THE SOCIALIST REPUBLIC OF VIETNAM
MINISTRY OF TRANSPORT
DIRECTORATE FOR ROADS OF VIETNAM

THE SOCIALIST REPUBLIC OF VIETNAM
PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE

FINAL REPORT

April 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
KATAHIRA & ENGINEERS INTERNATIONAL
ORIENTAL CONSULTANTS
CENTRAL NIPPON EXPRESSWAY CO. LTD.

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ABBREVIATIONS

AADT	:	Annual Average Daily Traffic
ADB	:	Asian Development Bank
C/P	:	Counterpart
CS	:	Conversion Software
CV	:	Curriculum Vitae (Bridge)
DB	:	Database
DOT	:	Department of Transport
DRVN	:	Directorate for Roads of Vietnam
FWD	:	Falling Weight Deflectometer
HDM-4	:	Highway Development & Management Module 4
IRI	:	International Roughness Index
ISDP	:	Implementation of Sector development Policy
ITST	:	Institute of Transport Science and Technology
JCC	:	Joint Coordination Committee
JCTC	:	Japan Construction Training Centre
JICA	:	Japan International Cooperation Agency (Japan)
JRA	:	Japan Road Association
LCC	:	Life Cycle Cost
MH	:	Maintenance History
MLIT	:	Ministry of Land, Infrastructure, Transportation and Tourism (Japan)
MOC	:	Ministry of Construction
MOET	:	Ministry of Education and Training
MOF	:	Ministry of Finance
MOT	:	Ministry of Transport
MPI	:	Ministry of Planning and Investment
MS	:	Microsoft
NEXCO	:	Nippon Expressway Company Limited (Japan)
NILIM	:	National Institute for Land and Infrastructure Management
NTSS	:	Northern Transport Secondary School
ODA	:	Official Development Assistance
OJT	:	On the Job Training

PBC	:	Performance Based Contract
PC	:	Pavement Condition
PDM	:	Project Design Matrix
PDOT	:	Provincial Level Department of Transport
PMS	:	Pavement Management System
PMoS	:	Pavement Monitoring System
PMU	:	Project Management Unit
PMU TA	:	Project Management Unit Technical Assistance
PPC		Provincial People's Committees
PRRMC	:	Provincial Road Repair and Maintenance Company
PTISRS	:	Project on Transportation Information System for Road Sector
PWRI	:	Public Works Research Institute (JAPAN)
QL	:	National Road (Vietnam)
RA	:	Road Asset
RB	:	Road Bureau
RCMC	:	Road Construction/ Maintenance Company
R & D	:	Research and Development
RDB	:	Road Development Bureau
REC	:	Road Engineering Center
RIMS	:	Road Infrastructure Management System
RMU	:	Road Management Unit
RNIP	:	Road Network Improvement Project
RoSy BASE	:	Database program, part of the RoSy PMS RIMS program suite
ROW	:	Right of Way
RRMB	:	Regional Road Management Bureau
RRMC	:	Road Repair and Maintenance Company
RRMU	:	Regional Road Management Unit
RTC	:	Road Technical Centre
SAPI	:	Special Assistance For Project Implementation for Transport Sector Loan for National Road network Improvement
SCIC	:	State Capital Investment Corporation
SOE	:	State Owned Enterprises
ST	:	Station
TV	:	Traffic Volume
TWG	:	Technical Working Group

UTC	:	University of Transport and Communication
UTT	:	University of Transport Technology
VBA	:	Visual Basic Application
VBMS	:	Vietnam Bridge Management System
VEC	:	Vietnam Expressway Company
VFCEA	:	Vietnam Federation of Civil engineer's Association
VIBRA	:	Vietnam Bridge and Road Association
VPMS	:	Vietnam Pavement Management System
VRA	:	Vietnam Road Administration
VTRANSS	:	Vietnam Transport Sector Study
WB	:	World Bank
WG	:	Working Group

SUMMARY

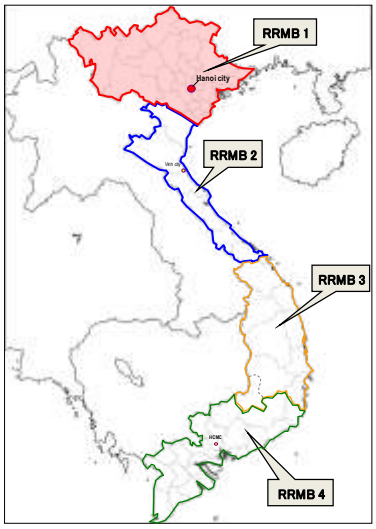
1 PROJECT OUTLINE

1.1 GOALS

(a) Road facilities are properly maintained in the target region

(b) Project outputs are disseminated across the county

(*) Targeted region; RRMB I jurisdiction



1.2 PROJECT OBJECTIVES

(a) To enhance road maintenance capacity in the targeted region

(b) Disseminate project outputs across the country

1.3 COUNTERPART

Directorate of Roads for Vietnam (DRVN), Ministry of Transport (MOT)

1.4 PROJECT MANAGEMENT

The Project management structure is shown in **Figure 1.1.**

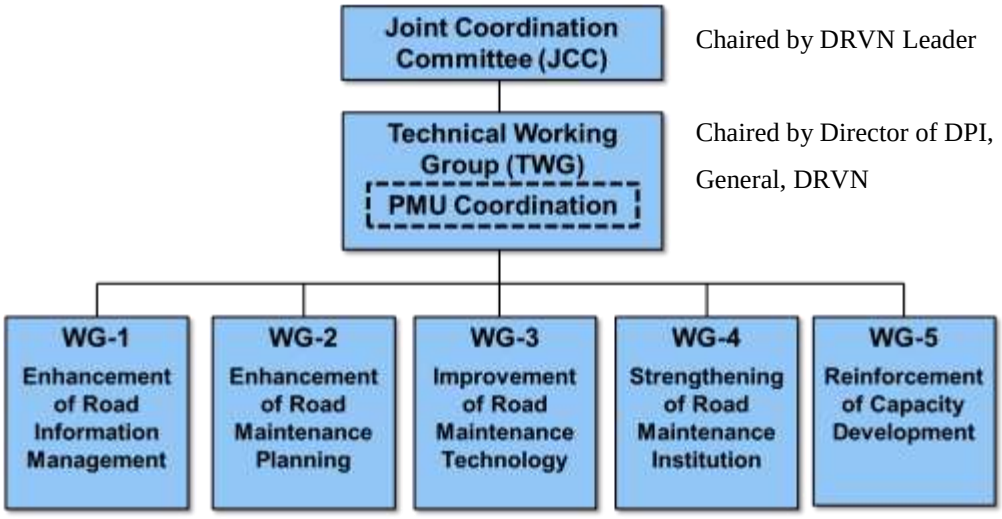


Figure 1.1 Project Management

1.5 PROJECT SCHEDULE

September 2011 to April 2014 (32 Months)

2 SCOPE OF PROJECT

The Project consists of the following activities; Summary of these activities including actions to be taken hereafter is elaborated in the next section.

ACTIVITY- 1; Enhancement of Road Information Management
ACTIVITY-2; Enhancement of Planning capacity for Road Maintenance
ACTIVITY-3; Improvement of Road Maintenance & Inspection Technologies
ACTIVITY-4; Strengthen of Road Maintenance Institution
ACTIVITY-5; Reinforcement of Human Capacity Development

3 SUMMARY OF ACTIVITIES

3.1 DEVELOPMENT OF ROAD INFORMATION MANAGEMENT

(1) Activity

In the past, DRVN (then VRA) had decided to use RoSyBASE as the DRVN's Road Database System. However, because of various technical and data input problems RoSyBASE is not in operation at present. Database is the heart of any management system. Data available in Road Database can be best utilized for various purposes such as asset management and traffic operation management. With this, the Project developed road asset database, focusing on the development of database formats and data input software system.

(2) Development of data input formats

Road databases under DRVN Road Information management System consists of the following five (5) databases;

a. General road management database
b. Road asset database (Road inventory database)
c. Pavement condition database
d. Maintenance history database
e. Traffic volume database

Figure 3.1 Road Asset Database Structure

The Project selected three (3) databases in the discussion with WG-1 and developed data input formats for the following databases;

a. Road asset (Road inventory) database

- Data formats were prepared for 29 road facilities.

b. Pavement condition database

c. Maintenance history database

Each of the above database has a table of "Road Main Detail" which integrally contains high priority data at the top of the database structure. Data conversion software will convert data to the PMS dataset, selecting some from the Road Main Detail table. For example, a road inventory database has about 700 data items and Road Main Detail has 70 data items out of 700 data.

Table 3.1 Road Facilities in the Road Asset DB (29 Facilities)

No.	Data Item	Priority	No.	Data Item	Priority
1	Road Main Details	I	16	Road Gradient	II
2	Pavement	I	17	Horizontal Curvature	II
3	Overlap Section	I	18	Slope	III
4	Bridge (VBMS Inventory Module)	II	19	Pedestrian Crossing Bridge	III
5	Road Intersection	II	20	Retaining Wall	III
6	Railway Crossing	II	21	Road Lighting	III
7	Submersible Drainage Facility	II	22	Roadside Plantation	III
8	River Crossing (Ferry, etc.)	II	23	Guard Fence	III
9	Pontoon Bridge	II	24	Disaster Response Storage	III
10	Tunnel	II	25	Median Strip	IV
11	Slab and Box Culvert	II	26	Road Sign	IV
12	Pipe Culvert	II	27	Kilo Post	IV
13	Vehicle Weighing Facility	II	28	Noise Barrier	V
14	Road Disaster Damage Inventory	II	29	Shade Fence	V
15	Pavement Marking	II			

Table 3.2 Details of Road Main Details (70 data)

Data Items	Data Items in Details	No. of Data
Road Information	Road Name, Road Class, etc.	5
Road Administration	RRMB, SB	2
Location	From / To, GPS Coordinate, Province, City, etc.	12
Kilopost and Length of Road	Kilopost, Road Length, Date of updates, etc.	4
Construction History	Construction completion, open for service, etc.	2
Terrain & Climate	Terrain type, temperature, precipitation, etc.	3
Road Cross-Section	ROW, Road Bed, Carriageway Width, Pavement Type, etc.	9
	Motorized Lane (No. of Lane, Width, Pavement type)	3
	Non-Motorized Lane (No. of Lane, Width, Pavement type)	3
	Median Strip Details	3
	Shoulder	3
	Footpath	2
	Ditch	2
Road Structures	Bridge	2
	Road Intersection	2
	Railway Crossings	2
	Box Culvert	2
	Slab Culvert	2
	Pipe Culvert	2
	Flyover Bridge	2
	Other Structure	2
Remarks		1
Total		**70**

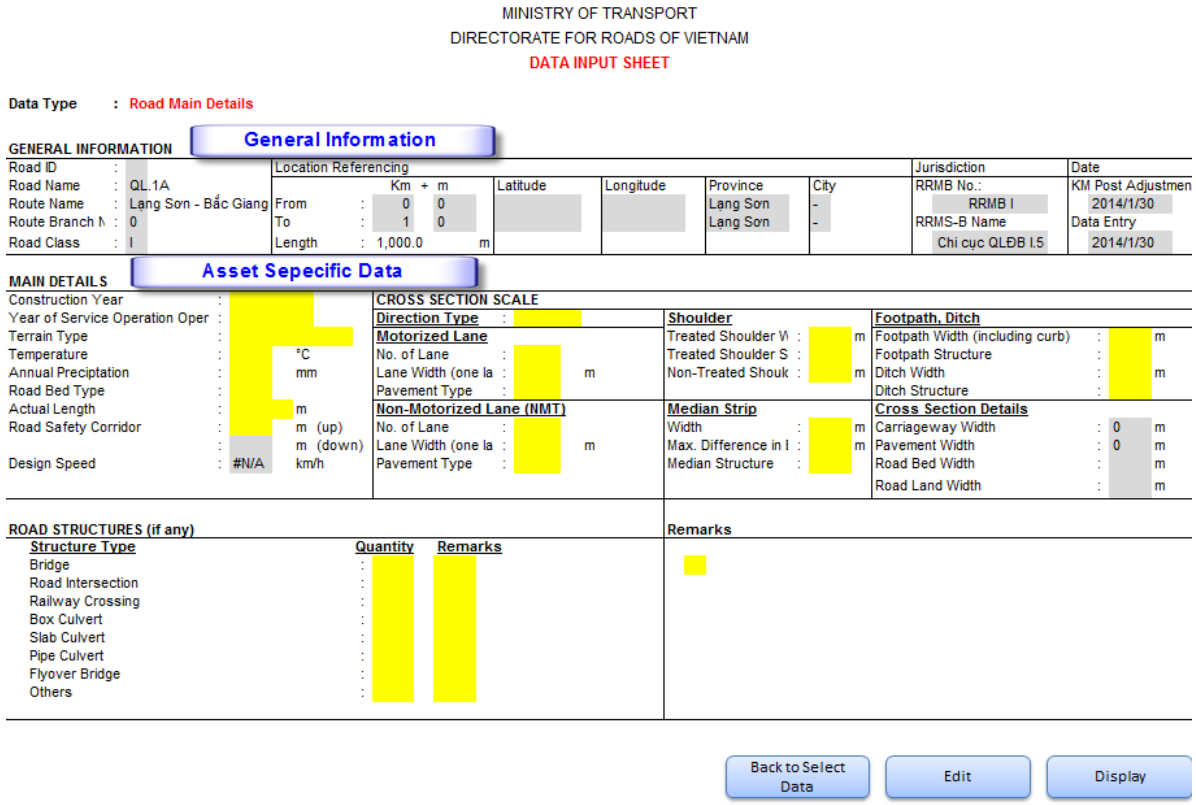


Figure 3.2 Data Input Sheet (Text Data)

Figure 3.3 Data Input Sheet (Photo/Drawing data)

(3) Development of database management software

The Project developed software systems which can support data input and database management including the development of data input control and data validation check. The database system includes the functions; (1) new data input, (2) data editing, (3) data search, display and print, (4) data assembling, (5) resumption of data input work, (6) create report/ data exporting, and (7) VBMS interface.

(4) Technology transfer

Data input to these databases, for the items of Road Main Detail, has been done by RRMB I staff as a trial data input aiming to evaluate appropriateness of data input formats and data input operation software, and the Project team has monitored the progress.

Currently, 91-percent data items of Road Main Detail were already inputted by RRMB I effort (as of the end of February 2014). In addition, data input software systems were upgraded based on the comments issued during the trial data input.

(5) Actions to be taken hereafter

DRVN is encouraged to take the following actions;

a. Assign RRMB I to continue data input and summarize comments on DB formats and data input and database management software.
b. Review and reset data input prioritization, taking account of urgency in maintenance and management tasks.

- Data items relevant to value estimate of road assets would be high priority in selection

c. Develop database management and operation methods and including outsourcing of data input following the recommendations of this Project.
d. Web-site operation of Main Detail data.
e. Provide DB software with appropriate technical support by competent departments to RRMB II, III, IV and PDOTs to study and operate DB software and collect their feedbacks.

3.2 ENHANCEMENT PLANNING CAPACITY FOR ROAD MAINTENANCE

(1) Activity

The Project has conducted a current status survey on the planning software for road maintenance plans previously installed in DRVN and analyzed technical and operational problems for the software (HDM-4). Based on this analysis and problem identification, the Project has implemented the following programs in order to enhance planning capacity for national road maintenance in cooperation with WG-2.

a. Implementation of pavement condition survey
b. Development of data conversion software
c. Development of planning software for pavement maintenance (PMS)

(2) Implementation of road pavement condition survey

PASCO implemented a road condition survey for 2,300 km sections under RRMB I from April 2012 to March 2013 including data analysis in a contract with JICA and formulated a pavement condition database for every 100-meter road section of whole RRMB I road network.

(3) Development of data conversion software

The Project then developed data conversion software to formulate PMS and PMoS dataset from four (4) databases including Road Inventory DB, Pavement Condition DB, Maintenance History DB and Traffic Volume DB. Data conversion software can select data items in accordance with PMS and PMoS data requirement, and convert them automatically to PMS and PMoS datasets.

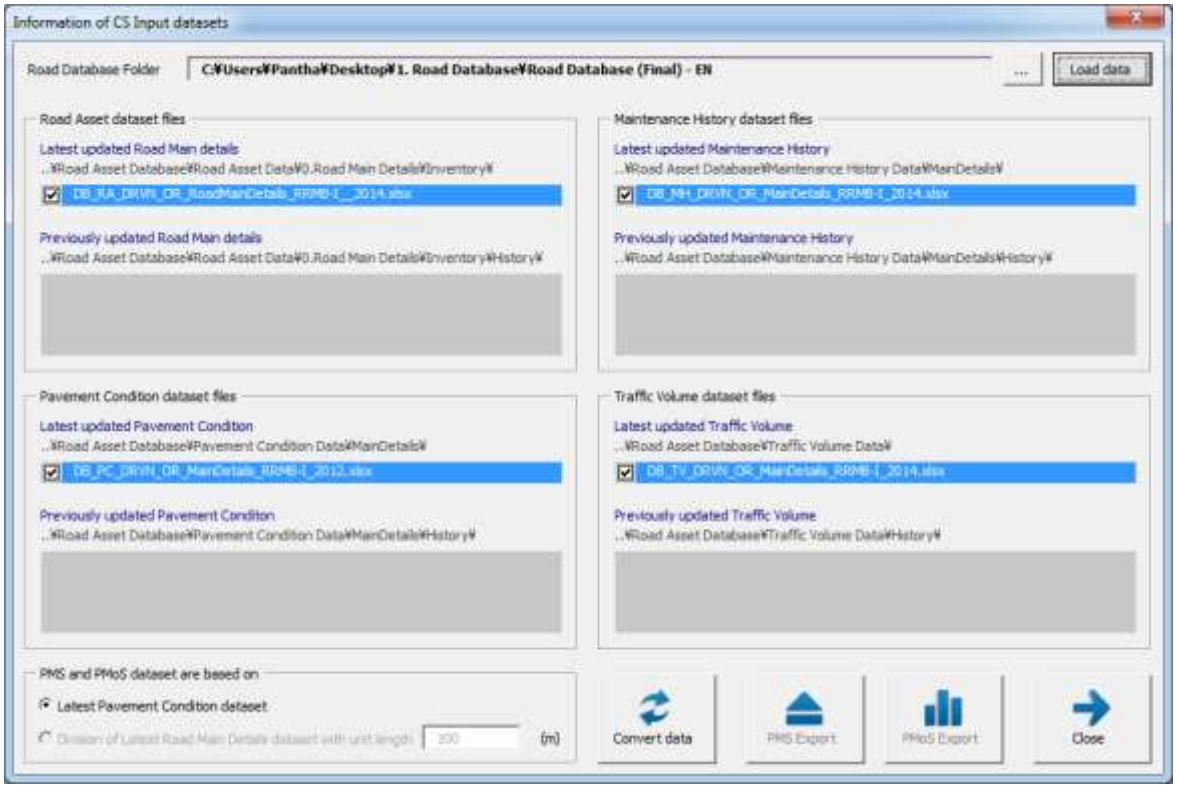


Figure 3.4 Data Conversion Software

(4) Development of road maintenance planning system (PMS)

The Project developed planning systems of road maintenance plan, focusing on road pavement management system (PMS). Based on the past lessons learned, the Project agreed with DRVN to develop PMS system specialized for DRVN use. PMS developed in the Project features as follows;

a. Function

- It can plan (1) Annual Road Maintenance Plans and (2) Mid-term Road Maintenance Plans for national road pavement facility.
- Mid-term plan takes account of pavement deterioration forecast.
- Planning of annual plans can be made at every 100-meter road section.
- It can point out the road sections which show faster pavement deterioration than other sections and need further FWD surveys (Benchmarking).

b. Data requirement

- Data requirement in computation is fairly small, 61 data items including three (3) pavement deterioration indexes.
- Automatic pavement data collection can ensure credibility of data, minimizing data input errors to small.
- Data conversion by software can reduce data input errors.

c. System development

- System was developed by the Project Team in cooperation with DRVN, Kyoto University and UTC.
- Update and upgrade of PMS can be made by domestic resources in Vietnam anytime as demand arises.
- Open source, which facilitates sustainable development and future upgrading.

(5) Planning of road maintenance plans for RRMB-1 road network

Annual and 3-year road maintenance plans for RRMB I road network were formulated based on the conditional data tentatively set for the trial run.

(6) Technology transfer

The Project implemented technology transfer through On-the-Job-Training conducted during successive four (4) days in the late February 2014 and in the intensive training courses.

(7) Actions to be taken hereafter

DRVN is encouraged to take the following actions;

a. Develop pavement condition survey plans for other national roads managed by RRMB II, III, IV and PDOTs.

b. Establish management methods for PMS software maintenance, upgrade, training programs and technical support needed for the dissemination of PMS to other regions

c. Assign DPI and RRMB I to keep operating PMS software and to formulate annual and mid-term plans.

d. Provide PMS software with appropriate technical support by competent departments to RRMB II, III, IV and PDOTs to study and operate PMS software and collect their feedbacks.

