Natual environment	13. Topography and Geographical features		Topography is not changed in any sections of the new road. No important geographical features are in the area.		Topography is not changed in any sections of the new road. No important geographical features are in the area.		Not applicable.
	14. Soil Erosion	B	Soil erosion may occur due to construction methods.	B	Soil erosion may occur due to construction methods.		Not applicable.
	15. Groundwater		No effect is foreseen.		Bridge piers are not deep enough to affect ground water.		Not applicable.
	16. Hydrological Situation	C	Some possible impacts on surface water may occur.	C	Some possible impacts on surface water may occur.		Not applicable.
	17. Coastal Zone (Mangroves, Coral reefs, Tidal flats, etc.)		No such areas are involved.		No such areas are involved.		Not applicable.
	18. Flora, Fauna and Biodiversity		No important fauna & flora inhabit the paddy field and residential area through which the road passes.		No important fauna & flora inhabit the paddy field and residential area through which the road passes.		Not applicable.
	19. Meteorology		No effect is expected		No effect is expected		Not applicable.
	20. Landscape	+	Paved lanes will improve the visual appearances of roads.	+	Paved lanes will improve the visual appearances of roads.		Not applicable.
	21. Global Warming	+	CO2 emission is reduced by improvement of accessibility to a destination.	+	CO2 emission is reduced by improvement of accessibility to a destination.		Not applicable.
Pollution	22. Air Pollution	B	Air pollutants emitted from construction machines and vehicular traffic will affect ambient air quality.	B	Air pollutants emitted from construction machines and vehicular traffic will affect ambient air quality.		Not applicable.
	23. Water Pollution	B	River water may be contaminated by construction activities.	B	River water may be contaminated by construction activities.		Not applicable.
	24. Soil Contamination	B	Spillage of lubricants or any petroleum products used for construction will cause soil contamination.	B	Spillage of lubricants or any petroleum products used for construction will cause soil contamination.		Not applicable.
	25. Waste	B	Construction debris need to be properly disposed.	B	Construction debris need to be properly disposed.		Not applicable.
	26. Noise and Vibration	B	Noise and vibration may increase due to increased traffic of heavy vehicles.	B	Noise and vibration may increase due to increased traffic of heavy vehicles.		No applicable.
	27. Ground Subsidence		No effect is foreseen.		No effect is foreseen.		Not applicable.
	28. Offensive Odor		No effect is foreseen.		No effect is foreseen.		Not applicable.
	29. Bottom sediment		No effect is expected.		No effect is expected.		Not applicable.
	30. Accidents	B	Accident may occur due to generation of traffic.	B	Accident may occur due to generation of traffic.		Not applicable.

* A: Serious impact is expected; B: Some impact is expected; C: Extent of impact is unknown (Examination is needed. Impacts may become clear as study progresses.);
No Mark: No impact is expected. IEE/EIA is not necessary.

Where positive impact is expected,
++: Significantly positive impact is expected; +: Some positive impact is expected.

(5) Expected Environmental Impacts of the Pre-FS and Mitigation Measures

New road construction proposed by the master plan would bring some significant impacts on natural and social environments, especially where some sections of the new road pass through paddy field and residential areas in which large number of land acquisition and resettlement activities are involved and further EIA study should be conducted complying with EIA regulations in Lao PDR. The followings are details of some negative and positive effects by construction of the new road:

Positive Impacts

Upon completion, it is expected that traffic congestion in urban areas should be reduced as a result of construction of the missing link road. In addition, the potential economic development including trade, commerce and other basic service activities will be induced along the both side of the road leading to increasing of job opportunities and employment of local people, especially the poor.

Negative Impacts during Construction Period

- Land acquisition and involuntary resettlement will be involved where the road passes through residential and agricultural areas.
- Utilization of local resources such as sand and rock for construction materials will affect environment of the proposed borrow pit or quarry site.
- Air pollutants emitted from construction machines and vehicular traffic will affect ambient air quality.
- River water may be contaminated by construction activities such as earth excavation and banking.
- Construction debris and solid waste from camp and office are generated.
- Noise and vibration generated by heavy trucks and machineries used for construction activities will be a major problem during construction period.
- Unforeseen risk of accidents that could affect human health and environment such as risks of traffic accidents, risks from transportation of hazardous materials, risks from accidental fire or explosion may occur if there are no proper prevention measures.

Negative Impacts during Operational Period

- Increased traffic after construction of the road has the potential to generate air pollution and noise and to increase the number of accidents.

Mitigation Measures

- Where acquisition of local residential land and relocation of local people are required, resettlement action plans with appropriate compensation measures will be prepared to minimize adverse impact on local residents especially, on the poor and vulnerable group of people.