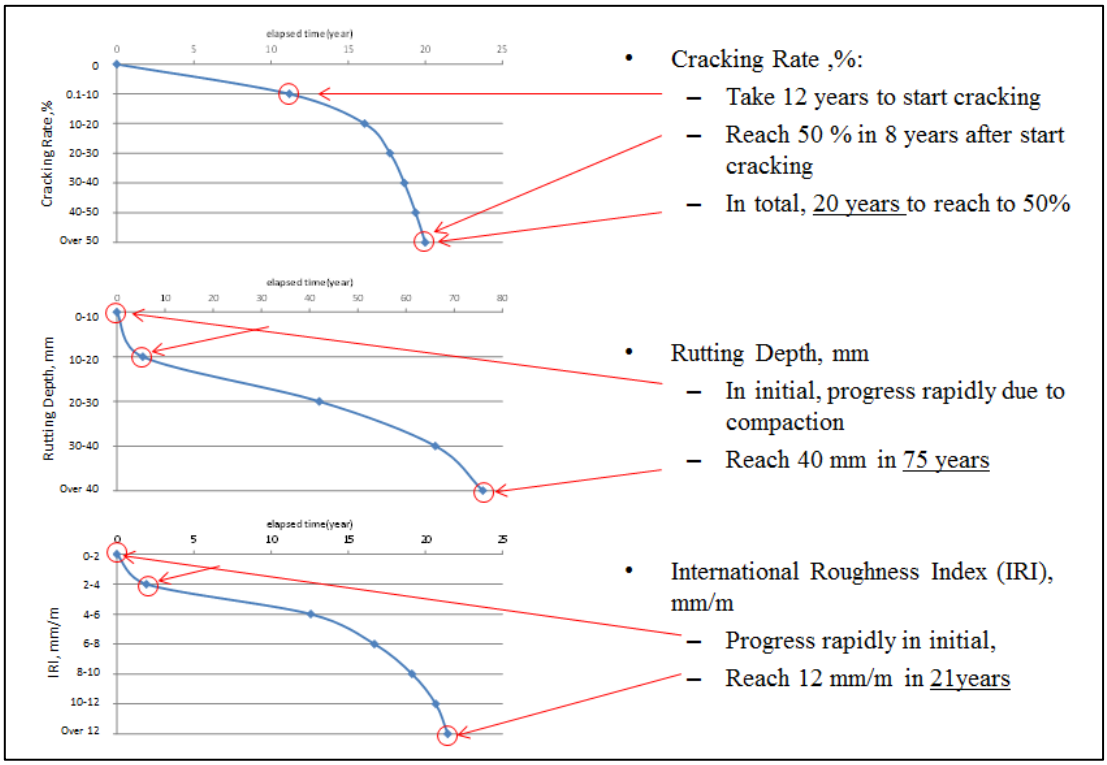


Figure 3.5 Pavement Deterioration Prediction

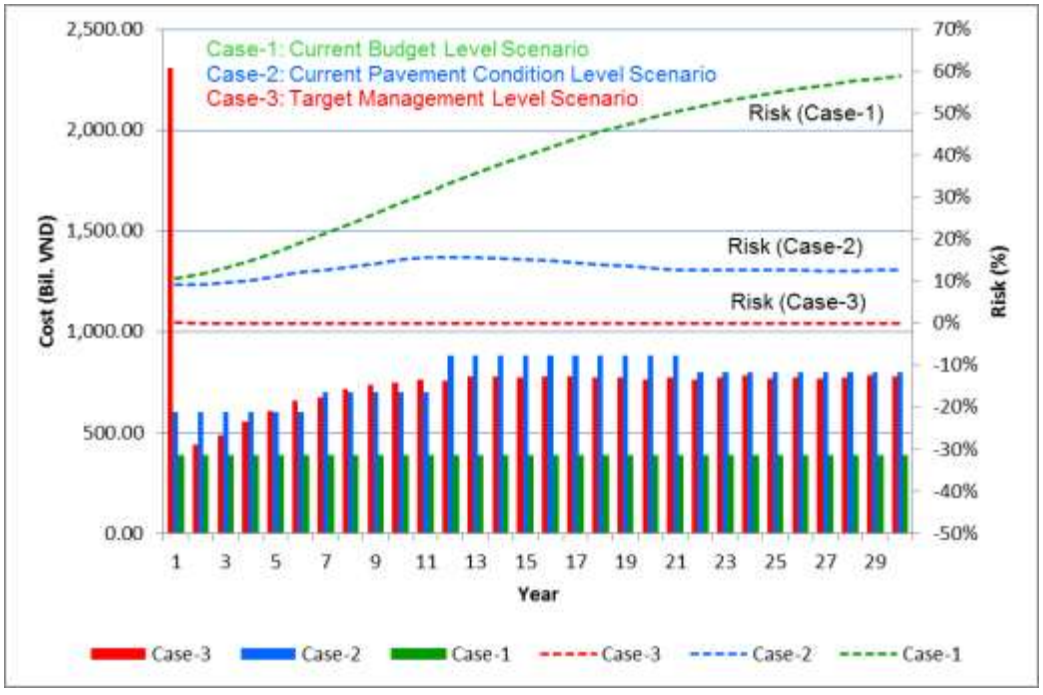


Figure 3.6 Three Budget Scenarios

Table 3.3 Three Budget Scenarios

Result Summary		Case 1	Case 2	Case 3
Annual Average Budget (Mil. VND)		389,998	769,998	778,851
Risk*	Average (%)	38.1	13.1	0
	Maximum (%)	58.8	15.8	0

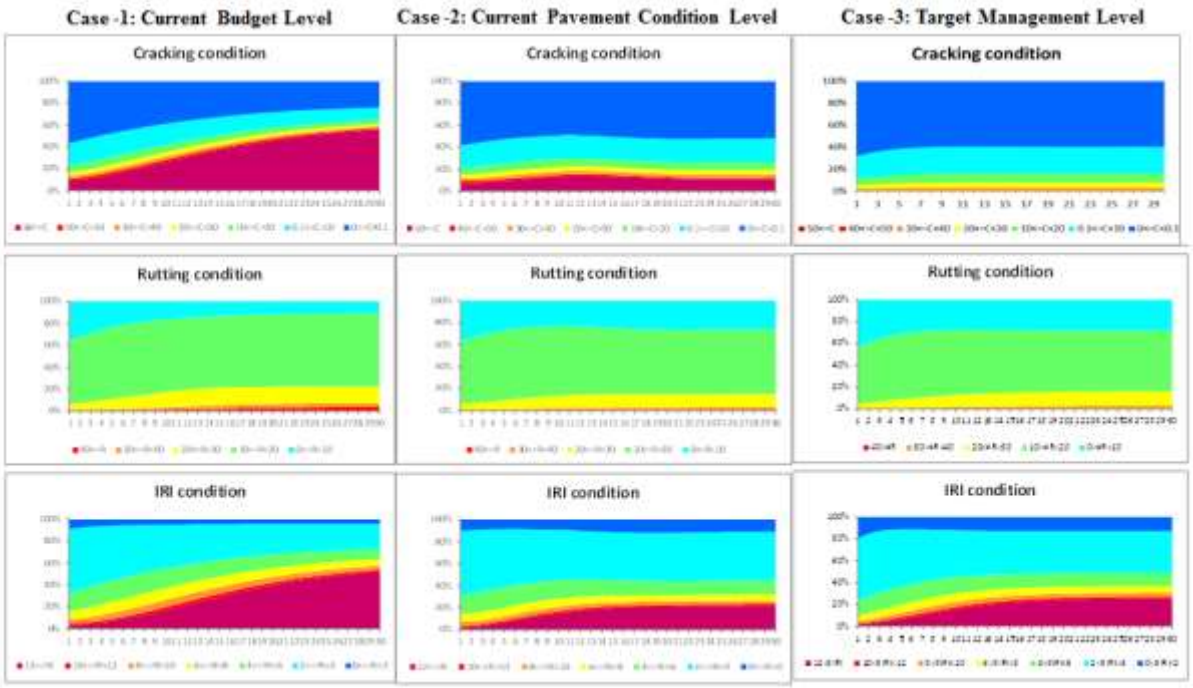


Figure 3.7 Pavement Defects Transition

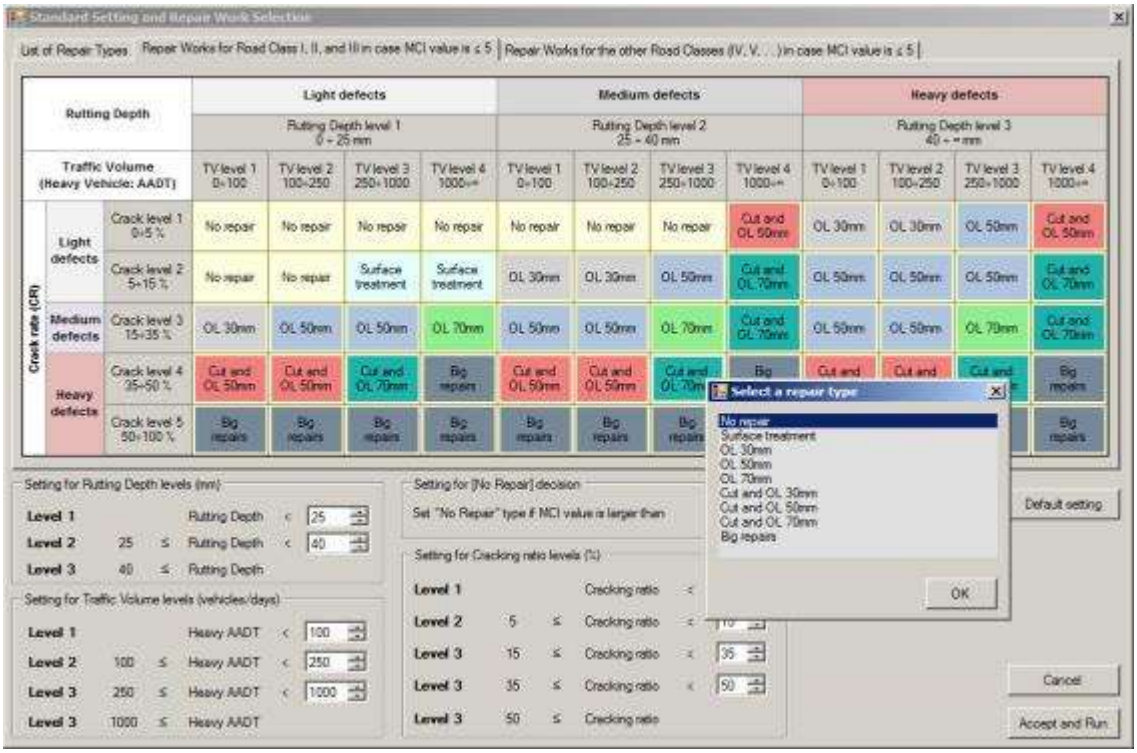


Figure 3.8 Repair Work Planning Module (Annual Budget Planning)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Road Inventory										Result of Pavement Condition Survey			MCI	Module Output (Annual Repair Planning recommendation)			
2	Route Name	Brunch No	Road Class	Kilo Post				Up or Down	Pavement Type	Width, m	Cracking Ratio, %	Rutting Depth, mm	IRI, mm/m		Repair method	Repair Classification	Unit Cost of Repair method	Repair Cost
3				from		to					Crack, %	Average, mm						
4				km	m	km	m											
5	NATIONAL HIGHWAY 1	0	III	10	200	10	300	U	AC	6	26	10		0	Cut and OL 50mm	Medium repair	400	120000
6	NATIONAL HIGHWAY 1	0	I	15	600	15	700	U	AC	6	17	2		0	OL 30mm	Medium repair	250	75000
7	NATIONAL HIGHWAY 1	0	V	9	200	9	300	D	AC	6	20	3		0.1	OL 30mm	Medium repair	250	75000
8	NATIONAL HIGHWAY 1	0	VI	18	100	18	200	U	AC	6	22	1		0.1	OL 30mm	Medium repair	250	75000
9	NATIONAL HIGHWAY 1	0	VI	7	300	7	400	U	AC	6	10	0		0.3	OL 30mm	Medium repair	250	75000
10	NATIONAL HIGHWAY 1	0	I	6	800	6	900	D	AC	6	5	33		0.7	OL 70mm	Medium repair	500	150000
11	NATIONAL HIGHWAY 1	0	III	7	0	7	100	D	AC	6	38	3		0.7	Cut and OL 70mm	Medium repair	550	165000
12	NATIONAL HIGHWAY 1	0	I	0	800	0	900	U	AC	6	28	45		0.8	Cut and OL 50mm	Medium repair	400	120000
13	NATIONAL HIGHWAY 1	0	III	14	600	14	700	D	AC	6	13	17		0.8	OL 30mm	Medium repair	250	75000
14	NATIONAL HIGHWAY 1	0	V	3	200	3	300	U	AC	6	13	7		0.9	OL 30mm	Medium repair	250	75000
15	NATIONAL HIGHWAY 1	0	I	5	800	5	900	U	AC	6	8	35		0.9	OL 70mm	Medium repair	500	150000
16	NATIONAL HIGHWAY 1	0	III	11	600	11	700	D	AC	6	26	41		1.1	Cut and OL 70mm	Medium repair	550	165000
17	NATIONAL HIGHWAY 1	0	I	3	700	3	800	U	AC	6	12	2		1.2	OL 50mm	Medium repair	400	120000
18	NATIONAL HIGHWAY 5	0	II	23	0	23	100	U	AC	6	25	42		1.2	Cut and OL 70mm	Medium repair	550	165000
19	NATIONAL HIGHWAY 1	0	V	25	700	25	800	D	AC	6	18	47		1.2	OL 30mm	Medium repair	250	75000
20	NATIONAL HIGHWAY 1	0	III	27	800	27	900	U	AC	6	34	7		1.2	Cut and OL 70mm	Medium repair	550	165000
21	NATIONAL HIGHWAY 1	0	III	4	200	4	300	U	AC	6	2	33		1.7	Cut and OL 70mm	Medium repair	550	165000
22	NATIONAL HIGHWAY 1	0	IV	9	900	10	0	D	AC	6	28	38		1.8	OL 30mm	Medium repair	250	75000
23	NATIONAL HIGHWAY 1	0	V	18	300	18	400	D	AC	6	7	10		2.1	OL 30mm	Medium repair	250	75000
24	NATIONAL HIGHWAY 2	1	II	26	800	26	900	U	AC	6	3	1		2.1	OL 50mm	Medium repair	400	120000
25	NATIONAL HIGHWAY 1	0	III	11	700	11	800	U	AC	6	37	13		2.2	Cut and OL 50mm	Medium repair	400	120000
26	NATIONAL HIGHWAY 1	0	I	13	500	13	600	D	AC	6	28	2		2.5	Cut and OL 50mm	Medium repair	400	120000
27	NATIONAL HIGHWAY 1	0	V	4	600	4	700	U	AC	6	18	59		2.6	OL 30mm	Medium repair	250	75000
28	NATIONAL HIGHWAY 1	0	VI	7	900	8	0	D	AC	6	15	0		2.6	OL 30mm	Medium repair	250	75000

Figure 3.9 Output of Repair Work Planning Module (Annual Budget Plan)

3.3 IMPROVEMENT OF ROAD MAINTENANCE & INSPECTION TECHNOLOGIES

(1) Activity

The Project has reviewed and studied actual road inspection and maintenance currently implemented for national roads in Vietnam including document review. The Project also reviewed institutional system and the status of road inspection and maintenance in Japan, collected and summarized technical specifications and manuals used in Japan. Upon completion of these preparatory works, the Project developed Road Facility Inspection Guideline, Road Routine Maintenance Manual and Road Pavement Monitoring System in cooperation with WG-3.

(2) Road Facility Inspection Guideline

Standardization of road facility inspection technology was fairly new to the existing Specification of Road Routine Maintenance Standard, so that more in-depth discussion than the road routine maintenance manual may be needed before standardization. It was therefore agreed that a road facility inspection technical standard be developed as a guideline.

Based on this policy, the Project first developed the framework of a road facility inspection guideline which can provide technical and institutional information to organize and implement road facility inspection. Then, the road facility inspection guideline was developed in the Project.

a. Framework of road facility inspection guideline

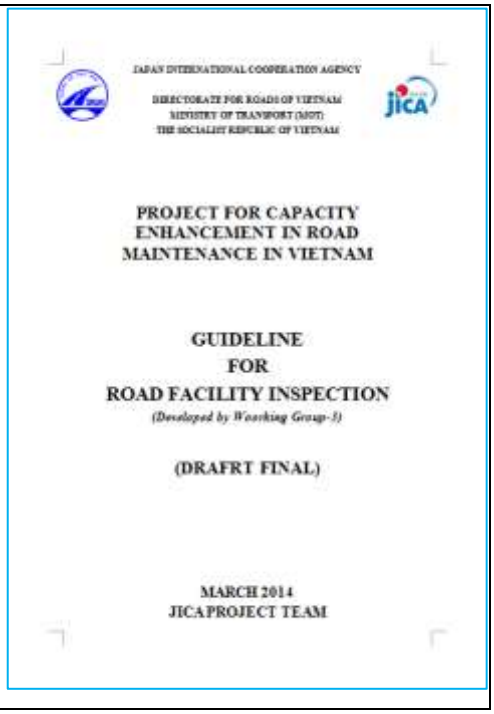
The framework of guideline consists of the following contents;

- Definition of road inspection
- Inspection methods
- Inspection frequencies
- Diagnosis and rating of inspection results
- Inspection staff arrangement and their eligibility

b. Road facility inspection guideline

Inspection guideline was developed for road facilities shown below. The Guideline covers all road components, structures on the road and structure items: (superstructure, slab deck, substructure and foundation, bearing), road slope, tunnel, box culvert, traffic safety and traffic control facility). The Guideline also provides descriptions of defects and locations where the defects potentially are occurred that should be checked, the methods and equipment used for inspection, evaluation criteria of inspection. These guidance covers all road and structure components and items.

MAIN ELEMENTS	

• Pavement Inspection
  - Asphalt pavement
  - Concrete pavement
• Bridge Inspection
  - Steel Bridge superstructure
  - Concrete bridge superstructure
  - Concrete slab deck
  - Substructure and foundation
  - Bearing
• Slope Inspection
• Tunnel Inspection
• Box Culvert Inspection
• Traffic Safety Facility Inspection
• Traffic Control Facility Inspection
	

(3) Road Routine Maintenance Manual

The Project initially started improving the current road routine maintenance technical standard coded 22 TCN 306-03 as a WG-3 activity. However, during the implementation of this project, urgent need of revising the standard arose from field engineers, so that DRVN decided to take an immediate action of revising the road routine maintenance technical standard coded 22 TCN 306-03 by domestic efforts, so that DRVN and JICA Project Team

agreed to develop a manual which can supplement information to the revised road routine maintenance standards, Specification of Road Routine Maintenance.

a. Framework of Road routine maintenance manual

The Manual is a comprehensive document with all road and structure items. The contents for each item consist of full process from defining defects, treatment selection and treatment implementation. Road Routine maintenance Manual developed in this Project takes the similar report organization to that for Specification of Road Routine Maintenance (TCCS-07-2013).

i. Scope of application
ii. Relevant documents
iii. Terms and definitions
iv. General Regulations
v. Routine Maintenance Works
vi. Acceptance of Routine Road Maintenance
vii. Traffic safety
viii. Labor safety
ix. Environmental protection during implementation of road routine maintenance

b. Road routine maintenance manual

The manual provides information on all items of road as stated in current Vietnam Specification of Routine Road Maintenance, which includes guidelines on full processes of maintenance ranging from definition of defects, selection of work and maintenance technologies for various structures as shown below;

MAIN ELEMENTS	
i.	General provisions
ii.	Roadside area routine maintenance
iii.	Drainage system routine maintenance
iv.	Routine maintenance of transverse drainage or culverts system
v.	Bituminous pavement maintenance
vi.	Concrete pavement routine maintenance
vii.	Unpaved pavement maintenance
viii.	Pavement cleaning
ix.	Maintenance of pavement on bridge
x.	Maintenance of pavement in tunnel
xi.	Road protection structure maintenance
xii.	Drift and causeway routine maintenance
xiii.	Tunnel routine maintenance
xiv.	Maintenance technologies for ferry access road
xv.	Emergency escape ramp maintenance technologies
xvi.	Bridge routine maintenance
xvii.	Maintenance of road associated facilities
xviii.	Planting maintenance


PROJECT FOR CAPACITY ENHANCEMENT IN ROAD MAINTENANCE IN VIETNAM

MANUAL
FOR
ROAD ROUTINE MAINTENANCE

(DRAFRT FINAL)

MARCH 2014
JICA PROJECT TEAM

(4) Road Pavement Monitoring System (PMoS)

The project developed Road Pavement Monitoring System (PMoS) which can display maintenance and repair work information on the computer system, thereby help assist maintenance units to conduct pavement maintenance. Information to be displayed on the computer screen includes pavement condition survey data (crack rate, rutting depth, IRIs and FWD data) and repair work types for the past three (3) years. Five (5)-kilometer section data can be displayed continuously to the end of the road section.

Figure 3.10 Pavement Monitoring System (PMoS)

(5) Technology transfer

Workshops and technical trainings and on-the-job training were held in 2013 and 2014. Further details of the training courses are summarized in the relevant sections coming hereinafter in this chapter.

(6) Actions to be taken hereafter

a. DRVN is encouraged to go into dissemination procedures, asking comments on the Road Routine Maintenance Manual to related competent organizations including MOT (Science Dept., Infrastructure Dept., ITST), UTC, VIBRA, RRMBs RTCs, etc. aiming to publish the Manual.

b. DRVN is encouraged to provide PMoS software and Road Facility Inspection Guideline to RRMBs, Sub-bureaus, PDOTs, RTCs etc. for trial application.

3.4 STRENGTHEN OF ROAD MAINTENANCE INSTITUTION

(1) Activity

In addition to the development and improvement of road maintenance and management technologies as shown in Activity-2 to Activity-3, capacity enhancement plans of road maintenance were developed in cooperation with WG-4 and reported to DRVN as recommendations. Based on the current status survey conducted on the legal procedures and DRVN institution for national road maintenance, the Project identified issues to be improved. Japanese practices regarding maintenance procedures and institutional issues were also briefly introduced.

(2) Improvement of road maintenance procedures

Analysis was conducted on the current status of road maintenance in Vietnam including legal framework, organization and staff, maintenance procedure manual, maintenance plan and approval, budget plan and approval, cost estimate, contractor selection and technical standards.

Recommendations were made on the following issues;

a. Improvement of legal framework with clear demarcation between routine road maintenance, periodic maintenance (medium repair) and rehabilitation (Big repair). Focuses of improvement are to be placed on institutional arrangement, formulation and approval of maintenance plans, budget proposal and approval, cost estimate, contractor selection and technical standards.

b. Improvement of maintenance procedure manual and cost estimate norms for road routine maintenance

c. Development of technical standards specialized for periodic maintenance (Medium repair).

d. Others

(3) Strengthening of DRVN institutions for road maintenance

Recommendations on the enhancement road maintenance and management capacity were made on the following issues.

a. Enhancement of planning capacity
b. Development of road asset DB management
c. Enhancement of R & D capacity
d. Enhancement on training capacity
e. Development of road facility inspection standards
f. Review of responsibility assignment between DRVN organizations
g. Review of responsibility assignment between DRVN and PDOTs
h. Others

(4) Technology Transfer

Workshops were held in 2013 with introduction of practices in Japan.

(5) Actions to be taken hereafter

DRVN is encouraged to take the following actions;

a. Discuss recommendations of this Project with related competent organizations including MOT, ITST, UTC, VIBRA, RRMBs, RTCs, etc.

b. Incorporate recommendations into the current comprehensive renovation plan and set target plans.

3.5 REINFORCEMENT OF HUMAN CAPACITY DEVELOPMENT

(1) Activity

The Project implemented a baseline survey on the prevailing training programs, implementation bodies, training material and so forth. On the basis of this survey, the Project developed training programs during project implementation and those after the Project completion in cooperation with WG-5. In addition, a comment was also issued on the future training programs with introduction of the practices in Japan. Of these training programs, the Project implemented training programs during project implementation.

(2) Plan and implement training during project implementation

The Project conducted analysis on the training requirements for the smooth implementation of project outcomes. Analysis was made on the training requirement by stakeholder, training type, training implementation body, training program and frequency. Training programs including workshops were carried out during project implementation in order to transfer technologies and to raise trainers for their future training. **Table 3.4** shows the implemented training and workshop programs during project implementation.

(3) Recommendation on the post-project training

Post-project training programs aim to disseminate project outputs to nationwide road maintenance organizations including RRMBs, RTCs, Sub-Bureaus and PDOTs. It is recommended that training programs be continuously implemented by trained trainers, dividing target trainees into two levels; (1) Management staff and (1) Technically professional staff. Relevant departments in the DRVN Headquarters are requested to implement management level training, and RTC Central and UTC are requested to provide technically professional training.

(4) Comment on the future training for road maintenance

A comment was issued on the future training program. Training plans falls into the following three (3) plans; (1) DRVN-level training plan focusing on national road construction, maintenance and operation, (2) MOT-level training focusing on construction, maintenance and operation of national roads, provincial roads, district roads and commune roads, and (3) MOC-level training programs focusing on infrastructure construction and maintenance. Practices in Japan consistent with these training programs were introduced, taking an expressway company case, a MLIT college case and a Japan Construction Training Center case as examples.

(5) Actions to be taken

DRVN is encouraged to take the following actions;

a. Implement post-project training programs, following recommendations of this project.

b. Make best use of trainers raised in this project and also training materials developed in the Project.

Table 3.4 Outline of During-Project Training Programs (2012-2014)

Category	Training		Contents	Date	Duration	Participants
Training courses	Road database system (Act 1)	1st	Overall database system	06.06.2013	1 day	**24**
		2nd	Database operation & management	20.06.2013	1 day	**18**
		3rd	Database operation & management	28.08.2013	1 day	**19**
	Pavement Condition Survey	1st	Introduction on pavement condition survey and analysis	25/26 02.3014	2 days	**16**
	PMS/PMoS dataset CS development (Act 2.2a)	1st	PMS/PMoS dataset & development of pivot type data, conversion to dataset	27.08.2013	1 day	**31**
	Road maintenance planning (Act 2.2b)	1st	Capacity enhancement in software for road maintenance plans	27.08.2013	1 day	**31**
		2nd	Capacity Enhancement in software for Road maintenance plans	24-28.02.2014	5 days	**3.1814**
	Inspection Method (Act 3.1)	1st	General guidance on inspection & manual	18.07.2013	0.5 day	**13**
		2nd	Inspection on facilities / inspection technique	28.11. 2013	0.5 day	**7**
				29.11. 2013	1 day	**17**
	Revised routine maintenance standard (Act 3.2a)	1st	General on routine maintenance standard and Japanese practices	24.07.2013	0.5 day	**31**
		2nd	New routine maintenance standard on road maintenance	25.09.2013	0.5 day	**26**
	Operation of PMoS (Act 3.3)	1st	PMoS system	02.08.2013	0.5 day	**13**
		2nd	PMoS system	18.09.2013	0.5 day	**17**
	SUB TOTAL	**13**				**265**
Intensive Training Course	Road database system (Act 1)		Overall Road information database system	04.03.2014	1 day	20

Category	Training		Contents	Date	Duration	Participants
	PMS/PMoS dataset CS development (Act 2.2a)		Overall PMS/PMoS dataset CS system development	05.03.2014	0.3 day	20
	Road maintenance planning (Act 2.2b)		Overall road maintenance planning system	05.03.2014	0.5 day	16
	Inspection Method (Act 3.1)		Overall road inspection technology	06.03.2014	0.5 day	16
	Revised routine maintenance standard (Act 3.2a)		Overall road maintenance technology	06.03.2014	0.5 day	16
	Operation of PMoS (Act 3.3)		Overall pavement monitoring system	05.03.2014	0.2 day	20
	SUB TOTAL	**6**				**108**
Workshop	New Technology (Act 3.2b)	1st	Pavement repair technology	15.05.2013	0.5 day	**21**
		2nd	Pavement repair technology	11.10. 2013	0.5 day	**15**
	Road Maintenance Institution (Act 4)	1st	Pavement management system	28.06.2013	0.5 day	**45**
		2nd	Technology management, development & transfer on road engineering	08.10.2013	0.5 day	**30**
	Road Asset Management	1st	Introduction on pavement management system (KYOTO Model)	20.06.2012	0.5 day	**60**
	The Project	1st	Report on progress of project activities	26.09.2012	1 day	**100**
		2nd	Report on achievement of project activities	07.03.2014	0.5 day	**131**
	SUB TOTAL	**7**				**402**
TOTAL		**26**				**775**

4 EQUIPMENT SUPPLY

4.1 PAVEMENT CONDITION SURVEY VEHICLE

Equipment		Unit	Delivery
TOYOTA	Hi-Ace, equipped with laser system, digital camera, GPS antenna, recording unit and related facilities	1	Match 2014
Computer for Analysis	Desk top computer	10	March 2014

4.2 COMPUTER HARDWARE AND TRAINING EQUIPMENT

Equipment		Unit	Delivery
Personal desktop computer	HP, Dell	4 Sets	March 2014
Projector / Screen	EPSON	1 unit each	March 2014
Color printer	EPSON	1 set	March 2014

CHAPTER 1 PROJECT OUTLINE

1.1 PROJECT BACKGROUND

The Socialist Republic of Vietnam (hereinafter referred to as Vietnam) has set its development goal as "to accelerate Industrialization by the year 2020 through emerging out from the low income countries", in the Socio-Economic Development Plan 2006-2010. As a one of strategies to achieve this target improvement of transport infrastructure has been recognized as a critical issue, and currently a large scale transport infrastructure developments such as airports, ports, expressways and urban railways have been proposed and implemented. The national road network in Vietnam is managed by Directorate for Roads of Vietnam (hereinafter referred to as DRVN) under Ministry of Transport (hereinafter referred to as MOT), and road constructions and renovations are in progress with supports including Government budgets, Yen- loans, World Bank (hereinafter referred to as WB) and Asian Development Bank (hereinafter referred to as ADB). In 2010, the national road network has reached to a total length of 17,385 km, and plays an essential role in transport infrastructure as well as contributes to a recent rapid economic development.

However, due to low social interest in road maintenance, sufficient budget for road maintenance work has not been allocated. This constrains not only the implementation of actual road maintenance work but also distribution of appropriate amount of budget required for the capacity development of road maintenance work and related personnel trainings. Issues identified in relation to the national road maintenance are; (1) Existing road maintenance plans are formulated with inadequate methods, (2) Detail inventory methods and evaluation criteria for diagnosis are not incorporated into the existing technical standards, (3) Inconsistency between Technical Standards on Road Routine Maintenance 2003 (hereinafter referred to as Technical Standards 2003), and Road Maintenance Norms 2001. In addition, due to a delay in computerization of road inventory data and road maintenance history data, they have not been utilized. As a result of above issues, a chronic cycle is incurred in road maintenance; lack of grounds in road maintenance plans and explanations to the relevant financial departments, has been leading to the lack of ability to secure sufficient budget for the road maintenance work.

With this background, RoSyBASE for the Pavement Management System (hereinafter referred to as PMS) and HDM-4 for the mid-term maintenance planning have been introduced as technical assistance projects of WB and ADB respectively. In 2007, both systems were recognized as the official system of DRVN. However, due to a poor reliability in data, complex data operation systems and insufficient personnel trainings etc., above systems have not yet reached to the operational level. Therefore an establishment of alternative system is urgently required.

Under above background, DRVN requested Japan International Cooperation Agency (hereinafter referred to as JICA) for the assistance on capacity enhancement in road maintenance.

1.2 GOALS AND OBJECTIVES

1.2.1 Goals

(1) Road facilities are properly maintained in the targeted region.

(2) Project outputs are disseminated across the country.

(*) Targeted region; RRMB I jurisdiction

1.2.2 Objectives

(1) Road maintenance capacity in the targeted region is enhanced.

(2) Dissemination system of the project outputs across the country is developed.

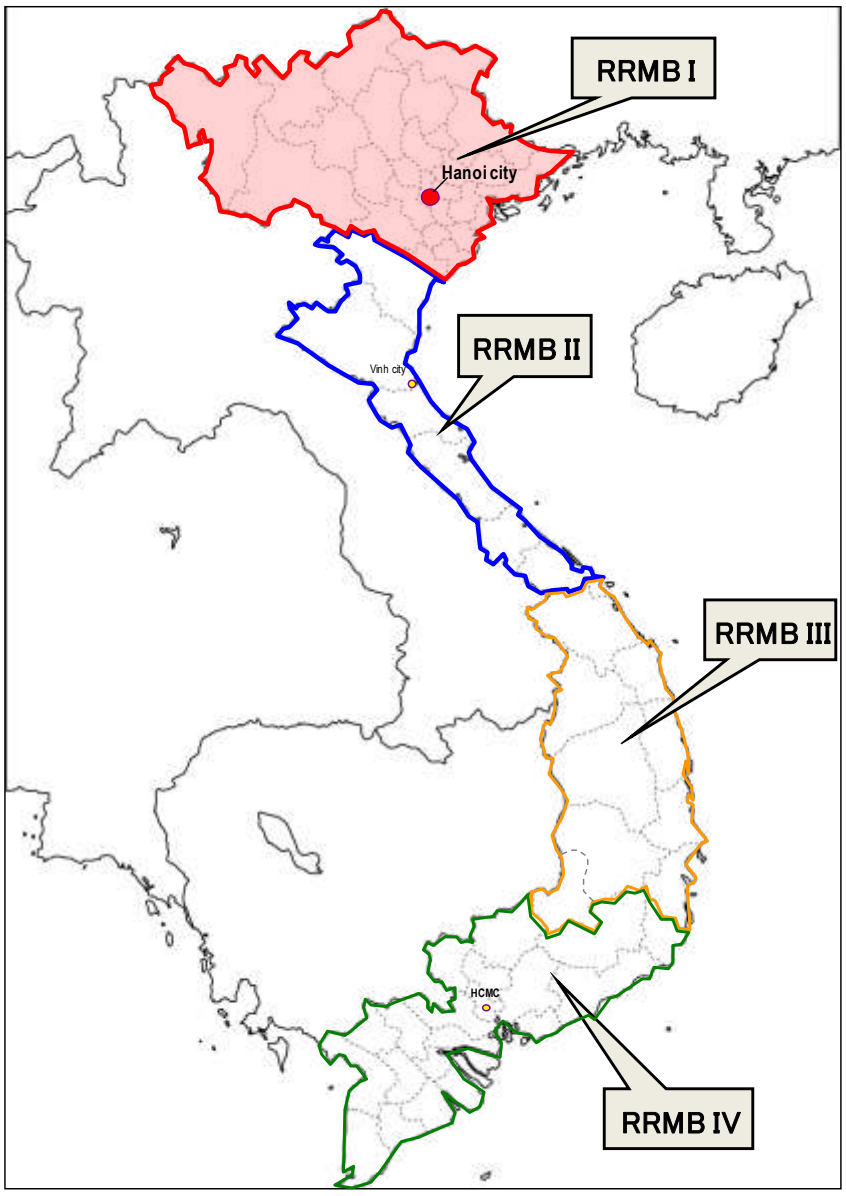


Figure 1.2.1 RRMB I jurisdiction

1.3 PROJECT MANAGEMENT

The Project management structure is shown in below;

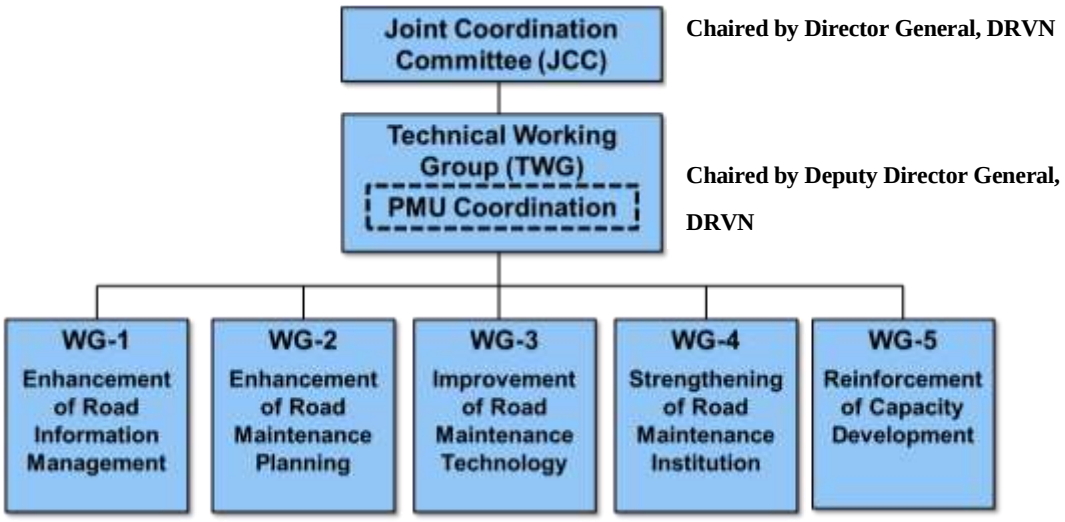


Figure 1.3.1 Project Management

Table 1.3.1 shows the outline of Joint Coordination Committee (JCC) and Technical Working Group (TWG).

Table 1.3.1 Outline of JCC and TWG

Committee		Joint Coordination Committee（JCC）	Technical Working Group（TWG）
Chairperson		Director General of DRVN	Deputy General Director of DRVN
Frequency		Twice a year (at the time of consulting Work Plan and reporting Progress Report and a project Completion Report in principle)	At necessary timing (1 to 2 times a year)
Function / Approval		• Discuss and approve Work Plan based on R/D • Review the progress of the Project based on annual Work Plans. • Promote dissemination procedure of project outputs • Exchange views on main issues arising from the project in progress	• Discuss and Coordinate project progress based on annual work plans • Review and coordinate a progress of the project • Discuss issues related to Project implementation
Members	Vietnamese site	• Deputy Director General of DRVN • PMU • Representative of MOT • Director of Planning and Investment Department of DRVN • Directors of departments related to DRVN • Representatives of RRMBII and main RRMBs • Director of RTC Central etc.	• Deputy General Director of DRVN • PMU • Directors of departments related to DRVN • Representatives of RRMB I and main RRMBs • Director of RTC Central etc.
	Japanese side	• Chief Representative of JICA Vietnam Office • JICA Long-term Expert • JICA Expert	• JICA Long-term Expert • JICA Expert

(Source) Minutes of Meeting (signed 4th March 2011)

1.4 JICA PROJECT TEAM

Figure 1.4.1 shows the team organization structure. JICA Project Team consists of 13 experts; one JICA expert and 12 consultant experts.

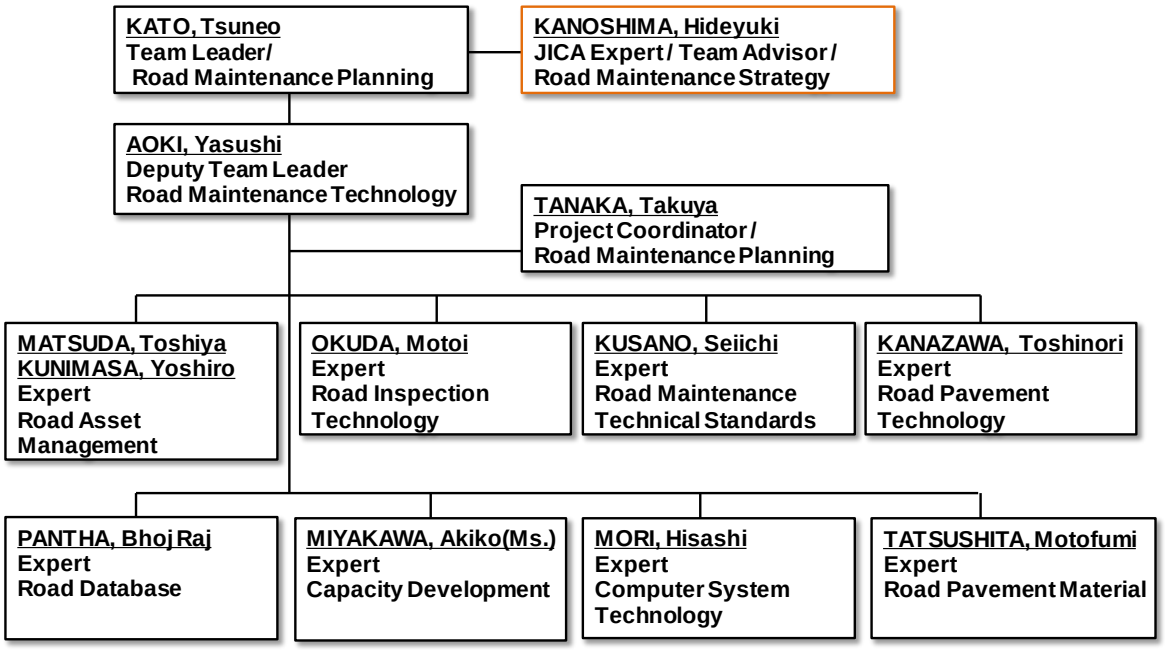


Figure 1.4.1 JICA Team Members

Experts work assignments of whole project team are shown in **Figure 1.4.2**.

Expert Status	Name	Company	2011				2012												2013												2014			
			Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
JCC / TWG			△ KickOff				△ JCC							△ TWG				△ JCC														TWG	△△	JCC
Reporting			△ ICP				△ WP											△ PR															△ DF	△ FR
JICA Expert/Team Advisor/ Road Maintenance Institutions	Hideyuki KANOSH	MLIT																																
Team Leader/Road Maintenance Planning	Tsuneo KATO	KEI																																
Deputy Team Leader	Yasushi Aoki	KEI																																
Road Asset Management	Toshiya MATSUDA	KEI																																
Road Inspection Technology	Motoi OKUDA	Oriental Consultants																																
Road Maintenance Technical Standards	Seiichi KUSANO	KEI																																
Road Pavement Technology	Toshinori KANAZAWA	Oriental Consultants																																
Road Database	Pantha Bhoj Raj	KEI																																
Capacity Development	Akiko MIYAKAWA	KEI																																
Computer System Technology	Hisashi MORI	Assistant For KEI																																
Project Coordinator/Road Maintenance Planning	Takuya TANAKA	Central NEXCO																																
Road Pavement Material	Motofumi TATSUSHITA	Assistant For KEI																																
Pavement Condition Survey Technology	Yoshirou KUNIMASA	KEI																																

(Note) MLIT: Ministry of Land, Infrastructure, Transport and Tourism
KEI; Katahira & Engineers International
NEXCO; Nippon Expressway Companies

Figure 1.4.2 JICA Experts Work Assignment

1.5 DRVN COUNTERPART GROUP

In order to ensure smooth implementation of the project, five (5) Working Groups (WGs) were set up in accordance with the project activities. Counterpart (C/P) members were selected from, DRVN, RRMB I and RTC Central. C/P members list with JICA experts in charge shown in **Table** 1.5.1**.**

Table 1.5.1 Counterpart Member Lists

(According to the Decision No. 1698/QD-TCDBVN dated October 17th2011, Updated 13 December, 2013

Working Group	Members List		
	JICA/CP	**Name**	**Position**
WG-1; Enhancement of Road Information management	JICA Project	**Dr. Bhoj Raj PANTHA**	Road Database
	Counter part	Mr. Quach Van Khoa	Team leader -Director of Road Infrastructure and Traffic Safety Dept., DRVN
		Mr. Dang Cong Chien	Deputy Director, Science and Technology and International Cooperation Dept., Director of Information Technology Center, DRVN
		Mr. Trinh Xuan Sinh	Expert, Planning and Investment Dept. -DRVN
		Mr. Luong Van Minh	Expert, Road Maintenance & Management - DRVN
		Mr. Tran Quoc Toan	Expert, Road Maintenance & Management - DRVN
		Mr. Tran Minh Giap	Expert, Science and Technology and International Cooperation Dept., DRVN (CHANGED)
		Mr. Nguyen Khanh Toan	Expert, Road Infrastructure and Traffic Safety Dept., DRVN
		Mr. Hoang Ngoc Nhi	Expert, Technical & Construction Management Dept., RRMBI
WG-2; Enhancement of Road Maintenance Planning	JICA Project	**Mr. Tsuneo Kato**	Team Leader/ Road Maintenance Planning
		Mr. Toshiya Matsuda	Road Asset Management
		Mr. Yoshiro Kunimasa	Road Asset Management
		Mr. Hisashi MORI	Computer System Technology
	Counter part	**Mr. Pham Thanh Binh**	Team leader/Director, Planning and Investment Dept., DRVN
		Mr. Nguyen Van Kinh	Deputy Team Leader/ Deputy Director, Planning and Investment Dept., DRVN (CHANGED)
		Mr. Dang Cong Chien	Deputy Director, Science and Technology and International Cooperation Dept., Director of Information Technology Center, DRVN
		Ms. Ta Thi Thuy	Expert, Planning and Investment Dept., DRVN
		Mr. Nguyen Van Minh	Expert, Planning and Investment Dept., DRVN
		Ms. Nguyen Thi Hai Ha	Expert, Planning and Investment Dept., DRVN
		Mr. Luong Van Minh	Expert, Road Maintenance & Management, DRVN
		Mr. Tran Quoc Toan	Expert, Road Maintenance & Management Dept., DRVN
		Mr. Vu The Hoan	Expert, Financing Dept., DRVN (CHANGED)
		Ms.Nguyen Thi Minh Chau	Expert, Road Infrastructure and Traffic Safety Dept., DRVN (CHANGED)
		Ms. Phuong Thi Hong	Director - Economic and Planning Dept., RRMB I
WG-3; Improvement of Road Maintenance Technology	JICA Project	**Mr. Yasushi Aoki**	Deputy Team Leader/ Road Maintenance Technology
		Mr. Motoi Okuda	Road Inspection Technology
		Dr. Seiichi Kusano	Road maintenance Institution
		Mr. Toshinori Kanazawa	Road Pavement Technology
		Mr. Motofumi Tatsushita	Pavement Material
	Counter part	**Mr. Nguyen Trong Phu**	Team Leader/ Director of PMU TA, DRVN
		Mr. Thieu Duc Long	Deputy Team Leader/Deputy Director, Science and Technology and International Cooperation Dept., DRVN
WG-3; Improvement of	Counter part	Mr. Dang Cong Chien	Deputy Director, Science and Technology and International Cooperation Dept., DRVN

Working Group	Members List		
	JICA/CP	Name	Position
Road Maintenance Technology		Mr. Luong Van Minh	Expert, Road Maintenance & Management , DRVN
		Mr. Tran Quoc Toan	Expert, Road Maintenance & Management , DRVN
		Mr. Cao Hoang Can	Expert, Road Maintenance & Management Dept. - DRVN (CHANGED)
		Ms. Ta Thi Thuy	Expert, Planning and Investment Dept., DRVN
		Mr. Nguyen Viet Tuan	Expert, Science and Technology and International Cooperation Dept., DRVN
		Mr. Nguyen Anh Tu	Director - Transport Management Dept., RRMB I
		Mr. Nguyen Vu Tuan	Road Technical Center (RTC)
		Mr. Nguyen Tri Dung	Road Technical Center (RTC)
WG-4; Strengthening of Road Maintenance Institutes	JICA Project	**Mr. Hideyuki Kanoshima**	Team Advisor/ Road Maintenance Institutions
		Mr. Tsuneo Kato	Team Leader/ Road Maintenance Planning
	Counter part	**Mr. Vu Ngoc Lang**	Team Leader/Director, Road Maintenance & Management, DRVN
		Mr. Nguyen Duc Cuong	Deputy Team Leader/Vice Director, Road Maintenance & Management, DRVN
		Mr. Dang Cong Chien	Deputy Director, Science and Technology and International Cooperation Dept., Director of Information Technology Center, DRVN
		Mr. Nguyen Van Minh	Expert, Planning and Investment Dept., DRVN
		Mr. Tran Duc Toan	Expert, Organization & Personnel Dept., DRVN
		Mr. Luong Van Minh	Expert, Road Maintenance & Management, DRVN
		Mr. Tran Quoc Toan	Expert, Road Maintenance & Management Dept., DRVN
		Mr. Tran Quoc Thanh	Road Infrastructure and Traffic Safety Dept., DRVN
		Ms. Dinh T Thanh Huyen	Expert, Science and Technology and International Cooperation Dept., DRVN
		Mr. Cao Tien Hao	Expert, Transport and Legislation Dept., DRVN
		Mr. Nguyen Anh Tu	Director, Traffic Management Department, RRMB I
		Mr. Nguyen Vu Tuan	Deputy Director, RTC
WG-5; Reinforcement of Human Capacity Development	JICA Project	**Ms. Akiko Miyakawa**	Human Capacity Development
		Experts Related	
	Counter part	**Ms. Nguyen Thi Nhat**	Team Leader/ Vice Director, Organization & Personnel Dept.
		Mr. Dang Cong Chien	Deputy Director, Science and Technology and International Cooperation Dept., Director of Information Technology Center, DRVN
		Ms. Nguyen Thi Hai Ha	Expert, Planning and Investment Dept., DRVN
		Ms. Nguyen Hai Vinh	Expert, Organization & Personnel Dept., DRVN
		Mr. Luong Van Minh	Expert, Road Maintenance & Management, DRVN
		Mr. Tran Quoc Toan	Expert, Road Maintenance & Management , DRVN
		Mr. Nguyen Anh Tu	Director, Traffic Management Department, RRMB I
		Mr. Nguyen Vu Tuan	Deputy Director, RTC

1.6 PROJECT SCHEDULE

The Project commenced in September 2011 and finish in April 2014. The project work flow as of Work Plan is shown in **Figure 1.6.1**, The schedules in the work flow have been arranged/adjusted in each WGs activity which are described in Chapter 5 to 9.