- To protect environment around the sites for construction materials environmental assessment should be executed and proper measures taken.
- Proper signage and information dissemination should be prepared by the contractor during construction period to avoid an accident.
- Appropriate traffic control measure and traffic management plan should be prepared during construction periods.
- Water spray for earth road surface during construction period can minimize negative impact.
- All vehicles, equipment and machinery used for construction shall be regularly maintained and correctly operated (including the use of dust filters or hoods) so that air quality conforms to acceptable standard.
- To avoid discharge of turbid water generated by construction activities such as earth excavation and banking, settling basin should be established and construction work should be stopped when it rains heavily.
- Construction materials (sand, gravel and rock) and spoil materials will be transported by truck covered with tarpaulins, and storage of construction materials must be appropriate, especially inflammable and explosive materials.
- Propose plantation of trees and bushes to act as natural noise protection barriers on both sides of the road, particularly in habitation areas.
- Construction debris and solid waste from camp and office should be properly disposed.
- Road safety campaigns should be intensified and warning signage will be installed along the road during operational period to minimize road accidents.

(6) Environmental Management Plan

As was mentioned at the beginning of section 17.6.7, the project requires EIA according to EIA regulation (2004). The project owner submits EIA report to STEA which is responsible for reviewing and approving EIA report and issuing ECC (Environmental Compliance Certificate) for all development projects (Figure 17.6-2). The condition to start construction is to obtain ECC issued by STEA.

Table 17.6-22 shows general contents of EIA report. Marked “YES” means that enough information to draw up the section of the EIA report has been collected before. Marked “NO” should be studied as followings;

1. The project owner draws up an EIA report. (Further study or possible study)

2. Also describe environmental impact after project closing. (Study after outlined design)

3. To hold a public consultation during public inspection of EIA report, and report the results;

A public consultation is held 2 or 3 times. The project owner revises the EIA report based on

the opinions from residents, the persons concerned, NGOs, etc. as well as reviewing committee (STEA).

4, 5, 6 are to describe construction plan, operation plan and cost to select alternative.
（Same as above-mentioned 2.）

7. To describe land acquisition and resettlement;
The project owner computes the compensation expense based on farmland, houses, trees, etc. Especially, the compensation expense for households to be relocated should be based on the resettlement action plan. In the project approximate ten households are assumed to be relocated, however, it is easy to find out substitute land in the neighborhood. Therefore, it may not seem that there are decrease in income and inconvenience to commute to and from working place and school.（Same as above-mentioned 2.）

8. To draw up environmental monitoring plan;
The project owner builds a monitoring organization. In order to prevent bad influence on environment during and after construction, a monitoring organization is built for monitoring dust discharge, maintenance of the construction vehicles, noise, vibration and generation of turbid water. A plan contains a monitoring organization, monitoring items, places to be monitored, number of times, networking, reporting and budget. (Further study or possible study)

9. The method of the study session for carrying out environmental monitoring should be developed. A specialist holds study session and lectures about monitoring procedures and networking to a monitoring organization.（Same as above-mentioned 1.）

10. A plan is drawn up about the system for environmental monitoring, time and a budget. The activity of a monitoring organization and its budget draft are created to each phase.