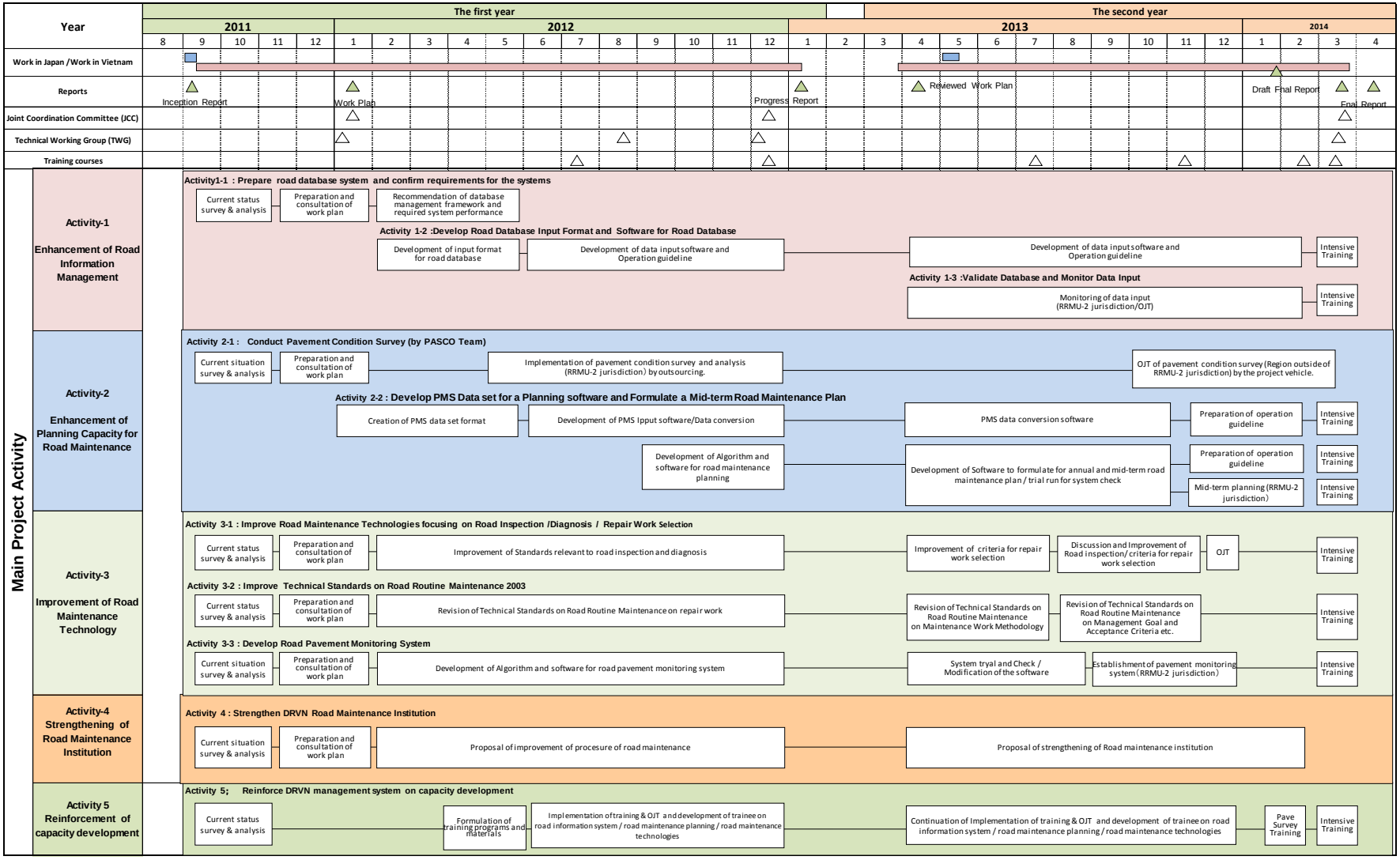


Figure 1.6.1 Project Work Flow

1.7 REPORTING

Table 1.7. 1 shows types of reports and date of issue.

Table 1.7.1 Reports

Name	Date	Remarks
Inception Report	October, 2011	Issued
Work Plan	January, 2012	Issued
Progress Report	December, 2012	Issued
Renewal of Work Plan	April, 2013	Issued
Final Report	April, 2014	

CHAPTER 2 SCOPE OF PROJECT AND METHODOLOGIES

2.1 SCOPE OF PROJECT

The project team implements the following activities. The details of the activities are elaborated in CHAPTER 4.

ACTIVITY 1: Enhancement of Road Information Management

ACTIVITY 2: Enhancement of Planning Capacity for Road Maintenance

ACTIVITY 3: Improvement of Road Maintenance Technology

ACTIVITY 4: Strengthening of Road maintenance Institution

ACTIVITY 5: Reinforcement of Human Capacity Development

2.2 POSITION OF EACH ACTIVITIES IN ROAD MAINTENANCE CYCLE

The positions of each activity in Road Maintenance Cycle are shown in the following figure.

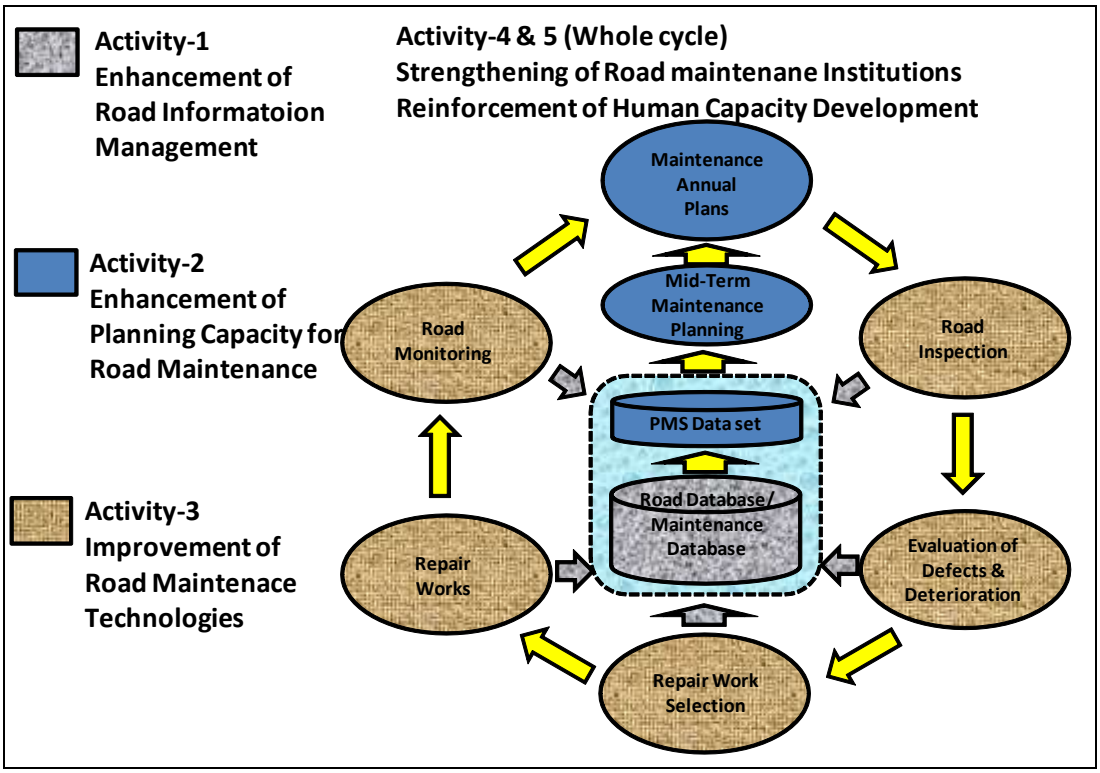


Figure 2.2.1 Road Management Whole Cycle

CHAPTER 3 CURRENT STATUS OF NATIONAL ROAD MAINTENANCE

3.1 OVERVIEW OF ROAD SECTOR

3.1.1 Road Classification

According to Decree No.11/2010/ND-CP on February 24, 2010 which was enacted pursuant to Law on Road Traffic (No.23 / 2008 / QH12 on July 1, 2009), the road system in Vietnam falls in Six (6) categories; (1) National Road, (2) Provincial Road, (3) District Road, (4) Urban Road, (5) Commune Road and (6) Exclusive Road. Exclusive roads are special roads that connect to industrial zones, military zones, forests, etc. The Decree also prescribes agencies responsible for the construction and maintenance of the road (**Table 3.1.1**).

Table 3.1.1 Administrative Road Classification

Classification	Definition	Agency Responsible	Total Length (km) (in 2009)
National Road	The main axial roads of the nationwide land road network, which are of particularly important effect in service of national or regional socio-economic development, defense and security, including: ▪ Roads linking Hanoi capital with the centrally-run cities; and with administrative centers of the provinces; ▪ Roads linking administrative centers of three or more provinces or centrally-run cities (hereinafter called provinces); ▪ Roads linking international seaports with international border gates and main land border gates.	Ministry of Transportation	16,758
Provincial Road	Axial roads within one province or two provinces, including roads linking a province's administrative center with districts' administrative centers or with adjacent provinces' administrative centers; roads linking national roads with districts' administrative centers.	Provincial People's Committee (DOT)	25,449
District Road	Roads link districts' administrative centers with the administrative centers of communes or commune clusters or with adjacent districts' administrative centers; roads linking provincial roads with administrative centers of communes or centers of commune clusters.	District People's Committee	51,721
Commune Road	Roads linking the communes' administrative centers with hamlets and villages, or roads linking communes together.	Commune People's Committee	161,136
Urban Road	Roads lying within the administrative boundaries of inner cities or urban centers.	Provincial People's Committee	16,075
Exclusive Road	Roads used exclusively for transport and communication by one or a number of agencies, enterprises and/or individuals.	(Investor)	7,838
Total			279,928

Source: Decree No.11/2010/ ND-CP, Prescribing the management and Protection of Road Traffic Infrastructures. Data as of Nov.5, 2010

(1) Road Network

Vietnam's road network, shown in **Table 3.1.2** and **Figure 3.1.1**, has a length of 279,928km, of which 161,136km (58%) are commune roads and 25,449km (9%) are provincial roads, both consisting of 67% of all road network. On the other hand, the national roads whose total length is

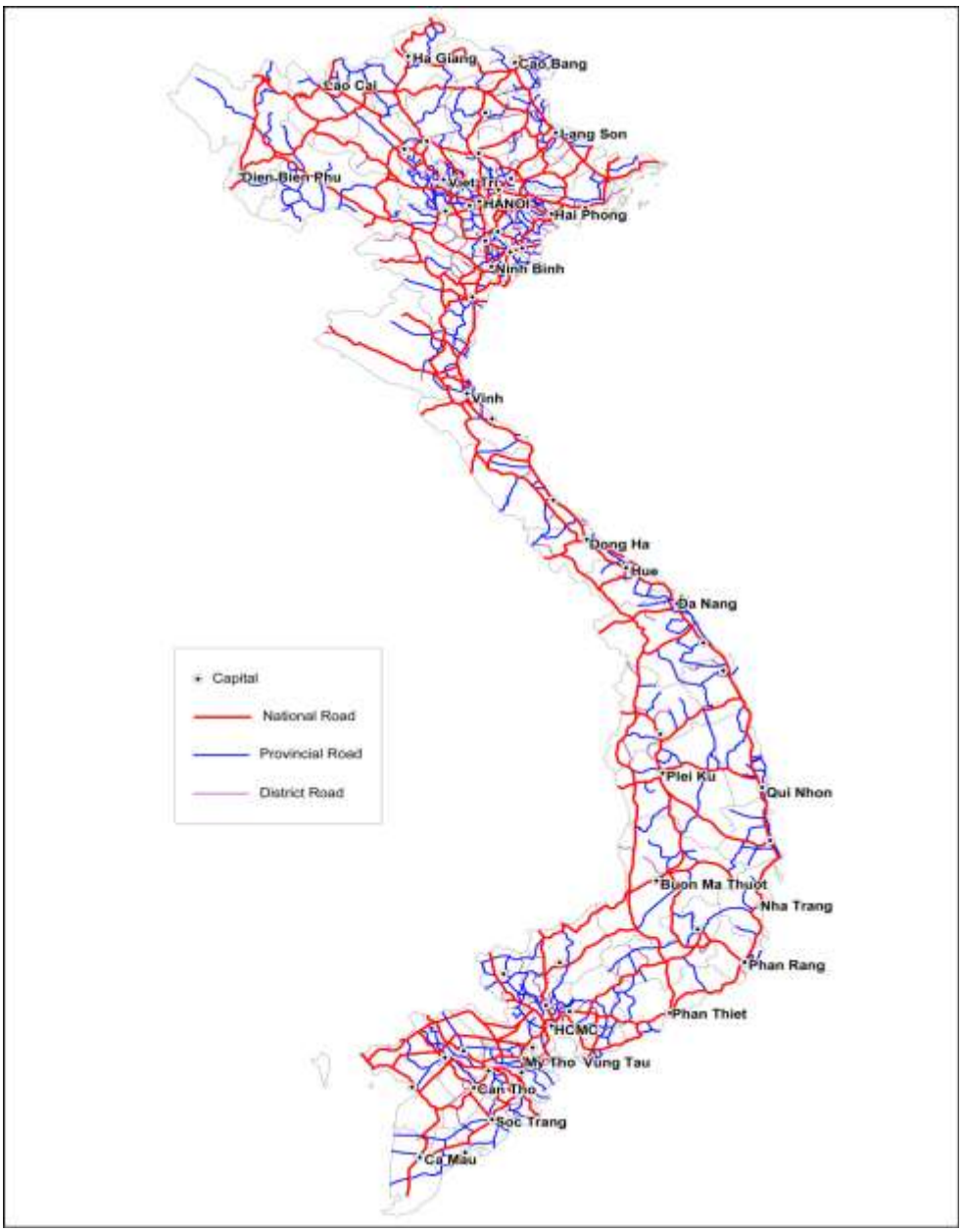
16,758km (6%) play function as the primary arterials of the road network. Overall road network has grown at a rate of 9,600 km, by 6%, per year, and the national road network 140 km and 1 percent per a year over the past twelve years since 1997. The national road network forms two north–south corridors, coastal and upland, with east–west roads along the central part of Vietnam. In the north, the national roads form a radial circumferential pattern. In the south, the national road network forms a grid pattern. The coverage of the national roads seems adequate. However, due to the topographic conditions of Vietnam, 39% of the national road network is in mountainous terrain. Therefore, the design standards of nearly half of the national roads are constrained. It also creates problems for road maintenance and is vulnerable to natural disasters, such as landslides.

Table 3.1.2 Road Length for the Road Network in Vietnam

Unit: km

Year	Total length	National Road	Provincial Road	District Road	Commune Road	Urban Road	Exclusive Road
1997	164,620	15,071	1,653	32,907	89,372	5,213	5,524
1998	171,071	15,286	17,097	34,519	92,558	5,534	6,077
1999	150,950	15,392	17,653	35,509	69,913	5,755	6,728
2000	183,177	15,436	18,344	36,840	99,670	5,919	6,968
2001	201,558	15,613	18,997	37,013	117,017	5,921	6,997
2002	221,295	15,824	19,916	37,947	134,643	5,944	7,021
2003	216,790	16,118	21,417	46,508	118,589	8,264	5,894
2004	223,287	17,295	21,762	45,013	124,942	6,654	7,621
2005	230,502	17,295	23,990	47,109	126,869	7,808	7,432
2006	268,778	16,125	24,822	50,844	155,968	15,182	5,836
2007	251,535	17,339	23,905	54,181	138,965	10,075	7,070
2008	277,560	16,913	24,750	43,520	175,329	9,558	7,490
2009	279,928	16,758	25,449	51,721	161,136	17,025	7,838

Source: Infrastructure & Traffic Safety Department, DRVN, Data as of December 2010



Source: DRVN

Figure 3.1.1 National Road Network

3.1.2 Pavement Conditions

Table 3.1.3 shows a road classification by pavement type. Looking an entire road network, the pavement ration of cement concrete, asphalt concrete and asphalt pavement constitutes 28% of all road networks, 224,482 km. Looking further the major roads, same pavement ratio goes up to 81 % for national roads, followed by 63% for provincial roads, 20% for district roads and 2% for commune roads. A major pavement type, shown in grey color, explains, an asphalt concrete pavement occupies 43% for national roads, an asphalt pavement 53% for provincial roads, gravel surface 44% for district roads and Earth type 86% for commune road. This clearly shows a more economical pavement structure has been applied in accordance with road classification.

Table 3.1.3 Road Classification by Pavement Type (2009)

Unit: km

Road Classification	Total Length	Asphalt Concrete	Bituminous Surface Treatment	Concrete Cement	Gravel	Earth/ Compacted Soil	Others
National Road	16,758	10,751	4,999	367	366	0	275
Provincial Road	25,449	4,398	14,904	620	3,027	15	2,485
District Road	51,721	3,039	14,833	5,189	13,974	426	14,260
Commune Road	161,136	2,820	16,516	36,904	33,315	1,978	69,603
Urban Road	17,025	8,063	4,403	1,700	1,601	28	1,230
Specialized Road	7,838	1,097	744	356	1,554	14	4,073
Total	279,928	30,168	56,399	45,136	53,837	2,462	91,926

Source; Infrastructure & Traffic Safety Department, DRVN, Data as of December, 2010

3.2 CURRENT STATUS OF ROAD MAINTENANCE

3.2.1 Overview of National Road Administration

(1) Legal Status of Road Administration

The principal governing law for road transportation is Law on Road Traffic, which was initially enacted by the National Assembly on June 29, 2001 (No. 26 / 2001 / QH10). The Law was recently revised and come to effect on July 1, 2009 (No.23 / 2008 / QH12). The Law prescribes roads traffic rules, road infrastructure facilities, vehicles in traffic and road users, road transportation and state management of road traffic. The six (6) administrative classifications of roads containing National Road, Provincial Road, District Road, Commune Road, Urban Road and Exclusive Road are set out in this document. The Law also prescribes provisions pertinent to road administration and maintenance.

Following the Law enactment, the Government issues Decree No. 186 / 2004 / ND-CP dated on November 5, 2004 which prescribes administrative organizations to be managing and operating all road networks in Vietnam. Vietnam Road Administration (Currently changed to the Directorate of Roads for Vietnam; DRVN) after referred to as VRA), which has changed its status to the Directorate of Road pursuant to Decision No. 60/2013/QD-TTg dated on October 21, 2013, is assigned to manage, maintain and exploit the national road system. Also, the Provincial People's Committees who are the administrators as were stipulated in Law on Road Traffic assign Provincial Department of Transportation the tasks of directly managing, maintaining the provincial roads. The following explains further.

a) **Ministry of Transport (MOT)** shall perform the uniform state management over roads nationwide and be responsible for organizing the management of construction and maintenance of the national highway system.
b) **Directorate for Roads of Vietnam (DRVN)** is assigned by Ministry of Transport the tasks of directly managing, maintaining and exploiting the national road system, providing the localities

throughout the countries with professional instructions on road management, maintenance and exploitation.

c) **Provincial People's Committees** (hereinafter referred as to PPC) shall manage the systems of provincial roads and urban roads within their respective localities and assign Provincial Transport Services (Provincial Department of Transportation (PDOTs)) and Provincial Traffic / Public Work Services the tasks of directly managing and maintaining provincial roads and provincial urban roads respectively.

d) **District and Commune People's Committees** shall manage, maintain and exploit district and commune roads upon receiving regulations issued by PPC.

(2) National Road Administration

There are three administrators being involved in the national road maintenance and management;

+ MOT
+ DRVN
+ PDOT

According to Decree No.107/2012/ ND-CP, December 20, 2012, MOT has the roles and positions in carrying out the state administrating functions over roadway, railway, waterway transport nationwide and also provides the administration of the public services as regulated by the law.

DRVN is an agency under Ministry of Transport performing the functions as an assistant for Transport Minister in state management on road transport and carry out the state management tasks on road transport in Vietnam. The responsibility assignment of DRVN is stipulated in Decision No.60/2013/QD-TTg issued by the Prime Minister.

PDOTs belonging to PPCs nationwide, have also been playing co-operators of the national roads, whose tasks, powers and organizations in national road management and maintenance are stipulated in the Joint Circular No.12 / 2008 / TTL-BGTVT / BNV issued jointly by MOT and the Minister of Internal Affairs. With this Circular, each of the 64 PPCs throughout the country issued its own Decision stipulating roles, functions and organization structures of their transportation departments (PDOTs).

1) DRVN

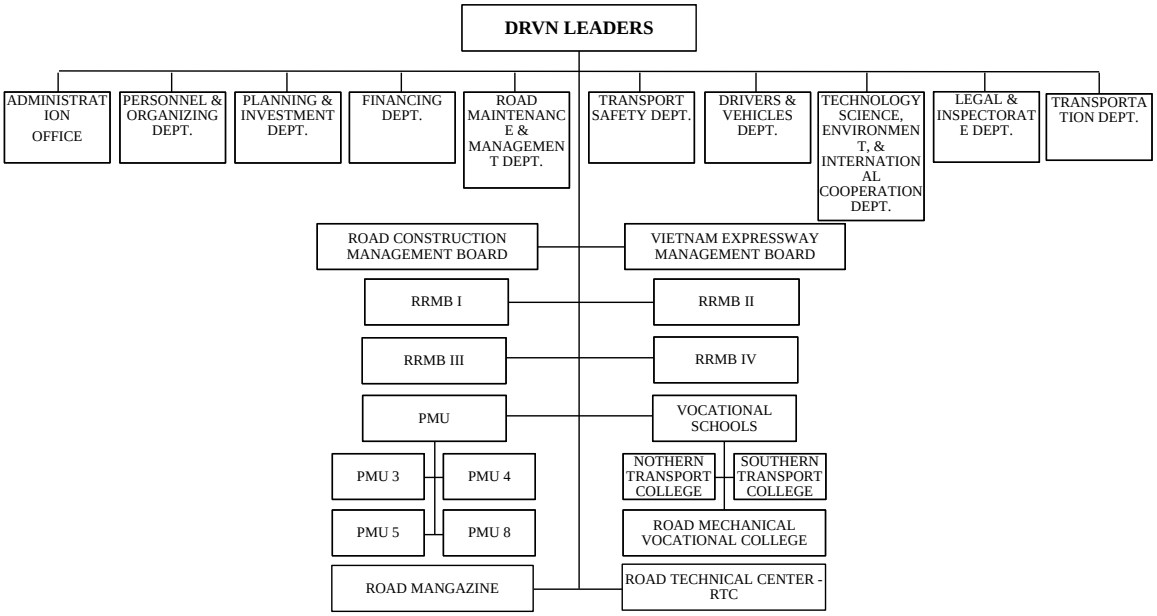
a. Organization Structure

DRVN is an agency under MOT that was founded in 1993 by the name of Vietnam Road Administration (VRA) pursuant to Decree No. 07 / CP dated on January 30, 1993. On April 1, 2010, VRA changed its name to Directorate of Roads in Vietnam (DRVN). The Decision No.60/2013/QD-TTg approves 16 departments to be located in DRVN. **Table 3.2.1** shows number of staff in DRVN and **Figure 3.2.1** shows DRVN organization chart.

Table 3.2.1 Number of staff under DRVN

Major Departments	No of staffs
(1) Planning – Investment Dept.	17
(2) Science, Technology, Environment and International Cooperation Dept.	21
(3) Traffic Safety Dept.	13
(4) Road Maintenance and Management Dept.	19
(5) Finance Dept.	16
(6) Transportation Dept.	10
(7) Vehicle and Drivers Management Dept.	16
(8) Organization & Personnel Dept.	9
(9) Administration Office	39
(10) Legislation - Inspection Dept.	15
(11) Administration of Road Construction and Management	48
(12) Administration of Expressway	5
(13) RRMBs	664
Total	892

Source: Organization & Personnel Department, DRVN, February 2014



Source: DRVN, December 2013

Figure 3.2.1 DRVN Organization Chart

b. Roles and Responsibilities

DRVN's major roles and responsibilities, which are defined in the Decision No.60/2013/QD-TTg dated 21/October/2013 issued by the Prime Minister at the request of Transport Minister, are stated below, but its main responsibility is to manage and maintain national road infrastructures in Vietnam. **Table 3.2.2** also shows information on DRVN administration.

- Draft Laws and legal documents, plan strategies including long-term, five-year and annual plans and develop national projects and programs in the road sector,
- Formulate national standards, national technical regulation and norms on road sector,
- Manage road infrastructure including operation and maintenance,

- Manage road transport infrastructure construction and investment,
- Manage road transport,
- Improve road traffic safety,
- Improve environment protection in road transport,
- Conduct research on scientific improvements and technology transfer in road transport sector.

Table 3.2.2 Outline of DRVN Administration

Items	VRD
(1) Law and decisions concerning establishment (Decrees, decisions)	• Decree 107/2012/ND/CP issued by the Government regulates functions, responsibilities, and organizational structure of MOT, including stipulations on organizational structure of DRVN • Decision No 60/2013/QD-TTg dated 21/10/2013 by the Government regulates functions, responsibilities, and organizational structure of VRD under MOT
(2) Functions, authorities, and responsibilities	• According to Decision No. 60/2013/QD-TTg on 21/10/2013 by Prime Minister
(3) Scope of works	• State management about road transport sector according to Decision 60 and hierarchy of MOT
(4) Organizational Chart	• Shown in **Figure 3.2.1**
(5) No of staffs	• Total: 892 staffs

Source: DRVN (March 2014)

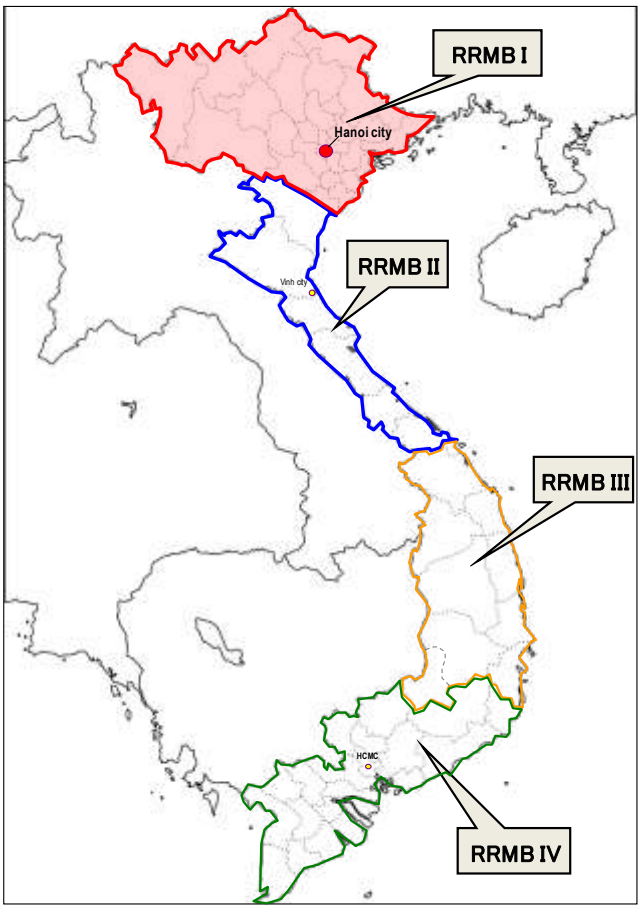
DRVN also has a responsibility for the construction and development works of the national roads. DRVN is given authority of construction management for Group-B and C project according to Decree No.11/2010/ND-CP on Prescribing the management and Protection of Road Traffic Infrastructures issued on February 24, 2004. The construction projects are being carried out by procurement from local construction enterprises. For managing construction projects, there are five (5) Project Management Units (PMUs) currently positioned under DRVN jurisdiction.

2) RRMBs

a. Organization Structure

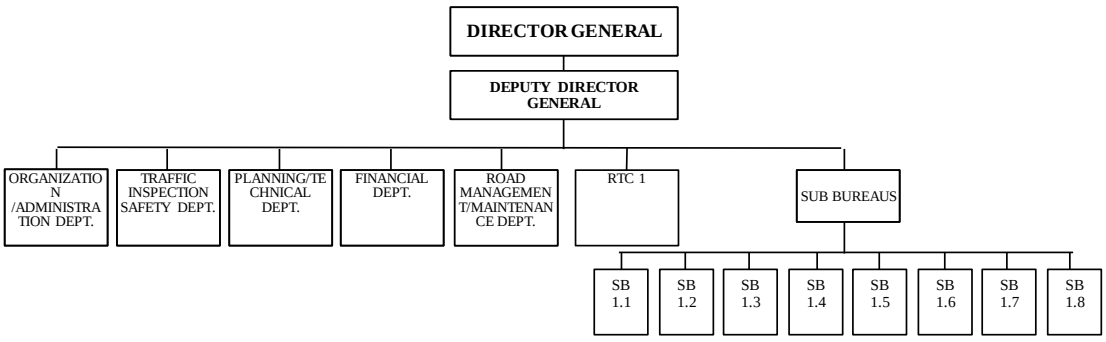
Regional Road Management Bureau, RRMB, is a regal non-productive agency under DRVN and performs the state management functions of road transport, maintenance and repair of national road infrastructure in the regional areas. There are four RRMBs nationwide. Until 1985, there were eight (8) region-based Construction Unions, which undertook both road management and the major road and bridge construction works. However, Construction Union numbers 1, 3, 6 and 8 became the first four state-owned Construction Companies, accordingly the road management function has been concentrated in other four organizations as RRMBs, and thus RRMBs turned to be the management bodies responsible for road maintenance works. Currently, RRMBs are in charge of the national road maintenance and management in the regions, dividing the whole country area into four regions; RRMB I for Northern area, RRMB II middle Northern area, RRMB III middle southern area and RRMB IV southern area. The national road under the jurisdiction of RRMBs totals 8,827 km in length, about 50% of the entire national road network. Remaining sections of the national roads are managed and maintained by PDOT in PPCs.

Figure 3.2.2 depicts RRMB jurisdictions with the outline of RRMB jurisdiction**.** RRMBs also operate a range of medical and welfare services and have access to their local Vocational Training College, mainly oriented at present to provide technical and grass-roots managerial training to technicians and foreman-grade staff. **Figure 3.2.3** illustrates a RRMB I organization chart.



Source: JICA Project Team

Figure 3.2.2 RRMB Jurisdiction



Source: RRMB I, 2013

Figure 3.2.3 RRMB Organization Chart (RRMB I)

b. Roles and Responsibilities

Roles and responsibilities of RRMBs are stipulated in the Decision No.2173, 2174, 2175 and 2176/QĐ-BGTVT dated on December 10th, 2013. Some of their major assignments, which are pertinent to the national road maintenance and management, are extracted from the above Decision and listed below. However, their main responsibility is to implement state managerial tasks on road transport mandated by DRVN.

- To plan the following and submit to DRVN for approval;
  - Long term, 5-year, annual plans, programs, projects, proposal on road transportation in its jurisdiction.
  - Regulations, standards, codes, economical-technical norms on management, maintenance and operation of road infrastructures.
- To implement state managerial tasks on road transport;
- To organize the management and maintenance of national highway system in assigned area according to regulations and norms about road management and maintenance;
- To formulate annual plans of road management, maintenance to submit to DRVN;
- To formulate price of public products, service in road management, maintenance for appraisal;
- To conduct routine maintenance for assigned highway sections;
- To act as Decision Maker or Project Owner in projects as delegated;
- To conduct inspection on compliance of regulations, procedures, norms;
- To conduct operation (or leasing) of road infrastructures as regulated.
- To assure smooth traffic along the National Highways within jurisdiction

3) PDOT

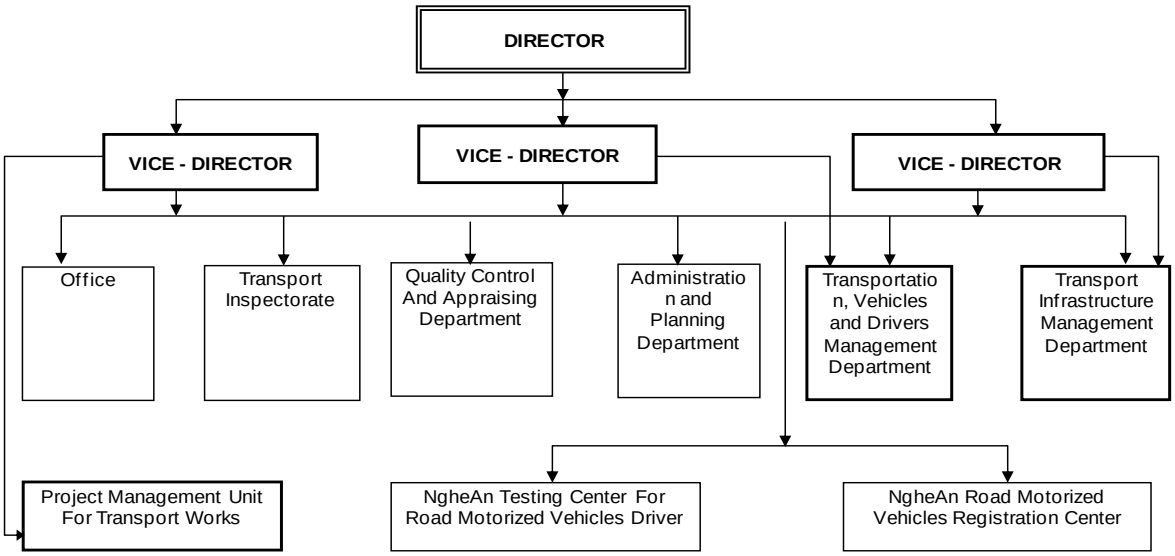
Besides RRMBs, Department of Transportation (PDOT), which belongs to the regional administration of PPCs, has been also involved in the maintenance and management of the national roads. At present, there are forty eight (48) provincial-level departments of transportation (PDOTs) involved in the national road maintenance and management as of March in 2010.

Local government in each of the Provinces is governed by PPCs. The road maintenance of the Provincial roads is managed by PDOTs, which operate as a division of local government. At present, PDOTs are also responsible for the maintenance of 8,739 km of National Roads, thus half of the National Roads are managed by DRVN through RRMBs and the other half is managed by PDOTs. As the case of RRMBs, the national road maintenance work is also undertaken by 65 subordinate bodies, so-called Provincial Road Repair and Maintenance Companies (PRRMCs) including government-owned enterprises and privatized companies. **Table 3.2.3** shows the outline of PDOTs jurisdiction. **Figure 3.2.4** shows an organization chart of PDOT in Nghe An Province.

Table 3.2.3 PDOTs Jurisdiction

Regional Road Management Units	No. of Organizations	Length of National Roads under their jurisdiction (km)	Responsibilities	PRRMCs (No. of companies)
PDOTs	49	8,739	Road maintenance of National roads and Provincial Roads	65

Source: SAPI-II Study Final Report, April, 2009
Note: Length of National Highways is as of January 2007.



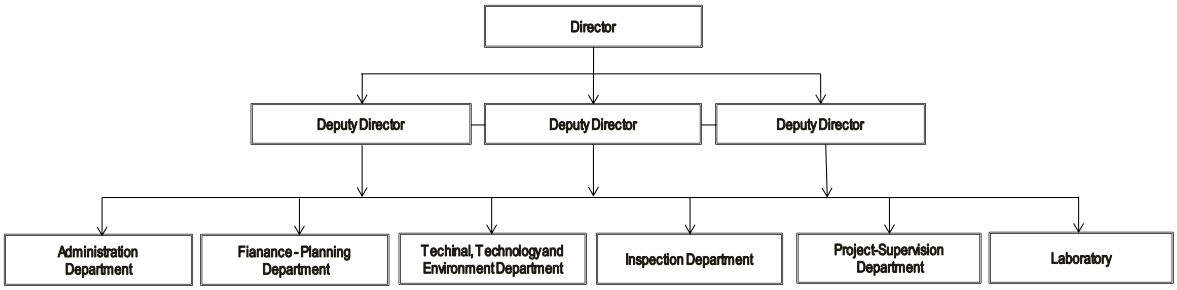
Source: PDOT Nghe An (May, 2010)

Figure 3.2.4 PDOT's Organization Chart (Nghe An Province)

4) RTCs

There are five (5) RTCs assigned to the maintenance and management of the national roads; four (4) of which belong to RRMBs and one belongs to DRVN in Hanoi. Their roles, functions and organization structures are stipulated in the Decision No.1698 / QD / TCCB-LD on 25th July, 1995 (RTC 4) issued by DRVN. RTC has a responsibility for supporting RRMBs to conduct technology and science tasks relevant to maintenance and management of the national roads under RRMB jurisdictions. **Figure 3.2.5** illustrated a RTC Central organization chart. All RTCs still remain as government entities, but are allowed to raise profits from contract-based consulting works, material testing, supervision, design, etc., although there have been many RRMCs changing their natures from State-Owned Enterprises to Limited Companies and Joint Stock Companies. RTCs have been involved in the pavement deterioration survey contracted out by RRMBs with advanced survey equipment including IRI measurement vehicles (ROMDAS) and falling weight deflectors (FWD). The pavement deterioration surveys were carried out in 2001, 2004 and 2007, in every three years. According to the 2007 survey, RTCs were responsible for measurement of pavement roughness, skid resistance, texture and rutting depth by making most of their survey equipment. RTC Central, one of the five RTCs belongs to DRVN directly. RTCs took responsibility for data collection 2007 over 3,500 km of National Roads upon request of 16 PDOTs under the jurisdiction of RRMB I and RRMB III.

However, as there are a few opportunities given to RTCs, they cannot make best use of their competence in research and technology tasks. This results in that they have to engage in consultant jobs other than research and technology jobs.



Source: RTC-Central, 2011

Figure 3.2.5 Organization Chart (RTC Central)

5) Responsibility Sharing between Central and Regional Agencies

Law on Road Traffic No. 26 2001 / QHD enforced in July in 2010 defines the fundamental role sharing of central and local governments. MOT is fully responsible for carrying out state administration over all road networks in Vietnam. DRVN, assigned by MOT, is responsible for the national road administration, while PPCs are responsible for the administration of provincial, districts and commune roads. However, the real management of district and commune roads is performed by District-level and the Commune-level PPCs upon receiving direct commitments from the Provincial People's Committees. However, when looking further into the national road construction, MOT owns a mandate of managing a part of the national road construction projects (Group-A Project) in which a real assignment is handed over to the Project Management Units (PMUs)under the MOT.

The DRVN responsibility for the national road administration falls in two (2) classifications; 1) road construction and development, and 2) road maintenance and management. The former assignment is carried out by PMUs under DRVN, and the latter by RRMBs also under DRVN and by PDOTs. Currently, 48 PDOTs are engaged in nearly a half in length of the entire national road network. Current demarcation of jurisdictions in road management between RRMBs and PDOTs explains that RRMBs are focused on managing trunk national roads with higher traffic demands, while PDOTs are managing regional national roads or branch roads extending from the trunk national roads like ones running in the mountainous areas.

Regarding the national road maintenance and management, DRVN owns full administrative functions over the national road maintenance and management with much focus on the followings: (i) to plan road maintenance plans including a 10-year strategic plan and a 3-Year mid-term maintenance plan; (ii) to develop database software tools and maintenance norms and standards; and (iii) provide training courses on database software operation.

On the other hand, the major focuses of RRMBs and PDOTs responsibilities are as follows; (i) to make annual plans for budget proposal; (ii) to inspect road structure deteriorations; and (iii) to implement road maintenance works including maintenance company procurement, supervision, inspection and acceptance of the maintenance works. They are also occasionally asked to support data collection needed for planning national road maintenance plans.

In addition, the closer cooperation is observed on the national road maintenance and management as in the following tasks; information on material and labor costs is prepared quarterly by PPCs; Equipment norms for maintenance and repair works are delivered by MOC; right-of-way acquisition for a new road construction and a development work is managed by PPCs; and the law enforcement to ROW encroachments on the national roads is also managed by PPCs upon reporting from RRMCs or PRRMCs.

3.2.2 Road Maintenance and Budget Plan

(1) Classification of Road Maintenance

Circular No.10 / 2010 / TT-BGTVT, April 19, 2010 issued by Transport Minister, which is on providing for road administration and maintenance stipulates the classification of national road maintenance works. The road maintenance works fall in three works; (i) routine maintenance and (ii) periodical maintenance and (iii) unscheduled maintenance. The following is the outline of these works.

1) Routine maintenance:

Maintenance works carried out regularly on a daily, weekly, monthly or quarterly to monitor the status of the roads, to introduce solutions to prevent damages and failures, to repair minor damages, which may affect the quality of the roads, and to maintain normal operating status of the roads to ensure smooth and safe traffic.

2) Periodical maintenance:

Repair works to be carried out according to the frequencies stipulated in Decree No.10 / 2010 / TT-BGTVT. The work aims to restore road structures from defects incurred during road operation and to recover the strength-ensuring road and traffic functions. Circular No.10 / 2010 / TT-BGTVT also stipulates that periodical maintenance for bridges be based on structure inspections and field experiments.

Furthermore, the periodical maintenance work includes medium repairs and big repairs whose work frequencies are stipulated in Circular No.10 / 2010 / TT-BGTVT as shown in **Table 3.2.4**. The medium repair is the repair of breakdowns and structural deterioration, which may possibly affect vehicle traffic and lead to traffic accidents. The big repair indicates the repair works to be conducted upon occurrence of breakdowns or degradations in the various parts of the road structures and to restore them to the original functions and quality.

Table 3.2.4 Work Frequencies of Medium and Big Repairs

No.	Road pavement type	Average repair frequency (year)	Major repair frequency (year)
1	Asphalt concrete	4	12
2	Cement concrete	8	24
3	Bitumen-mixed crushed rocks, black crushed rocks	3	9
4	Bitumen penetrated; 2, 3 layer- bitumen seal	3	6
5	Standard crushed rocks, graded crushed rock aggregate	2	4
6	Natural aggregate	1	3

Source: Circular No.10 / 2010 / TT-BGTVT (April 19, 2010)

3) Unscheduled maintenance:

Maintenance and repair works to be carried out to the failures or damages caused by natural disasters such as floods, typhoons or other unexpected incidents.

Besides road maintenance works categorized in Circular No.10 / 2010 / TT-BGTVT, DRVN is also assigned construction projects. The construction project includes a new road construction and development works such as reconstruction, realignment, widening and other large-scale civil works. The construction works whose responsibilities assignments belong to DRVN are Group-B and Group-C project, and Group-A project belongs to the responsibility of Ministry of Transportation. Group-B and C project are to be principally implemented by PMUs under DRVN jurisdiction, where five PMUs are now in operation.

(2) Road Maintenance Plan

There have been no officially approved long/mid-term maintenance plans which can indicate long/mid-term investment perspectives on the national road assets. However, several trials of plan formulation focusing on pavement structures have been made since early 2000's upon receiving international donor assistance. On the other hand, an annual plan has been playing a key role in formulating a budget proposal. Further details of these plans are elaborated below:

1) 3-Year Road Maintenance Plan

A three-year plan for national road maintenance is an official plan for DRVN. DRVN promulgated the correspondence, No.1481/TCDBVN-KHDT dated on April 12th 2013, giving instruction of development of mid-term plan in 2014-2016 for road infrastructure maintenance to RRMBs and authorized PDOTs. The correspondence was issued upon receiving MOT Decision No.438/QD-BGTVT dated on March 6th 2013.

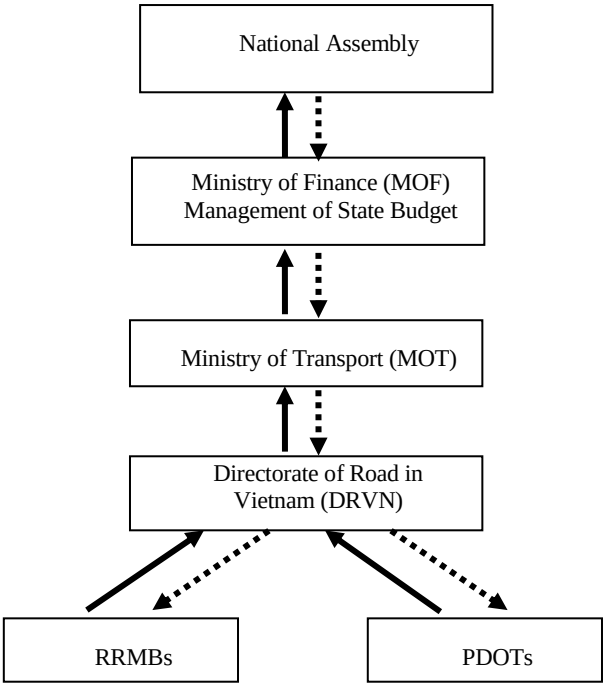
2) Annual Plan

Annual road maintenance plan is the prevailing means of formulating a budget plan. Regional agencies, including RRMBs and PDOTs, play a key role in organizing the annual plan. Annual plan includes the budget plans for routine maintenance and periodic maintenance consisting of medium repair and big repair. The annual plan is absolutely based on the accumulation of

maintenance costs following predetermined maintenance norms and standards. In formulating annual plans, much effort has been directed to planning repair works rather than routine maintenance plans, since works for the routine maintenance are prescribed in the maintenance norms and standards and a simple formula of budget estimate is presented.

(3) Budget Proposal/Distribution Process

As shown in **Figure 3.2.6**, the budget proposal for road maintenance originates from the regional organizations of RRMBs and PDOTs. The budget proposal and distribution procedures follow the following steps;



Source: JICA Project Team

Figure 3.2.6 Budget Proposal/Distribution Flow

1) Budget Proposal Processes

a) In every year, RRMBs and PDOTs prepare budget plans and send them to DRVN.
b) DRVN integrates all plans into single format, examines the contents and then submits this draft budget proposal to MOT in October each year.
c) On receiving the proposal from DRVN, MOT examines again the contents and sends the MOT plan to Ministry of Finance, where budget proposals assembled from various ministries are examined again referring to the expected revenue amounts.
d) The final budget proposal is subject to the decision of the National Assembly.

2) Budget Distribution Processes

a) After National Assembly approved the budget, MOF will decide to allocate the estimated amount to MOT.

b) Then, MOT will order DRVN to draft budget distribution plans to the regional agencies and report to MOT.
c) After appraising these draft plans, MOT will make a final decision on the budget allocation to the regional RRMBs and PDOTs for the national road maintenance.
d) DRVN convene a meeting with all RRMBs and PDOTs to reallocate the budget constrained.
e) Following the decision made at the meeting, RRMBs and PDOTs reorganize renew their initial annual maintenance plans, work out new implementation plans and send them to DRVN for approval.
f) Upon approval, RRMBs and PDOTs move forward to the next step of making maintenance contracts with maintenance companies.

3) Current Budget Status

DRVN has been faced with a chronic shortage of the national road maintenance budgets. **Table 3.2.5** shows proposed and distributed budgets for the past ten years, and **Figure 3.2.7** shows the growth of proposed and allocated budgets for the past nine years. It is often said that budget distribution can meet only 40 to 50% of the budget requirement. The amount of budget proposal has been decided on the basis of the past year trend. Many regional agencies reportedly pointed out that they estimated their budget proposal just in the same manner, taking a projection based of the allocated amounts in the past years. In addition, the budget allocation keeps growing in recent years, but price escalation of unit costs (labor and materials) is much higher than the growth of budget allocation, which resulted in the reduction in work volumes.

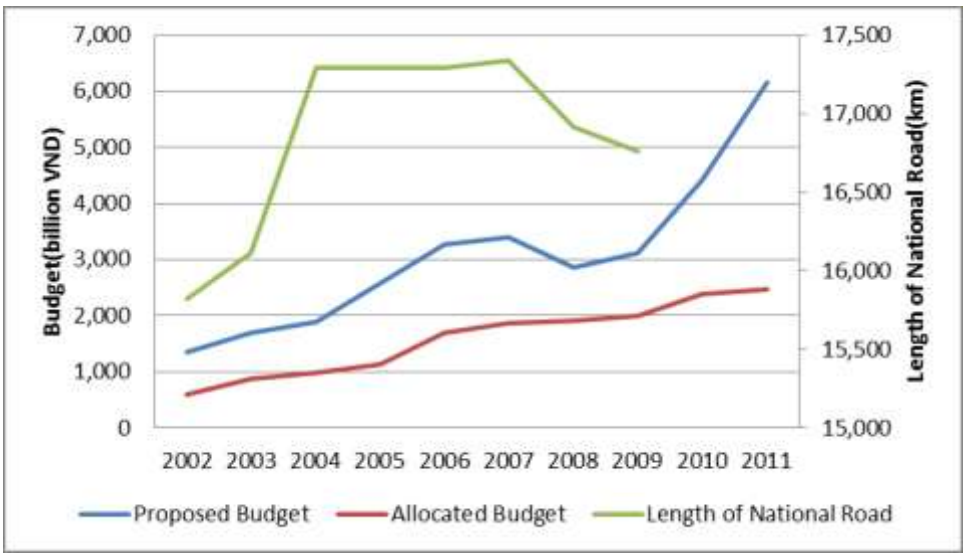
Due to the budget constraint, RRMBs and PDOTs cannot but directing their energy to the most seriously damaged roads structures and conducting reactive maintenance or repair works. In addition, this may lose morale of estimating true budget proposal and discourage field engineers to follow existing maintenance norms and standards.