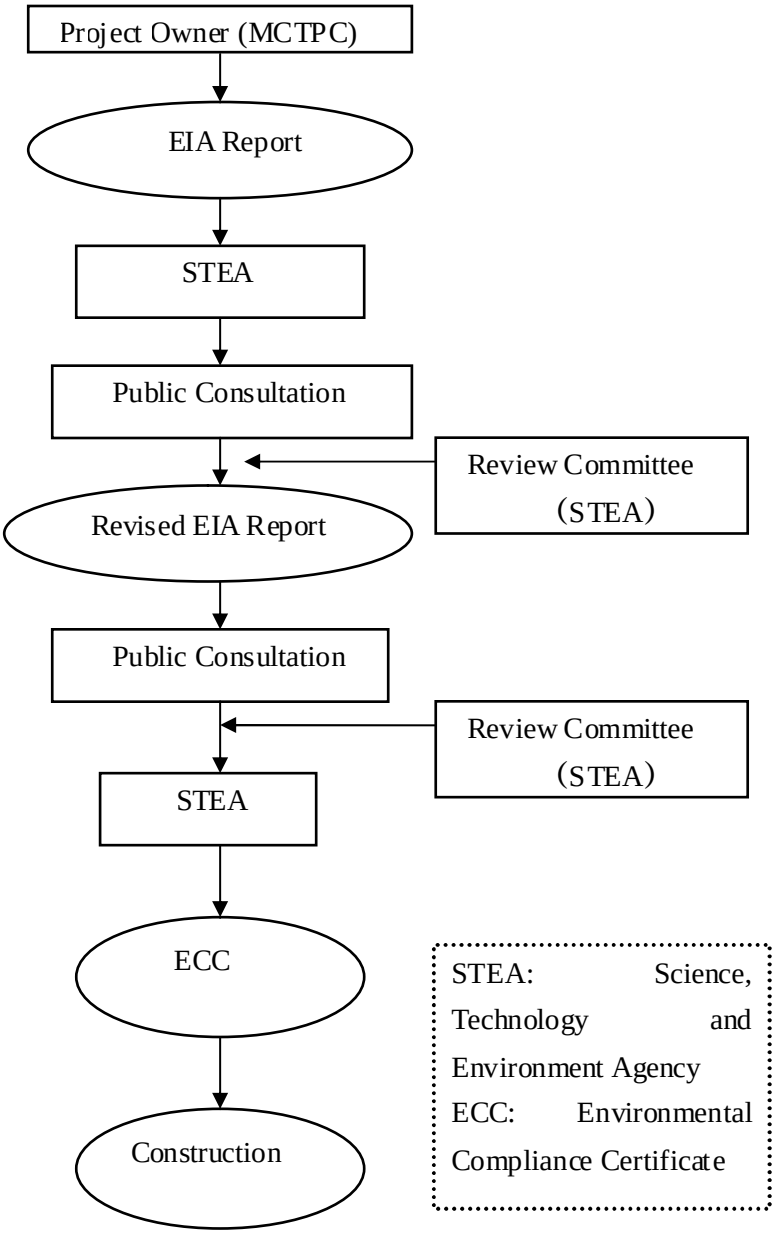


Figure 17.6-7 EIA Procedure (Simple Form)

Table 17.6-22 General Contents of EIA Report in the Lao PDR

Contents	Use of existing information	Note
Chapter 1: Executive Summary		
Chapter 2: Introduction		
- Name and address of project owner and DPRA	YES	
- Name, address and affiliation of the author of the report	NO	1
- Purposes of the project	YES	
- Institutional framework including relevant laws, regulation and international treaties that pertain to the project	YES	
Chapter 3: Description of the environment in the project Area (baseline data)		
- Physical	YES	
- Biological	YES	
- Economic	YES	
- Social	YES	
Chapter 4: Identification and evaluation of reasonable alternatives for achieving the project purpose(s)	YES	
Chapter 5: Direct and indirect significant environmental impacts including cumulative impacts for each of the alternatives		
- Impacts during project construction period (including preparation)	YES	
- Impacts during project operation period	YES	
- Impacts during project closure period	NO	2
- Compliance with laws, regulations, international treaties and land use or watershed management plan in the project area	YES	
Chapter 6: Summary on PI activities during preparation of EIA report	NO	3
Chapter 7: Identification of the chosen alternative and reasons for choosing the alternative	YES	
Chapter 8: Detailed description of the chosen alternative		
- Work plan including time intervals for project	NO	4
- Construction and operation of project	NO	5
- Project costing	NO	6
- Economic benefits versus environmental damage	YES	
- Social, natural resources, health risks and security of population	YES	
Chapter 9: Environmental management plan to prevent and reduce environmental impacts		
- Protective or reductive measures for physical, biological, economic and social impacts	YES	
- Compensation measures (if any)	NO	7
- Environmental monitoring program	NO	8
- Training workshops for implementation of EMP	NO	9
- Institutional arrangement, timing and budgets for implementation of EMP	NO	10
Chapter 10: Conclusions and recommendations		
Chapter 11: Reference		
Chapter 12: Annexes		
PI: Public Involvement		
DPRA: Development Project Responsible Agency		
EMP: Environmental Management Plan		

(7) Conclusions and Recommendations

Most predicted values for air quality in 2013, 2018 and 2025 are within the limits specified by the WHO guideline and standards from World Bank and Japan. Considering the predicted values, it can be assumed that emission levels of NO_2 and PM10 from vehicles are much smaller compared with the background concentration. All the predicted values for noise in 2013, 2018 and 2025 are within the limits specified by the standard from Japan.

According to "Regulation on Environmental Impact Assessment of Road Projects in Lao PDR (2004)", the project requires EIA because of new construction and passing through human settlement area.

To conduct EIA, the followings are recommended;

- Land acquisition plan and resettlement action plan;

It is important that the Lao government obtains the consent from land owners and leaseholders concerning land acquisition and resettlement. The government computes the compensation expense based on farmland, houses, trees, etc. Especially, the compensation expense for households to be relocated should be based on the resettlement action plan. In the project approximate ten households are assumed to be relocated, however, it is easy to find out substitute land in the neighborhood. Therefore, it may not seem that there are decrease in income and inconvenience to commute to and from working place and school.

- Environmental monitoring plan;

  Drawing up an environmental monitoring plan, it is important that the government builds a monitoring organization. In order to prevent bad influence on environment during and after construction a monitoring organization is built for monitoring dust discharge, maintenance of the construction vehicles, noise, vibration and generation of turbid water. A plan contains a monitoring organization, monitoring items, places to be monitored, number of times, networking, reporting and budget. Moreover, the method of the study session for carrying out environmental monitoring should be developed. A specialist holds study session and lectures about monitoring procedures and networking to a monitoring organization.

- Detailed project plan

  The Lao EIA regulation stipulates that the detailed project plan determined at F/S or B/D stage should be included in the EIA report.

Since possibly relocated residents did not attend the stakeholder meeting, it is necessary to carry out the procedure at the stage of F/S for new road construction.
Consensus building is required for the Lao side to obtain development permit, taking the initiative in land acquisition and following the EIA procedure.