Table 3.2.5 State Budgets for Maintenance, Repair Works and Construction

Unit: million VND

	Proposed Budget			Allocated Budget			
	Total	**Routine Maintenance**	**Periodical Maintenance & Unscheduled Maintenance**	**Total**	**Routine Maintenance**	**Periodical Maintenance & Unscheduled Maintenance**	**Basic Construction (Group C)**
2002	1,352,087	264,197	1,087,870	661,791	182,680	416,480	62,631
2003	1,694,910	311,310	1,383,600	1,382,017	243,990	640,417	497,610
2004	1,885,155	328,605	1,556,550	1,056,484	284,200	700,384	71,900
2005	2,583,809	381,502	2,202,307	1,137,392	326,180	811,212	0
2006	3,272,701	474,796	2,797,905	1,704,300	433,000	1271,300	0
2007	3,400,400	510,060	2,890,340	2,101,992	469,797	1405,015	227,180
2008	2,860,000	690,000	2,170,000	,2,080,889	518,892	1384,628	177,369
2009	3,126,400	757,288	2,369,112	2,140,328	546,611	1,451,517	142,200
2010	4,424,000	1,028,000	3,396,000	2,380,717	627,089	1,697,242	56,386
2011	6,167,980			2,481,968			

Source: DRVN (2011)



Source: JICA Project Team

Figure 3.2.7 Growth of Budget Proposal and Distribution

4) Cost Estimation of Annual Budget

a. Routine Maintenance Costs for Budget Proposal

For budget proposal, routine maintenance cost estimate for road and bridge structures is calculated based on a single formula as shown in **Figure 3.2.8**. When estimating routine maintenance costs following Road Maintenance Norm 2001 (Decision No.3479 / 2001 / QDBGTVT, October 19, 2001) (Hereinafter called as Road Maintenance Norms 2001) and Technical Standards 2003 (Decision No.1527 / 2003/ QD-BGTVT, May 28) (Hereinafter called as Technical Standards 2003), the estimated costs come out around 80 to 100milVND / km / year, but allocated budget can only satisfy about 25% of the actual demands according the reports obtained in the field survey. This formula is commonly applied to any kinds of terrains including flat, mountainous, urban etc. Many have reported in the survey that it is not appropriate to apply a single formula to all terrains because of so many differences in road structures and working environment.

$RM = R + PE$	*Ci: Annual norm price per km for road class (i)*
$R=R_{road}+R_{bridge}$	*Ii: Total length of road class (i) im km*
$R_{road}=\Sigma CiIi \quad (I=1 \text{ to } 6)$	*Cj; Annual norm price per square meter of bridge type (j)*
$R_{bridge}=\Sigma CjAj \quad (k=1 \text{ to } n)$	*(Steel, concrete, prestress, composite, arch, suspension, cable-stayed)*
$PE=P+E$	*Aj: Total square meters of bridge type (j)*
	P: Planned amount in medium term plan
	E: Estimation based on the last year amount

Source: DRVN (September 2008)

Figure 3.2.8 Formula of Estimating Routine Maintenance Costs

b. Routine Maintenance Costs for Making Contracts

In making contracts with maintenance companies, cost estimate of routine maintenance is to be done based on Road Maintenance Norms 2001 (Decision No.3479 / 2001 / QDBGTVT, October 19, 2001). Road Maintenance Norms 2001 explains the quantitative information on the standard norms applicable for the various types of routine maintenance works. However, many pointed out in the field survey Road Maintenance Norms 2001 is no longer applicable to the actual maintenance works and needs to be updates immediately. In addition, Road Maintenance Norms 2001 came out before Technical Standards on Road Routine Maintenance (Decision No.1527 / 2003 / QD-BGTVT, May 28) materialized. Therefore, there seem to be many inconsistencies in contents between Road Maintenance Norms 2001 and Technical Standards 2003.

c. Repair Costs

Construction standards have been applied to the cost estimate of repair works, as there is no guidelines specialized for repair works available.

5) Identified Issues for Road Maintenance and Budget Plan

The following are the issues identified in the analysis on the current road maintenance plan and budget plan

Planning of a long-term and a mid-term road maintenance plan is imperative not only to show maintenance strategies to the relevant ministries, but also to ensure maintenance budgets in the long course of road maintenance. However, the planning systems including HDM-4 and Rosy BASE database system have not been fully operational, although much effort and donor assistance have been directed to developing planning systems like PMS since early 2000. Underlying problems, which have already been identified, exist in the complexity in software operation, low database reliability and incomplete database software. It is important to take immediate item-by-item measures and let these systems operational.

DRVN has been faced with a chronic shortage of the national road maintenance budgets. Distributed budget explains that it can meet only 40 to 50% of the real demand of maintenance budgets. Due to the budget constraint, field agencies cannot but take reactive maintenance and repair measures to the most seriously damaged portions of road structures. However, there has been no analysis and evaluation on the effects of the constrained budget given to road infrastructures and traffic conditions on the national roads. The following **Table 3.2.6** shows an example of traffic volume and IRI matrix made in the JICA SAPI-II Study conducted in 2009. The analysis was done in reference to DRVN national road database 2007. In the table, IRI values were measured by equipment owned by RTCs. The figures in the table indicate the number of 1-km road sections. Continuous measurement would enable the analysis on the effects of maintenance investment.

Table 3.2.6 IRI & Traffic Volume Matrix (DRVN 2007 Data)

IRI		Traffic Count (AADT)										Total
		<= 1000	<= 2,500	<=5,000	<=7,500	<=10,000	<=20,000	<=30,000	<=40,000	<=50,000	>50,000	
Good	<= 2	1,655	69	175	84	1	41	1		1	3	2,030
	2< And <=4	1,930	1,403	2,215	360	118	302	8	3	1	12	6,352
	4< And <=6	1,608	1,001	648	52	41	78					3,428
	6< And <=8	619	170	138	8	5	14					954
	8< And <=10	305	72	217		6	5					605
	10< And <=12	75	63	185		2						325
	12< And <=14	1	13	27								41
	14< And <=16	3		5								8
	16< And <=18	5										5
	18< And <=20	6	3									9
Very Bad	>20	28	3									31
Total		6,235	2,797	3,610	504	173	440	9	3	2	15	13,788

Source: SAPI-II analysis on DRVN database analysis, 2009

Up until recently, an annual plan has been playing an important role in formulating annual budget. Regional agencies are in charge of making drafts on the budget plans for the repair works. However, the next year's budget is said to have been estimated based on the allocated budget in the previous year, thereby does not show the real demand of budget. In addition, inadequate maintenance norms and standards for routine maintenance seem to degrade the quality of budget estimation. It is also pointed out that the formula applied to calculate routine maintenance budgets does not fully take into account regional features of road and traffic.

3.2.3 Standards and Norms for Road Inspection and Maintenance

Inspection and routine maintenance works have been carried out in accordance with two standards; (1) Road Maintenance Norms issued pursuant to Decision No.3479 / 2001 / QDBGTVT, October 19, 2001, and (2) Technical Standards on Road Routine Maintenance issued pursuant to Decision No.1527 / 2003 / QD-BGTVT, May 28, 2003. Technical Standards on Routine Maintenance 2003 was later revised to Specification on Road Routine Maintenance, TCCS07: 2013/TCDBVN in 2013.

(1) Road Maintenance Norms 2001

Road Maintenance Norms 2001 is applied to the routine maintenance of the national roads. It stipulates information on norm issues including pay items, units of cost estimate, standard norms for labor and equipment. Generally, Road Maintenance Norms 2001 plays an important role in estimating routine maintenance costs. However, many pointed out in the field survey that existing Road Maintenance Norms 2001 was no longer applicable to the actual maintenance works, because there is little consideration on local conditions and inconsistency in contents between Road Maintenance Norms 2001 and Technical Standards 2003 including outdated information. In fact, the close examination conducted by the study team clarified the following discrepancies in Road Maintenance Norms 2001;

(1) Technical Standards 2003 obliges regional agencies to measure IRI, skid resistance and roughness in the pavement deterioration survey, but there are no provisions prescribing equipment costs for these works, and

(2) There are inappropriate and impractical definitions of routine maintenance works. For an instance, Road Maintenance Norms 2001 prescribes that slope sliding to be classified and treated in the routine maintenance be less than 60 m^3 per kilometer, which appears to be impractical in measurement. If the incident is more than the valued, it should be reported to DRVN for judgment.

(2) Technical Standards 2003

Technical Standards 2003 was applied to the routine maintenance of the national roads. As major components, Chapter 1 prescribes legal documents to be applied for the routine maintenance, Chapter 2 management tasks including responsibility assignment to RRMBs / RRMCs / RTCs and inspection, monitoring of structure conditions including road and bridge structures, Chapter 3 work standards and Chapter 4 prescribes approval of routine maintenance works stating about implementation bodies, benchmarks of approval, work types and so forth. The approval and acceptance was carried out based on the signed contracts between RRMBs and RRMCs, evaluating work performance in conformity with the contract documents.

However, Technical Standards 2003 did not include any standards for such specific issues as urban road routine maintenance and mountainous road routine maintenance. Many pointed out in the field survey that there were many difficulties in applying Technical Standards 2003 to the urban roads, because of significant differences in topography and road and traffic conditions. In the urban roads, there is a great number of facility including drain systems and culverts, resulting in more need of labor force for clearance. On the other hands, in the mountainous terrains, a slope collapse and a landslide are the main concern for a road operator. In addition, trees also grow fast and often hamper sight distance of road traffic. The technical standards with these regional characteristics in the contents have been strongly desired.

(3) Specification on Road Routine Maintenance TCCS 07: 2013/TCDBVN

Specification on Road Routine Maintenance, TCCS07: 2013/TCDBVN, is disseminated as the second version of Technical Standard on Road Routine Maintenance 22 TCN 306-03 with supplementations and updates. The purpose of the Specification on Road Routine Maintenance is to serve current need of road routine maintenance and management work for national roads. The Specification will be enhanced continuously during the use process hereafter, taking account of constructive opinions to be issued specialists, scientists, consulting firms, road construction and management units.

This standard regulates technical requirements and provides some guidelines on management and implementation of routine maintenance of roads managed by Central and Local agencies, including works on the roads. This standard does not apply to periodical and unexpected maintenance work of roads in general. This standard does not apply to highways and local roads

from communal level and below. For bridges on roads, this standard applies to small bridges. There is particular regulation on routine maintenance work for medium and big bridges.

The Specification regulates the following activities as main routine road maintenance activities; pavement crack sealing, pothole patching, repair slope protection, repair road geometry, vegetation control, drainage damage repair, masonry damage repair, mesh gabion repair, traffic management and safety and facility repair, painting and so forth,

(4) National Standards and MOT Standards

At present, there is no standard, which specialize in periodic maintenance works consisting of medium and big repair works, but construction standards have been commonly applied to the periodic maintenance. There are three (3) types of standards applicable for the repair works; 1) those prepared by Ministry of Science and Technology as National standards called TCVN, and 2) those prepared by MOT as ministerial standards called TCN, and 3) those called TCXD. MOT published over 100 design and construction standards being edited into 13 volumes.

An instance of medium repair work explains that a project for the national road No.1 near Da Nang City, where a medium repair work worth of 1.4 billion VND was carried out with a thin layer asphalt surface placed on the pavement, incorporated three TCNs; 22TCN271-01, 22TCN282-02 and TCN237-01. However, the field survey also has reported that there is a strong desire for establishing technical standards, which specialize in repair works, since there are big differences in working conditions in between a road already opened to traffic and a new road construction site.

(5) Responsibility assignment for making maintenance standards

The authority of making standards regarding the routine maintenance used to belong to Ministry of Transportation. However, MOT decentralized the authority, assigning this task to DRVN by Circular No.10/2010/TT-BGTVT, April 19, 2010 on providing for Road Administration and Maintenance. Article7 in the Circular prescribes that "DRVN is assigned the tasks of formulating, appraising and announcing basic technical standards on regular road maintenance". However, the authority appears to be limited to making the technical standards for the routine maintenance. The Circular also prescribes that the standards and norms used for the capital construction works should be applied to the repair works or the unscheduled maintenance works.

3.2.4 Road Inspection, Diagnosis and Maintenance Work Selection

(1) Road Inspection

1) Classification of Inspection

Technical Standards 2003 prescribes details of road inspection. The road inspections fall into three categories: (i) routine inspection, (ii) periodic inspection and (iii) special inspection. Their focuses are road pavements and bridge structures. The routine maintenance also includes traffic counting.

Table 3.2.7 and **Table 3.2.8** outline these inspections and the traffic counting. Technical Standards 2003 also shows various reporting formats.

Table 3.2.7 Outline of Road Inspection

Road Structures	Names of Inspection	Frequencies	Implementation bodies	Inspection Points
A. Roads & Structures	Routine Inspection	Once a day	Road Patrol, RRMCs	
	Periodic Check	Monthly	RRMCs, Repair Team	Pavement Surface, Drainage system, Road Signal, Dikes, etc.
		Quarterly	RRMU/PDOTS, RRMCs	
	Special Check		RRMUs/PDOTs	Pavement & Sub-grade Strength, Evenness
B. Bridges	Routine Check		Repair team, Technicians	Bridge deck, Beam, Bearing, Abutment, Piers
	Periodic Check	Twice a year: Before after rainy season	RRMUs/PDOTs	Erosion, scour of piers etc.
	Unscheduled Check	Unscheduled As required	VRA, RRMUs/PDOTs, RRMCs	Bridge defects and damages
	Special Check		RRMUs/PDOTs	Subgrade in soft soil or sliding curb, Strength of Pavement, Bridge
	Bridge Inspection	First-time inspection; To record initial status of structures before traffic operation.	RRMUs/PDOTs	Whole bridge
		Following- time inspection; 10 years later, then 5-7 years interval	RRMUs/PDOTs	Whole bridge

Source: "Technical Standards on Road Routine Maintenance", May 28, 2003, MOT.

Table 3.2.8 Traffic Counting

Traffic Categories	Counting stations	Frequencies	Counting time
Primary station (High traffic sections)	30 – 50 km intervals, Ferry, Floating Bridge, Toll places	Once per month 5^{th}, 6^{th}, 7^{th} of each month	1^{st} day: 5:00-21:00 2^{nd} day; 5:00-21:00 3^{rd} day; 24 hours
Secondary station (Low traffic sections)	50 – 100 km intervals		

Source: "Technical Norm on Road Routine Maintenance", May 28, 2003, MOT

a. Routine inspection:

Road patrolling is the most prevailing inspection method which is implemented based on Decision 2044 / QD-GT dated 5th September 2000 by DRVN on *promulgating regulations on organizing of road patrolling.* The road patroller conducts visual inspection, checks, detects and records daily incidents occurring to the road system in line with the road-patrolling manual. Patrol staffs also do some minor tasks such as the repair on deteriorated marker posts and removal of rocks from roadway.

b. Periodic Inspection:

The periodic inspection is implemented monthly and quarterly for road structures and twice a year for bridge structures. In the quarterly inspection, RRMBs and PDOTs staffs participate in the inspection.

c. Special Inspection:

Special inspection has never been done so often, but as required or in case of emergency, since the special inspection need special survey equipment for analytical evaluation. RTCs have been engaged in the special inspection on a contract basis. In the past, the special inspections have been carried out three times, in 2001, 2004 and 2007, to prepare for the data needed for the DRVN's HDM-4 trial.

d. Other Inspection

Moreover, some further inspections are added to the bridge structures, which comprise an initial inspection, which is done immediately before the opening of traffic upon completion of construction, followed by a follow-up periodical inspection to be done after 10 years and every 5-7 years after the 10-year inspection.

e. Implementation body

All of the regional agencies are more or less involved in the road inspection. In General, RRMCs conduct the routine inspection by patrolling. On the other hand, the periodic and the special inspection are principally carried out by RRMBs and PDOTs.

(2) Diagnosis of Road Structures

1) Pavement Evaluation

Technical Standards 2003 stipulated criteria of pavement evaluation, which is to be performed after road inspection. Evaluation is done with the criteria based on the pavement survey results of potholes, IRIs and pavement strength. The result of evaluation finally falls into four grades; Good, Fair, Bad and Very Bad. **Table 3.2.9** shows the relationship between IRI data and the grades, and **Table 3.2.9** shows explanatory information on the grades including supplemental criteria. **Table 3.2.10** shows the case of Grade A2 type pavement as an example.

Table 3.2.9 Evaluation of Pavement Conditions (1)

Type of pavement	Grade of road	Pavement conditions			
		Good	Fair	Bad	Very bad
Grade A1: Asphalt concrete Cement concrete	Expressway grade 120, 100 and 80; roadway grade 80	IRI ≤ 2	2 < IRI ≤ 4	4 < IRI ≤ 6	6 < IRI ≤ 8
	Expressway grade 60, roadway grade 80	IRI ≤ 3	3 < IRI ≤ 5	5 < IRI ≤ 7	7 < IRI ≤ 9
	Roadway grade 40 and 20	IRI ≤ 4	4 < IRI ≤ 6	6 < IRI ≤ 8	8 < IRI ≤ 10
Grade A2:	Roadway grade 40 and 20	IRI ≤ 4	4 < IRI ≤ 6	6 < IRI ≤ 8	8 < IRI ≤

Type of pavement	Grade of road	Pavement conditions			
		Good	Fair	Bad	Very bad
Asphalt concrete Asphalt dressed macadam		(*1)	(*2)	(*3)	10 (*4)
	Roadway grade 40 and 20	IRI ≤ 5	5 < IRI ≤ 7	7 < IRI ≤ 9	9 < IRI ≤ 11
Grade B1: Macadam road Asphalt dressed reinforced stone	Roadway grade 40 and 20	IRI ≤ 6	6 < IRI ≤ 9	9 < IRI ≤ 12	12 < IRI ≤ 15
Grade B2: Improved earth road Reinforced earth road	Roadway grade 40 and 20	IRI ≤ 8	8 < IRI ≤ 12	12 < IRI ≤ 16	16 < IRI ≤ 20

Source: Technical Standards on Road Routine Maintenance issued pursuant to Decision No.1527 / 2003 / QD-BGTVT, May 28, 2003

Table 3.2.10 Grade Conditions and Supplemental Criteria for Grade A2 Pavement Case

Grade	Condition	Maximum pothole, break-edge:	IRI	Strength in comparison with $R_{equired}$:
(*1) Good	Stable pavement, no concavity, width as in the original design, smooth drainage, no damage. Pavement: no crack and no settlement, original camber	0%	IRI ≤ 4	100%
(*2) Fair	Stable pavement, no erosion, width as in the original design, proper drainage. Pavement: camber maintained, no wide crack and depression but on less than 0.5% with small crack(width of crack: ≤0.3mm) occurring every 2-3m	0%	4 < IRI ≤ 6	90% - 99%
(*3) Bad	Sliding slope, concavity at the roadside, continuous cracked pavement with the crack's width of 0.3-3mm; appearing depression on the pavement of 0.6-1%	0.3%	6 < IRI ≤ 8	80% - 89%
(*4) Very Bad	Concaving sub grade, sliding slope. Pavement: badly cracked with the width of >3mm. Loose stones, missing stones on macadam pavement dressed with macadam or aggregate stone	0.5%	6 < IRI ≤ 8	<80%

Source: Technical Standards on Road Routine Maintenance issued pursuant to Decision No.1527/2003/ QD-BGTVT, May 28, 2003

2) Bridge Structure Evaluation

Unlike pavement evaluation, evaluation on the bridge structure is commonly based on bridge inspection results including a periodic, an unscheduled and a special inspection. Regional management agencies are responsible for preparing bridge reports which will be a basis of making decision on the maintenance and repair plans. However, the diagnosis of structural deterioration appears to be done based on engineer's experience and judgment. There are no standards on the diagnosis available.

3) Overall Judgment on Diagnosis

Following diagnosis on the road structures, overall judgment is performed based on some criteria. There appear to be no common criteria set out for the judgment. However, the field survey has reported that the regional agencies are prepared for more or less similar criteria, which comprise

extent of structure damage and actions to be taken. Samples of the judgment are on; whether the damage needs an urgent treatment, whether repair works should be included in the next year budget proposal, whether loading limitation should be enforced, whether traffic control or road closure should be enforced, whether reconstruction is needed, and so forth. In the overall judgment, the first priority to take actions seems to be placed on weak bridges and road safety facility, and likewise, the second priority on pavement deterioration.

(3) Selection and Prioritization of Maintenance Works

Based on the inspection survey, selection and prioritization of maintenance works is done in the next step. The selection and prioritization of the maintenance works for routine maintenance is commonly carried out in line with inspection survey reports and the Technical Standard 2003. However, as is a case of the diagnosis, there are no standards available to make the work selection and prioritization, and they have been based on engineer's experience and judgment. A current practice explains that RRMCs/PRRMCs conduct an initial screening of work selection and prioritization, formulate maintenance work plans, and then bring the plans to RRMBs/PDOTs for further investigation. Before finalizing the maintenance plans, RRMBs/PDOTs also conduct a field survey to specify work types, locations to be treated and treatment techniques including cost estimates.

If estimated quantities and costs of maintenance works are within the range of Road Maintenance Norms 2001, regional agencies implement the works with budget allocated for the routine maintenance budget. If without the range, RRMBs have to report to DRVN to allocate further budget for medium repairs, big repairs or development works. DRVN used to apply too long intervals for the periodical maintenance because of the very limited budget, but the Circular No.10 / 2010 / TT-BGTVT issued on 19, April 2010 revised the intervals.

Under the current chronic budget constraint, regional agencies cannot help but take reactive countermeasures against deterioration rather than undertake preventive measures as the 10-Year Plan recommended. The reactive measure is a post-damage repair work to be taken after damages arise on the structures. This explains that the current work selection is nothing but the prioritization of works depending upon the magnitude of damage.

The field survey also identified that there are several agencies which set out their own criteria in selecting maintenance works such as; poor pavement conditions (loss of surface material, low severity of alligator cracking, potholes), poor permeability of side drains, broken-down drain facility, slope collapse and sliding and obstruction of sight distance caused by trees. Also, any agencies placed high priorities on ensuring road traffic, riding comfort and traffic safety.

In any cases, it is important to select and prioritize maintenance works taking into consideration not only the extent of structural deterioration, but also the foreseen impacts given on traffic, society, economy, nearby residents etc. that may arise when deterioration further progresses.

3.2.5 Road Maintenance Works

(1) Target levels of Maintenance Works

Target management levels of road maintenance are set in Technical Standard 2003. The criteria have been used as indexes in making judgment on pavement conditions, but have not been strictly observed under the current budget constraint.

(2) Supervision on Maintenance Works

1) Routine maintenance

Supervision on the routine maintenance has been done directly by RRMBs without hiring consultants. RRMBs assign engineering staff to supervise and inspect the progress of routine maintenance being carried out by RRMCs. Also, RRMCs perform their responsibilities to RMUs, since the routine maintenance is generally done by dividing RRMC's management area into several sections and assigning one RMU to each section. The supervision is being done on a monthly basis, since a contract is made quarterly. Likewise, RRMBs conduct an acceptance inspection at the end of each contract. If some works remain incomplete in the contract period, payment for the works will be carried over to the next contract.

2) Repair Works

Supervision on the repair works including medium repairs and big repairs has been done following Law on Construction, Law on Tendering and other relevant regulations. Depending upon project scales, RRMBs can choose either way of work supervision, (1) to conduct supervision themselves or (2) to hire supervision consultants. Law on Construction No.16 / 2003 / QH11 dated on November 26, 2003 prescribes in the Article 87 that the construction investors must hire supervision consultants or conduct the supervision by themselves when fully satisfy the conditions on capability for construction supervision activities. The Tendering Law has also been applied to the selection of consultants prescribing the application of Open Tendering, Limited Tendering, Direct Appointment of Contractor, etc. as is the case of selecting work contractors. When Direct Appointment of Consultants is chosen, RTCs are awarded the first priority in the consultant selection process. RRMBs and PDOTs are conducting supervision and an inspection on the road repair works monthly and quarterly.

(3) Quality Management and Acceptance

1) Routine Maintenance

Work quality management including inspection on the routine maintenance works is carried out in accordance with Technical Standards 2003. There are some regional agencies, which develop their own simple standards to evaluate the road routine maintenance works. The sample criteria are stated as follows;

+ Pavement: must be smooth without potholes
+ Drainage work: in good condition

+ Traffic safety facilities: in good condition and usable
+ ROW: there is non-illegal occupation

Material test is also conducted by contractors for concrete, pavements, steel bars, etc. Contractors are commonly said to commission material tests to public laboratories rather than to private laboratories. However, the tests for the routine maintenance are likely rather simple and less strict than those for the repair works or the development works.

2) Repair Works

Work quality management and inspection on the repair works including medium repairs and big repairs is based on the existing laws, regulations, national standards and MOT technical standards. RRMBs and PDOTs conduct an inspection by comparing work records with achievements observed in the site.

3) Acceptance

Acceptance for the routine maintenance works is based on the criteria stipulated in Technical Standards 2003, and likewise, the acceptance for repair works is to be based on existing laws, regulations, national and MOT standards mainly set out for construction and development works. Performance levels for approval are shown in **Table 3.2.11**.

Table 3.2.11 Performance Levels of Acceptance

Performance level	Requirements
Good	Achieve the objectives assigned by RRMBs/PTA in the maintenance contract. Perform all the tasks properly and efficiently so that quality and good looking landscape are ensured
Fair	Achieve the objectives assigned by RRMBs/PTA in the maintenance contract. Main and important works are well performed, but there are still some minor problems that affect traffic operation.
Intermediate	Achieve the objectives assigned by RRMBs/PTA in the maintenance contract. Main and important works are done but they are not beautiful looking and their quality is not high. There are still some problems that affect traffic operation such as traffic blockage and etc.
Bad	Not yet, achieve the objectives assigned by RRMBs/PTA in the maintenance contract. Performance does not meet the requirements, quality is poor and there are many problems or traffic accidents caused by poor quality bridges and roads.

Source: Technical Standard on Road Routine Maintenance issued pursuant to Decision No. 1527/2003/ QD-BGTVT, May 28, 2003

3.2.6 Maintenance Management System

In managing the national roads, DRVN needs to have various databases whatever the formats are. **Table 3.2.12** shows operation status of computer software for road management. The field survey has clarified that DRVN, RRMBs and PDOTs have already assembled massive data pertinent to the national road management. However, most of the data have yet to be computerized, but are kept maintained as a hard copy.

Table 3.2.12 Operability and Distribution of Software Tools

Computer Software	Operability	National Roads			Provincial Roads	
		DRVN	RRMBs	PDOTs	PDOTs	PRRMCs
HDM4	Under development	X				
RoSyBASE	Under development	X	X	X		
RoSyMAP	Operational	X	X	X		
VBMS	Operational	X	X	X		
RoadNAM	Not confirmed				X	X
Stripmap	Not confirmed				X	X
Bridge CV (Hard-Copy)	Operational	X	X	X		

Source: JICA Project Team

(1) Road Inventory Data

DRVN is responsible for the storage of original road and bridge structure data including as-built records of construction. These records include bridge inspection data, bridge CVs and road registration forms. On the other hand, RRMBs/PDOTs are responsible for storing copy of the as-built records and periodic and unscheduled road maintenance records. These records include bridge survey and inspection documents, reports on treatment of encroaching on and transgressing of road reservation, bridge CVs and road registration forms. Also, RRMCs are also responsible for the storage of as-built records of periodic maintenance and unscheduled road maintenance.

Field survey of this study has reported that RRMBs and PDOTs preserve many data at their offices including road inventory data, road inspection data, repair history data, before/after comparison of repair works, road geometry data, pavement deterioration data, environmental data, traffic accident data, road defects/distress and regional condition data. Since computer-based databases for these data have yet to be operational, RRMBs and PDOTs should preserve data in the forms of hard copy. Even RoSyBASE, which was already delivered to RRMBs and PDOTs, is not operable due to difficulties in data input and system operation.

(2) HDM-4

HDM-4 has been developed by World Bank and used for over a decade to combine and economic appraisals of road projects and to analyze road network strategies. The various versions of the models have been widely used in a number of countries. The model has been used to investigate the economic viability of road projects and to optimize economic benefits to road users under different levels of expenditures. Table shows HDM trial case studies on the national roads in Vietnam. Since its first introduction to the VRA national roads in 1988, there have been six trials made up to 2006 by World Bank and Asian Development Bank. The DRVN's past trials including donor assistance are tabulated in **Table 3.2.13**. HDM-4 trials carried out from 1998 to 2006 mainly used Microsoft Excel formats for making datasets for analysis without relying on an

external database. On the other hand, in 2007 VRA made decision on the use of RoSyBASE as official database software trying to convert data from RoSyBASE database to HDM-4 dataset. This is because HDM-4 should take either way of preparing its dataset, one by directly constructing datasets into HDM-4 formats, and the other by converting and importing data from an external database and creating a dataset for HDM-4 analysis. RoSyBASE was expected to play a role as an external database for data conversion.

Table 3.2.13 Past Trials of Long-Term and Mid-Term Road Maintenance Plans

Year	Name of System	Fund / Consultant	Database Length	Remarks
1998－2000	RoSy	World Bank / Parkman & Nedeco	1,962 km	Data necessary to convert into HDM-4 is not available and data conversion is practically impossible.
1998－2000	HDM-III	ADB / Booze Allen Hamilton	1,936 km	Analyses performed on these data would never result in a realistic evaluation of the entire road network
2001	HDM-4	World Bank	7,005 km	The data was used for formulation of 10 year strategic maintenance plan prepared by Luis Barger in 2003
2003	HDM-4	World Bank / Louis Barger Group	481 km	Louis Berger could not prepare 2nd and 3rd year work program due to lack of network data to be provided by VRA
			15,565 km	10-year maintenance cost between 2004 and 2013 with 3 scenarios were estimated.
2004	HDM-4		15,395 km	LEA International has utilized VRA data for preparation of 2nd and 3rd year program under Road Network Improvement Project with financial assistance of World Bank
2004-2005	HDM-4	World Bank / LEA International	1,762 km	Second year work program with total length of 656 km was prepared. However, the result was not officially approved.
2005	RoSyBASE	ADB / SMEC International and Carl Bro Pavement	11,034 km	ISDP provided 8 full version of RoSy Systems to VRA head office and 4 RRMUs. Trial conversion of RoSy data into HDM-4 was not successful due to data inconsistency.
2006	HDM-4	WB/BCEOM	11,586 km	Preparation of 2nd and 3rd year work program was not completed due to unidentified reason.
2007	RoSyBASE	VRA(own fund) / RRMUs, PDOTs, RTC	11,032km	Data was compiled from data gathered by RRMUs and PDOTs.

Source: JICA SAPI-II Study

(3) Data Collection

DRVN conducted data collection in 2001 and 2004 in order to collect road and traffic data with much focus on the pavement deterioration. The observed data were assembled into Microsoft Excel formats. In 2007, VRA institutionalized the use of HDM-4 and RoSyBASE in the maintenance planning of the national road issuing Decision No.06 / Decision-VRA, January 4, 2007 on assigning the tasks of implementing RoSy and HDM-4 in national road maintenance and management. In this Decision, VRA assigned RRMUs and PDOTs nationwide the tasks of collecting road and traffic data in 2007 and input them into RoSyBASE. It was therefore the first data collection with RoSyBASE as a data input tool. The Decision also prescribes the VRA's assignment of analyzing mid-term and long-term road maintenance plans by means of HDM-4 analysis. The following is the outline of data collection and processing by DRVN given software and copyrights from MOT (**Table 3.2.14**).

Table 3.2.14 Outline of Data Collection

Year	Outline
1999 – 2000	Data on 1.962km (of PMU II) was collected to run a test of ROSY version 7.3.2; data on 550 bridges (PMU II) to run a test of BRIDEMAN program.
2001	Collected data under form of HDM 4 in National Roads with the total length 8000 km to run test on HDM 4.
2003	Collected data under form of HDM 4 on National Roads with the total length of 2000 km for complementing data (2001), as a base for Louis Berger Consultant to help MOT building the 10year Road Maintenance Strategy for the whole national road network. This strategy was used to develop funds and negotiate the Loaning Agreement with international sponsors for road maintenance. After analysis results, the Government approved the 10-year Strategy for road maintenance and WB provided loans for Vietnam to upgrade and maintain road network under the WB 4 project within 4 years.
2004	Data was collected in form of HDM 4 for National Roads with the total length of 11.600 km. This data was analyzed by Consultant ND Lee (Canada) to help analyze the 1st and 2nd year maintenance plan in the first 3 year-plan of the 10-year Strategy for road maintenance based on the HDM 4 program version 1.3.
2007	After SAPI 1's results, DRVN issued Decision No 06/QD-CDBVN dated 4/1/2007 on officially applying ROSY and HDM 4 programs in the national road management and maintenance. Then, DRVN continued to collect data of RoSyBASE/ HDM 4 over all the National Road with the total length of 17.112 km. That data was used to analyze the 3 years followed –up management and maintenance plan under the 10 – year – Strategy.
	JICA supported DRVN to analyze the 3 years followed –up management and maintenance plan basing on 2007's data and evaluate overall compatibility of software system under the SAPI2 framework. Results and projected plans for road maintenance - Scenario until 2017 were presented in Final report and DRVN has reported to MOT.
2010	DRVN plans to continue to collect and summarize data on roads and bridges for every 3 year.

Source: DRVN material, May 2010

(4) RoSy System

RoSyBASE is commercial software and a component of the RoSy System developed by Carl Bro Pavement Consultant. It was first introduced to VRA by ADB in 2005. The RoSy system includes RoSyBASE, RoSyPLAN, RoSyMAP, etc. RoSyBASE is a computer-based pavement management database for storing road and traffic data obtained in the VRA data collection. The data cover not only physical data, i.e. road lengths, widths etc., but also, traffic and pavement condition data, IRIs, cracks, potholes, traffic volumes, etc. Table shows RoSyBASE past trials in VRA. The first data input to RoSyBASE was carried out by RRMBs and PDOTs in 2007. JICA SAPI-II Study supported 2007 data input editing data input manuals and delivering them to the regional agencies including RRMBs, PDOTs, RRMCs, PRRMCs and RTCs in regions nationwide.

On January 2007, DRVN made decision on the use of RoSyBASE as a database tool for the national road maintenance management. However, the field survey to the regional agencies carried out in this study has reported many severe comments on this database system. Some of the comments are introduced as follows: it has been mobilized only for the purpose of data collection for HDM-4 analysis, but cannot be applied to the daily maintenance management in the regions; this makes it difficult for the regional staff to handle database with care and zeal; the regional staff

have a lot of difficulties in handling the system due to insufficient technical support from supplier and DRVN; there is only one hard key delivered to a regional office which makes it difficult to share the data input job between several staff in the office; software function of input data control does not work well and needs to be modified; data input guidelines are not user friendly; reporting functions of the system do not suit the maintenance management in the regions; there are a small number of training opportunities, so that the outcomes are far from expectation; and so forth.

RosyMAP is mapping software and can provide a way to visualize and analyze road data as geographical information. Using the new road reference system, the whole National Road network has been divided into links, which are referenced to road centerlines in the map. The tool uses the road number to link the road reference system and the map.

3.2.7 Training Courses for ROSY and HDM-4 Operation

(1) Training for ROSY Operation

ROSY operation trainings targeted to VRA staff were conducted by ISDP and SAPI in 2005 and 2006 respectively. VRA does not have its own program for training their staff on ROSY.

Table 3.2.15 History of Training for ROSY in Vietnam

TA Project	Date	Organization	Number of Participants	Contents of Training
ISDP ADB	Sept. 19-22 in 2005	VRA RRMU II RRMU IV RRMU V RRMU VII PMU1	5 2 2 2 2 1	Road Network Strategy Plan: 0.5 day ROSY ADMIN: 0.5 day ROSY PLAN: 2.0 days ROSYMAP: 0.5 day
SAPI JBIC	Nov. 27 in 2006	MOT VRA RRMU PDOT RTC RRMC PRRMC	2 8 9 61 12 19 18	ROSYBASE ROSY PLAN & HDM-4 Total 1 day

Source; SAPI-II Final Report, April 2009

(2) Training for HDM-4 Operation

HDM-4 operation training targeted to VRA staff was also conducted by ISDP in 2005. SAPI-2 team also held a technical seminar on HDM-4 for the VRA request.

Table 3.2.16 History of Training for HDM-4 in Vietnam

TA Project	Date	Organization	No. Participants	Contents of Training
ISDP ADB	Sept. 22-23 in 2005	VRA RRMU II RRMU IV RRMU V RRMU VII PMU1	5 2 2 2 2 1	HDM-4: 1.5day
SAPI-2 JICA	Feb.12 In 2009	VRA RTC RRMU II RRMU IV RRMU V RRMU VII MOT	20 8 1 2 3 3 4	HDM-4: 1.0day Trace the SAPI-2 Trial Studies

Source: SAPI-II Final Report, April 2009

3.2.8 Overseas Donor Assistance

Table 3.2.17 summarizes history of international donor assistance.

Table 3.2.17 History of Donor Assistance

Year	Outline
1999 - 2000,	DRVN received Technical Assistant (TA) - "Upgrading the capacity for RRMUs" under the WB1 project that was funded by the World Bank (pilot study for RRMU II). The investor was PMU1 and the Technology Transfer Consultant was Parkman-Nedeco (The United Kingdom). ROSYBASE and ROSPLAN software version 7.3.2 were bought by MOT from Denmark (Carl Bro Company) and bridge management software BridgeMAN (Vietnamese version 1.1) were purchased from Institute for Transportation Studies of The United Kingdom and transferred to DRVN for application.
2001	Under the project ADB 2 whose investor was PMU 1, DRVN received a program of analyzing maintenance and development plan for roads at HDM4 network level, that program was run and applied by World Road Association (PIARC) in DRVN office.
2005	DRVN received TA "ISDP Developing policies" sponsored by ADB (belonged to ADB3 project) and the investor was PMU 1. In this TA, CarlBro – SMEC Joint venture upgraded ROSY version 11.20 (its function was to transfer original database from RoSyBASE into HDM4). The Consultant agency provided training, transferring and licensed passwords for PMU II, IV, V, VII for 48 Provincial Departments of Transportation/Provincial Departments of Transport and Public Works and other PRMMCs, RMMCs. The bridge management program was also upgraded and converted into Vietnamese version named VBMS, then delivering and training for implementing agencies.
2006	VBMS continued to be upgraded and more items were completed under the framework of technological assistant part B of the project for upgrading national road network (Weak bridges project) with borrowing from JBIC.
2008	DRVN received granted TA from JIBC (SAPI – 1) for upgrading the national road network, in which SAPI - 1 Consultant completed the manuals for ROSY, HDM4, VBMS and provided additional training for 4 RRMUs and 20 Provincial Departments of Transportation/Provincial Departments of Transport and Public Works with having mandated National Road (versions of software were upgraded).
2009	DRVN received the second TA from JICA (formerly was JBIC) named SAPI – 2 for upgrading national road network, in which Consultant Agency reviewed data collection by DRVN and made comparison on analyzing level of ROSY Plan and HDM4 Plan Analyzing Program; run test and recommended using compatible programs; analyzed programs that would be used for National Road Maintenance Program in the next 3 years; drawing a development route map for roads – bridges network in the next period.

Source: DRVN (May 2010)

3.3 PROBLEM IDENTIFICATION

Table 3.3.1 shows the summary of problem identification. The following is the major findings identified in the problem identification, categorizing problems into three groups; 1) Maintenance technologies and 2) Human capacity development, and 3) Institutional issues.

3.3.1 Road Maintenance Technologies

(1) Road inspection, diagnosis on structural deterioration and maintenance work selection

The processes including road inspection, structure diagnosis and maintenance work selection are ones of the key activities in deciding the types and magnitudes of road maintenance and repair works which directly lead to up and down of the maintenance costs. However, the study on the current status has explained that professional engineer's involvement in these works is not institutionalized. Likewise, making judgment on the structure deterioration and the selection of maintenance works has not been based on engineering criteria, but based on the engineer's experience. Current Technical Standards 2003 shows the statues of inspection including inspection types, frequencies, implementation bodies etc., but does not detail information on where to inspect, on how to inspect and on how to preserve data.

(2) Planning capacity

DRVN's long-term and mid-term planning system, HDM-4 software, is not operable now because of complexity in operation, low database reliability and system troubles in the database software. As road assets need to be maintained over the long course of road maintenance and taken over to the next generation, it is necessary for a road administrator to formulate long-term or mid-term road maintenance plans and to apply planned maintenance in order to find out best economy and to stabilize maintenance budgets in the long maintenance period. Immediate actions are now needed to get the planning systems on the right truck.

(3) Maintenance budget

DRVN is now faced with chronic shortage of road maintenance budget. It is reported that a new budget source of Road Maintenance Fund will become available shortly. However, whatever the budget sources are, DRVN will be sought to make efforts to enhance its budget proposal technologies. In making the budget proposal more reliable, it is necessary to develop long-term or mid-term road maintenance plans, in particular a 3-Year plan, in order to stabilize the road maintenance budget.

Under the constraint budget condition, budget proposal has been made taking projection from the allocated budgets in the recent years, and it does not show real demand of maintenance budget. In addition, effects of the constrained budgets on the road conditions have not been fully analyzed. Asset management explains that the backlog of maintenance works is the same meaning as carrying over the debts to the next generation and should be avoided as much as possible. In order

to evaluate the effects of budget constraint, it is necessary to monitor structure deterioration quantitatively.

(4) Maintenance and repair work management

Field study has explained that a direct contract seems to be a prevailing method not only to routine maintenance but also to repair works rather than outsourcing repair works to private sectors. Although the success of outsourcing depends on contractor's availability and capacity, it will be a way to pursue more economy and engineering quality in the maintenance works, in particular in the developed urban areas. Cutting down on the maintenance work expenditures is as important as proposing more budgets.

In addition, the field survey has pointed out that Road Maintenance Norms 2001 is no longer applicable to the current maintenance works and also includes inconsistency in contents with Technical Standards 2003. Immediate actions on these issues are needed.

(5) Monitoring system and data preservation

At present, fundamental data for road maintenance are preserved by the regional agencies in the form of hard-copy. The survey has reported that preserved data include road inventory data, road and traffic condition data, maintenance work records, disaster restoration work records and so forth which are playing an important role not only in the daily maintenance management, but also in planning road maintenance plans. On the other hand, computerized data are VBMS database and RoSyBASE PMS database, although the latter is still inoperable. Also, some of the pavement condition data, i.e. IRIs, measured by RTCs and traffic count data by RRMBs are preserved in Microsoft Excel formats. In order to enhance information exchange between central and regions, further step-by-step systematization is needed, in particular for the fundamental road inventory data and road maintenance data.

3.3.2 Human Capacity Development

(1) DRVN capacity development programs

Although there have been many training courses conducted by donor countries since the year 2000 in conjunction with database and planning system development. However, technology transfer has not been accomplished well enough to raise the planning capacity of DRVN staffs and to provide technical support to the regional agencies, RRMBs and PDOTs. DRVN is requested to be capable enough to support regional maintenance activities.

(2) RRMBs/PDOTs capacity development programs

The field survey has clarified that regional agencies are given a few opportunities to undertake training courses and have strong demands for training courses. Their interests on the training courses include those on the road inspection technology, data registration, database operation and planning of annual budgets. Also, they show demands for DRVN's technical support, in particular,

to the advanced database and planning systems like VBMS and RoSyBASE. As these database systems generally require high knowledge and expertise in operation, regular technical supports from either DRVN or the supplier is indispensable.

3.3.3 Institutional Issues

(1) Road maintenance strategy

Survey on the current status of the National Road has reported fairly wide status in road usage; 50% of the road sections have small vehicle traffic volumes of less than 1,000 vehicles per day, and 5% more than 10,000 vehicles per day. Under these circumstances, it is necessary for road operator to define a road maintenance strategy and to gain consensus on that between stakeholders in order to maximize benefits of road maintenance investment. Prioritization of road maintenance investment over the National Road network will be a key element of this strategy. However, the strategy is unlikely to be available now.

(2) Responsibility assignment

Major responsibilities regarding road maintenance assigned to the regional agencies include the following; (1) maintenance planning, (2) budget proposal, (3) survey and diagnosis on road facility deterioration, (4) tendering, (5) maintenance/repair work supervision, and (6) data preservation including database management. However, some of the responsibilities, such as planning road maintenance plans, survey and diagnosis of road facility which may need higher knowledge and expertise in operation, should be integrated to some specially trained organization, as enhancing human capacity for all responsibilities for all regional agencies will be fairly hard tasks, thereby requiring prioritization of human capacity development. Also, review of the responsibility assignments needs to be performed in accordance with changes in road maintenance strategy as stated in "1) Road maintenance strategy". In addition, as the field survey has pointed out the lack of DRVN's technical support to the regional agencies, it is necessary to enhance central DRVN's governance in road maintenance and management over regional agencies.

(3) Inter-agency coordination

The assessment has pointed out insufficient inter-agency coordination between planning, construction and maintenance bodies of the national road development. Field survey has identified that timber loaded tracks are rapidly degrading pavement strength and accelerating deterioration and likewise many cut-slope breakdown and landslides reportedly occurred in the mountainous regions due to torrential rains. In principle, road maintenance cannot always take best measures to cope with these problems due to limited road maintenance budget, so that proper measures should be taken in the planning or in the construction stage before going into the maintenance stage. Road administrator is anytime required to select best economy in selecting measures looking over planning, construction and maintenance.

(4) Technology development

DRVN institutional capacity of developing new technologies including software tools and database systems is not sufficient enough. Also, collaboration in technology development with universities and external research institutes has yet to be adopted so often. In many cases, new technologies specially developed for road maintenance and management may need further development, regular system maintenance, upgrading, customization and technical support, unlike the market software such as Microsoft Word and Excel. There are only a few systems directly put into practical use in the fields without customizing or further developing the systems.

(5) Information Management

To enhance administration functions over all maintenance agencies in the regions, information exchange will be the key factor to the better administration. However, systematization including information management systems and electronic databases has not been sufficiently developed.

Table 3.3.1 Summary of Problem Identification

Categories		Problems Identified
(1) Maintenance technologies	Road inspection, diagnosis on structure deterioration and maintenance work selection	• Inspection points and methods are not instructed in detail. • Specifications prescribing inspections are not well prepared.
		• Professional engineers have not been involved in road inspections except for mechanized inspections. • Professional engineer participation is not institutionalized.
		• Quantifiable measurements using equipment have been rarely conducted • Special inspection has been hardly implemented.
		• Diagnosis on structure deterioration is done based on engineers experience • Professional engineer participation is not institutionalized in diagnosis and work selection • Diagnosis of deterioration is not benchmarked.
	Planning capacity	• Planning software is not operational (HDM-4) • Much complexity in data preparation and system operation (HDM-4).
		• Low database reliability (RoSyBASE) • Insufficient data input guidelines • Immature software in data input control and in data conversion to HDM-4. • Lack of training opportunities.
		• RRMBs/PDOTs are not involved in long/mid-term planning, but annual plan planning. • Lack of technical support. • Lack of training opportunities (HDM-4, RoSyBASE).
	Maintenance budget	• DRVN is faced with chronic shortage of maintenance budget distribution, which meets 40% of proposed budget. • Budget proposal for the periodic maintenance is based on the projection from past years' budgets • Effects of budget constraint on road conditions have not been properly evaluated.
		• Budget computation formula does not represent essential components of road routine maintenance • Regional features of road and traffic are not properly taken into account.
	Maintenance work management	• Insufficient outsourcing criteria for maintenance and repair works • Outsourcing has been rarely applied to medium or to big repair works.

Categories		Problems Identified
	Technical Standards and Norms	• Road Maintenance Norms 2001 is outdated and hard to apply to the current maintenance works. • Pay items shown in Road Maintenance Norms 2001 are not enough. • Road Maintenance Norms 2001 is not consistent in contents with Technical Standards 2003.
		• Management levels stipulated in Technical Standards 2003 do not represent reality of road maintenance. • Construction standards have been applied to medium/big repair works, and those specialized for the repair works in the traffic service roads are not available.
		• Traffic control measures have not been properly taken at work maintenance zones.
	Monitoring system and data preservation	• Management systems for daily maintenance, e.g. pavement management diagram, have not been well prepared for the maintenance task forces.
		• Data have been preserved in hard-copy. • Computerization of database is in delay.
(2) Human Capacity Development	DRVN capacity development programs	• Lack of programs aiming to enhance planning capacity for DRVN staffs • Insufficient supplier's technical support for database management and computer software operation.
	RRMUs/PDOTs capacity development programs	• Lack of programs aiming to enhance maintenance management capacity for RRMBs and PDOTs staffs. • Insufficient technical support for database management and computer software operation.
(3) Institutional issues	Responsibility assignments	• Weak central governance over regional agencies • Insufficient technical supports to the regional agencies. • Despite big difference in road usage, there is no framework of preferential investment. • Advances in maintenance require high knowledge and expertise in operation, but all regional agencies are assigned the same responsibilities for planning, inspection and diagnosis
	Inter-agency coordination	• Maintenance Information cannot be fed back to planning or construction • Organization structures are functionally separated each other between planning, construction and maintenance • Inter-agency coordination between planning, construction and maintenance does not function well.
	Technology development	• Institutions including staff assignment are not prepared enough to develop and evaluate advanced road maintenance technologies. • Professional experience and expertise in developing technologies has not accumulated well. • Cooperation with R&D institutes in developing advanced technologies is not well established.
	Intra-agency Information exchange	• Systematization including information management systems and electronic database has not been fully developed.

Source: JICA Project Team

CHAPTER 4 FRAMEWORK OF IMPROVEMENT

4.1 ACTIVITY 1: ENHANCEMENT OF ROAD INFORMATION MANAGEMENT

4.1.1 Concept for Improvement

The Activity 1 aims to develop original road database system in Vietnam. The system should be simple and easy to input unlike neither RoSyBASE nor HDM-4. The system is developed in Microsoft Excel base with off-line system, and will be studied for web-base with on-line system in the future.

4.1.2 Methodology

- Develop road database systems and confirm requirements for the systems, taking synchronization with existing or under-planned road information systems into account.
- Develop data input format for; (1) road assets (road inventories), (2) pavement conditions, (3) pavement maintenance data, and (4) traffic volume data.
- Develop data input software.

4.1.3 Outputs

- Recommendation on the road maintenance database structure and system requirements
- Database operation software and operation manual

4.2 ACTIVITY 2: ENHANCEMENT OF PLANNING CAPACITY FOR ROAD MAINTENANCE

4.2.1 Concept for Improvement

The Activity 2 aims (1) to supervise pavement condition survey for national roads in the pilot area, RRMU II jurisdiction, and (2) to prepare for PMS data set format with data conversion system from database for annual and mid-term road maintenance plans.

4.2.2 Methodology

- Conduct road pavement condition surveys.
- Develop PMS datasets and a planning software to formulate mid-term maintenance plans for road pavement, taking the issues related to annual maintenance planning into account.
- Conduct planning of annual and mid-term road maintenance plans for the target region as a case study.

4.2.3 Outputs

- Summary reports of the road pavement condition survey and recommendations or guidelines for next survey.

- Planning software for annual and mid-term road pavement maintenance plans and software operation manual.

4.3 ACTIVITY 3: IMPROVEMENT OF ROAD MAINTENANCE TECHNOLOGY

4.3.1 Concept for Improvement

The Activity 3 aims (1) to improve technologies on road inspection, diagnosis and repair work selection (Activity 3-1), (2) to improve road routine maintenance technologies (Activity 3-2), and (3) to develop road pavement monitoring system (PMoS) (Activity 3-3). JICA experts are assigned to each of these activities. In addition, the Project introduces information on road inspection and maintenance technologies in Japan as foreign practices in the WG.

4.3.2 Methodology

- Activity 3-1; Develop Guidelines for Road Facility Inspection which can provide information on the know-how of road facility inspection, diagnosis of defects and deterioration and repair work selection.
- Activity 3-2; Develop Road Routine Maintenance Manual which can supplement technical to the existing technical standards.
- Activity 3-3; Develop road pavement monitoring system making use of road and traffic database.

4.3.3 Outputs

- Activity 3-1; Guideline for Road Facility Inspection
- Activity 3-2; Road Routine Maintenance Manual
- Activity 3-3; Road pavement monitoring system (PMoS) with software operation manual.

4.4 ACTIVITY 4: STRENGTHENING OF ROAD MAINTENANCE INSTITUTION

4.4.1 Concept for Improvement

The Activity 4 aims (1) to improve road maintenance procedures, and (2) to strengthen DRVN road maintenance institutions.

4.4.2 Methodology

(1) Improve road maintenance procedures

- Evaluate current maintenance procedures and identify points of improvement
- Recommend improvement plans

(2) Strengthen DRVN road maintenance institutions

- Evaluate current status of maintenance institutions and identify points of improvement
- Recommend capacity enhancement plans;
  - Enhancement of planning capacity

  - Enhancement of R&D capacity
- Review responsibility assignment between DRVN and RRMBs.
- Review responsibility assignment between DRVN and PDOTs.

4.4.3 Outputs

- Recommendations on the improvement of maintenance procedures
- Recommendations on the institutional capacity enhancement for road maintenance organizations.

4.5 ACTIVITY 5: REINFORCEMENT OF HUMAN CAPACITY DEVELOPMENT

4.5.1 Concept for Improvement

The Activity 5 aims (1) to manage trainings in Japan and in Vietnam for road management in the project, (2) to formulate training programs with raising instructors in Vietnam for technical transfer of road maintenance.

4.5.2 Methodology

- Conduct a baseline survey
- Formulate training programs to disseminate project outputs
- Conduct training courses on the following topics and raise training instructors;
  - Management of road information system
  - Planning of mid-term road maintenance plans
  - Road maintenance technologies

4.5.3 Outputs

- Framework of human capacity development
- Training programs and materials
- Training courses

CHAPTER 5 ENHANCEMENT OF ROAD INFORMATION MANAGEMENT

5.1 RATIONALE OF ROAD DATABASE

Database is a heart of any management system. As for road asset management and road & traffic operation management system its necessity is more indispensable than for the other management systems because, in general, road network expands in a large extent regardless of variation in geography, topography, hydrology, environment, etc., and deterioration speed of road asset depends on such natural and environmental conditions greatly. Also, in managing road asset and road & traffic operation, a large number of organizations are involved and thus using a common and consistent data is necessary for efficient and smooth management. Therefore, road database is a very important for road administrator for various purposes including road asset management, decision making for policy formulation, and operation & management of road & traffic.

The road database system under the scope of this Project is focused mainly on data related to road assets, pavement condition, pavement repair history, and traffic volume of the Vietnamese national roads under jurisdiction of RRMB I which accounts a total of approximately 2,360km of road. Since DRVN is intending to develop an unified road database system incorporating data related to road assets, general road management, vehicle and driver license management, road construction and maintenance (project management), etc., JICA Project Team had proposed the name of the database to be developed under this Project as "Road Asset Database". However, DRVN requested to use "Road Database" as the name of the database to avoid any misleading about road asset database. Therefore, "Road Database" is used as the name of the database system which has been developed under this project. However, inside the main "Road Database" folder database has been developed broadly into "Road Asset Database" and "General Road Management Database". The road database developed under this project will be a component of the unified database system to be developed by DRVN in the future.

It is anticipated that this road database system can provide data for several purposes including Pavement Management System, Pavement Management Monitoring System, management of other road assets and road & traffic management and calculation of asset values of the road asset which will be computed in the near future. The scopes of road asset data (i.e. road inventory data)are asset inventory (location, detailed features of the asset facility), data elements needed for computing asset value and outline of the latest asset repair. Data to be acquired through routine/periodic/unscheduled inspection work are not included. As for pavement, pavement structure data are included under road asset data, however, pavement condition and pavement repair history data are dealt separately and not included in road asset data. The details of the database structure are explained in succeeding sub-chapters.

5.2 DRVN'S PRACTICES IN ROAD DATABASE

5.2.1 Past Practices

DRVN has been using RosyPLAN and HDM-4 as planning software since 1998 and 2000 respectively and required datasets have also been collected and managed accordingly. Therefore, in principle, DRVN has more than a decade of experience in data collection and management. However, in most of the time, data has been collected and managed to fulfill the requirement of planning software only rather than the concept of road asset management in a broader context. It is also reported that data were not sufficient in each data collection. Therefore, effectiveness of planning software was limited in the past.

DRVN conducted data collection in 2001 and 2004 with assistance of donors in order to collect road and traffic data with much focus on the pavement deterioration. The collected data were compiled in MS-Excel formats. Data collection and management were performed by the consultants with financial assistance from donors. After introducing RosyBASE in VRA in 2007, VRA assigned RRMUs and PDOTs nationwide for the tasks of collecting road and traffic data and inputting them into RosyBASE to utilize data for HDM-4 and RosyPLAN. It was the first data collection with RosyBASE as a data input tool by VRA's own fund. However, there are severe comments from DRVN itself on this database such as low reliability of data and cannot be used for planning purpose as a time series data. It is also reported in Special Assistance for Project Implementation – II (hereinafter referred to as "SAPI-II") final report that there are data duplications, data missing, blank data, mistakes in number and text data, etc. Under this project also, validation check has been conducted for pavement condition and road inventory data for reconfirmation, and found the similar problems as reported in SAPI-II final report. RosyBASE was the first road database system intended to apply in DRVN, however, because of the above mentioned reasons it could not be operational. Therefore, DRVN had no operational road database system in the past.

5.2.2 Responsibility Sharing between Central and Regional Agencies

Responsibility sharing between central and regional organizations for management of national roads under the jurisdiction of RRMUs is summarized in **Table 5.2.1**.

Table 5.2.1 Responsibility Sharing between Central and Regional Agencies

Responsibilities	DRVN	RRMUs RRMB	RRMCs / RRMU FO**	RTCs	Remarks
Data Preservation (Hard-copy)					
As-built Data	Original	Copy			
Road Inventory Data		Main Task	Support		
Bridge CV		Main Task	Support		
Maintenance Work Records		Main Task	Support		
Disaster Restoration Records		Main Task	Support		

Responsibilities	DRVN	RRMUs RRMB	RRMCs / RRMU FO**	RTCs	Remarks
Database Software Management					
RosyBASE	System	Main Task	Support	Support	Not operable at present
VBMS	System	Main Task	Support		

Source: Vietnam Transport Sector Study, 2010

*** Due to organizational restructuring of RRMU, RRMCs are no longer under RRMUs. RRMCs are moved to CIENCOS under MOT. In replacement of RRMC, RRMU Field Offices (RRMU FO) were established to perform same functions as performed by RRMCs while they were under RRMU.However, RRMU and RRMU FOs have also been replaced by Regional Road Management Bureau and Regional Road Management Sub-BureausbyDecision No.60 /2013/QD-TTg dated October 21, 2013.*

5.2.3 National Roads under Jurisdiction of RRMU II

Summary of national roads under jurisdiction of RRMU II is presented in **Table 5.2.2**. Since there are some changes in road alignment in some sections of national roads after the kilometer posts were installed, road length calculated based on kilometer post and actual length in the field is different. The alteration in road length might be because of construction of new bypass roads, improvement in road alignment (horizontal and vertical) and realignment of certain section of roads. At present, the total length of national roads under jurisdictions of RRMU II is approximately 2,360 km.

Table 5.2.2 National Roads under Jurisdiction of RRMU II (as of June 2012)

Route Name	Kilometer Post (km)		Road Length as per KM Post (km)	Actual Road Length (km)		
	From	To		Down-bound	Up-bound	Average
National Road No. 1	0.00	285.40	285.40	275.83	276.92	276.37
Southern Ring Road No.3to Cau Dau	0.00	2.70	2.70	13.98	13.99	13.99
National Road No. 2	30.60	312.50	281.90	275.02	274.15	274.58
National Road No. 3	33.30	344.40	311.10	298.45	298.39	298.42
National Road No. 4E	0.00	44.20	44.20	43.51	43.50	43.51
National Road No. 5	11.10	92.50	81.40	81.71	81.72	81.71
National Road No. 6	38.00	383.30	345.30	345.72	345.38	345.55
National Road No. 6-1 (The old bypass road)	70.80	78.30	7.50	7.94	7.93	7.93
National Road No. 6-2 (The old bypass road)	323.80	328.00	4.20	4.11	4.11	4.11
National Road No.6-3 (The old bypass road)	384.7	398.50	13.80	13.74	13.85	13.79
National Road No. 10	0.00	173.30	173.30	171.16	171.20	171.18
Connecting National Road No. 1with Ninh Phuc Port	0.00	6.41	6.41	6.42	6.41	6.41
National Road No. 15	0.00	20.00	20.00	20.05	19.99	20.02
National Road No. 18	0.00	46.30	46.30	46.00	45.95	45.97
National Road No. 37	61.00	98.20	37.20	34.80	34.78	34.79
National Road No. 38	0.00	84.50	84.50	86.85	86.80	86.82

Route Name	Kilometer Post (km)		Road Length as per KM Post (km)	Actual Road Length (km)		
	From	To		Down-bound	Up-bound	Average
National Road No. 43	26.00	79.70	53.70	53.34	53.40	53.37
National Road No. 70	0.00	198.10	198.10	198.84	198.19	198.51
National Road No. 279	0.00	116.00	116.00	110.93	110.74	110.83
Route Noi Bai – BacNinh	0.00	31.10	31.10	32.85	32.79	32.82
Ho Chi Minh Route	409.00	503.00	94.00	94.55	94.49	94.52
National Route No. 38B	0.00	120.00	120.00	144.91	144.84	144.87
Total	**-**	**-**	**2,358.11**	**2,360.64**	**2,359.45**	**2,360.05**

Source: JICA Pavement Condition Survey, 2012

5.2.4 Current Status of Data

In the current status survey, questionnaire survey was conducted by asking various questions to all concerned agencies to grasp the current status of road information management system in DRVN and requested to provide all related available data to the JICA Project Team. **Table 5.2.3** shows the road database related data provided by DRVN and RRMU II together with the answers on questionnaires.

Table 5.2.3 Data Provided by DRVN and RRMU II (Road Database related)

SN	Name of Data	Year	Data Type	Source	Remarks
1	HDM-4 Data	2004	MS-Excel	RRMU II	
2	HDM-4 Data	2007	MS-Access	DRVN &RRMU II	Provided same RosyBASE data
3	RosyBASE Data	2007	MS-access	DRVN	
4	Traffic Counting Data	2004, 2005, 2006,	Hard-Copy	RRMU II	
5	Traffic Counting Data	2007 ~ 2010 and 3 quarters of 2011	MS-Excel	DRVN & RRMU II	2004, 2007 & 2010 from DRVN
6	Bridge Classification Data	2010	MS-Excel	RRMU II	
7	Bridge Condition Data	2010	MS-Excel	RRMU II	
8	Condition of Road Facility (Lighting, Guard Rail & Median Strip)	2006, 2010	MS-Excel	RRMU II	
9	Road Condition of National Roads	2010	MS-Excel	RRMU II	
10	Road Sections Surveyed in 2007 Pavement Condition Survey	2007	MS-Excel	RRMU II	
11	Proposal for Development of Road Database			DRVN	Infrastructure and Traffic Safety Dept.

(1) Road Asset (Road Inventory) Data

Some basic road inventory data (road length, road width, pavement type, etc.) have been inputted in RosyBASE and data are available in RosyBASE at present. However, RosyBASE has not been updated after 2007 though there are some changes in road alignments and road

cross-sections. Most of the road inventory data still have been kept as a hard copy in RRMUs[1]. As for RRMU II also, most of the road inventory data has still been kept as a hard copy.

Very few road asset data, namely pavement, bridge, lighting facility, guardrail / fence and median strip data are available in RRMU II as a soft copy. However, information on these road asset data are very limited. RRMU II informed that most of the road asset data are preserved as a hardcopy. **Table 5.2.4** shows the details of information on road assets that has been preserved in a soft copy format in RRMU II.

Table 5.2.4 Available Soft Copy Road Facility Data under RRMU II Jurisdiction

Name of Road Asset	Details of Information
Road Lighting	Location Referencing (From –To), Pole Type (Steel or Concrete), Number of Pole, Load Capacity
Guardrail / Fence	Location Referencing (From - To), Type (Iron, Steel,..), Surface Condition (Painting, etc.)
Median Strip Separation	Location Referencing (From – To), Facility Type (Rigid, Flexible, Grass, Plant, Steel Fence)

(2) Pavement Condition Data

Pavement condition data of 2004 and 2007 which were specifically prepared for HDM-4 dataset are available in RRMU II. HDM-4 2004 data are available in MS-Excel format whereas 2007 data are available in MS-Access format. As stated in **Section 5.2** above also, reliability of these data are low and there are some issues such as data duplication, data missing, section overlap, blank data and mistakes in data format(i.e. number and text). Since it has been decided not to use RosyBASE data in PMS operation RosyBase data were not processed further for storing these data in road database. The latest maintenance history data required for PMS have been inputted by RRMU II and it is confirmed that the inputted data satisfies the requirement of PMS as one set of time series data which is required for pavement deterioration evaluation. Though RosyBASE data will not be used in the newly developed PMS, DRVN can decide how these data will be stored and utilized in the future.

(3) Pavement Maintenance History Data

There are pavement maintenance history data in 2004 HDM-4 dataset. However, there is no pavement maintenance history after 2004 neither in RosyBASE 2007 data nor in any soft data format. Pavement maintenance history data including before/after comparison of repair works are preserved as a hard copy data in RRMU II[2].As explained above the latest pavement maintenance history data required for running PMS in 2014has inputted by RRMU II. Therefore, maintenance history data of 2004 HDM-4 will not utilize in newly developed PMS.

[1]Source: Vietnam Transport Sector Study, Progress Report, 2010.
[2]Source: Vietnam Transport Sector Study, Progress Report, 2010

(4) Traffic Volume Data

1) Data Availability

Traffic volume data are used for making annual repair, maintenance as well as construction strategy planning. Traffic volume data are available from the year of 2004. Traffic data of 2004, 2005 and 2006 have preserved in a hard copy format. Since 2007 traffic volume data has been preserved in MS-Excel format. However, soft copy data are available in the form of monthly, quarterly and yearly average and these average data have been computed without considering of duration of traffic counting (i.e. 16hr and 24hr). Therefore, daily traffic records are necessary for the projection of traffic volume in the form of monthly, quarterly and yearly average by taking account of traffic counting duration. However, only some RRMCs have preserved daily records of traffic volume in a hard copy format.

2) Regulations

DRVN has regulation on traffic counting which stipulates vehicle classification system, arrangement of traffic counting stations and traffic counting time. According to regulation, vehicles are classified into 11 categories based on number of axles. However, only 10 types of vehicles have been recorded during traffic counting because light trucks (2 axles, 4 wheels and 2 axles, 6 wheels) are being recorded as a single vehicle type though the regulation categorized them into two different categories. Traffic counting station categories, counting stations interval, counting frequencies and counting time are summarized in **Table 5.2.5**.

Table 5.2.5 Traffic Volume Counting[3]

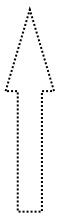
Traffic Counting Station	Counting Stations	Frequencies	Counting Time
Primary Station (High Traffic Sections)	30-50 km intervals, Ferry, pontoon bridge, toll stations	Once per month 5th, 6th and 7th of each month	1st day: 5:00~21:00 (16hr) 2nd day: 5:00~21:00 (16hr) 3rd day: 0:00 ~24:00 (24hr)
Secondary Station (Low Traffic Sections)	50-100 km intervals		

Traffic volume is counted on 5th, 6th and 7th day of each month in a robust manner (i.e. irrespective of weekdays or weekends). Therefore, it is possibility to fall all three days on the weekdays in some months or two days fall on the weekends and only one day on the weekdays. Also, there is no provision of converting 16hr traffic volume into 24hr traffic volume. Traffic volume of three consecutive days is simply added (i.e. without converting 16hr traffic into 24hr traffic) and average monthly, quarterly and yearly volumes are calculated.

Current practice of traffic data collection and reporting mechanism is shown in **Table 5.2.6**.

[3]Source: "Technical Standard on Road Routine Maintenance", 2003, MOT

Table 5.2.6 Traffic Volume Data Summarizing and Reporting Mechanism

Flow	Organization	Responsibility	Date of Reporting
	DRVN	Central collection of data from the entire stations located across the country	
	RRMU II	Analysis, summarizing and reporting in every 6 months to DRVN	20-30th of July and January
	Read Repair and Management Unit (RRMC/ SB)	Summarizing and reporting data to RRMU / RRMB	15th of every month
	Traffic Counting Station (RRMC/ SB)	Reporting Traffic Data	10th of every month
		Traffic Counting	5th, 6th & 7th of every month

3) Traffic Counting Stations

As illustrated in **Table 5.2.5** Technical Standard on Road Maintenance 2003 stipulates primary and secondary traffic counting stations considering the volume of traffic in the road sections. Primary stations are fixed and traffic volumes counted at primary stations are used to study characteristics on traffic volume, traffic type and loading of vehicle in a route or a particular section. Secondary stations are floating and traffic volumes counted at primary stations are used to determine local volume in a short route, narrow area or road with low traffic volume to serve for road repair and design upgrading. A total of 43 traffic counting stations exist in national roads under RRMU II jurisdiction. Traffic counting stations (as of 3rd quarter, 2011), irrespective of counting station type (i.e. primary station or secondary station), are shown in **Table 5.2.7**.

Table 5.2.7 Traffic Counting Stations under RRMU II Jurisdiction (as of 3rd Quarter, 2011)

Road Name	Station No.	Name of Station	Ch. of Station	Responsible Organization
NH 1	1	Thanh Tri Bridge	164+646	RRMC 248
	2	Khe Hoi Bridge	192+880	RRMC 236
	3	Doan Vy Bridge	251+000	RRMC 236
	4	Yen Bridge	270+000	RRMC 236
NH 2	1		51+800	RRMC 238
	2		108+000	RRMC 238
	3		145+000	RRMC 232
	4		219+000	RRMC 232
	5		270+000	RRMC 232
NH 3	1		91+850	RRMC 238
	2		144+000	RRMC 244
	3		213+000	RRMC 244
	4		283+000	RRMC 244
NH 3(B)	1		1+000	RRMC 244
	2		106+000	RRMC 244
NH 4 (E)	1		27+000	RRMC 242
NH 5	1		12+300	RRMC 240
	2		58+800	RRMC 240
NH 6	1	Ky Son	63+969	RRMC 222
	2	Tan Lac	91+500	RRMC 222
	3		162+300	RRMC 224

Road Name	Station No.	Name of Station	Ch. of Station	Responsible Organization
	4		213+750	RRMC 224
	5		272+360	RRMC 224
	6	Thuan Chau	350+000	RRMC 226
	7	Tuan Giao	405+750	RRMC 226
NH 10	1		19+780	RRMC 234
	2		74+800	RRMC 234
	3		114+800	RRMC 234
	4		157+000	RRMC 234
NH 15	1	RMU Mai Chau	4+250	RRMC 222
NH 18	1	Pha Lai Bridge	26+000	RRMC 248
	2		20+000	RRMC 248
NH 37	1		78+300	RRMC 240
	2		88+300	RRMC 240
NH 38	1	Ho Bridge	13+500	RRMC 248
	2	RMU 2	78+300	RRMC 248
NH 43	1		42+350	RRMC 224
NH 70	1		3+000	RRMC 232
	2		46+000	RRMC 242
	3		125+000	RRMC 242
NH 279	1		38+000	RRMC 226
HCM	1	Chuong My	422+300	RRMC 222
	2	Yen Thuy	493+300	RRMC 222
Total Stations: 43				

5.2.5 Identified Issues on Current Status of Database

(1) Any database system shall be users friendly and supplemented by user's manual, details of system configuration and algorithms so that any unexpected technical troubles / errors to be occurred in the system can be fixed by referring such documents. However, the database systems which have been practiced in DRVN have been either poorly documented or not provided a complete set by the system developer. Furthermore, there are lack of training opportunities to the DRVN and regional agency staff. As a result, after completion of the projects funded by donors, nobody can handle any system troubles or errors in the database. There are series of documents related to RosyBASE but unfortunately, they are either not sufficient for fixing the system or there are no capable staff who can handle the system in DRVN because RosyBASE is not operational at present.

(2) DRVN (then VRA) issued the decision No. 06/Decision-VRA and made decision on January 04, 2007 on the use of HDM-4 as a planning tool and RosyBASE as a database tool for the national road maintenance management, and RRMUs and PDOTs were mobilized for data collection accordingly. However, because of lack of some fundamental functions of database system such as data input control and validation check, various types of unexpected errors had been occurred and data inputted in the database became not only unreliable but also not compatible with the data format of planning software (i.e. HDM-4). As a result, planning software could not be run successfully.

(3) Though VRA has officially decided to use RosyBASE as database and realized the system problem of RosyBASE, DRVN has not been paid much attention in fixing the problem. With inoperative existing database system of RosyBASE, alternative database system is indispensable for DRVN.

(4) DRVN has been administrating more than 17,000 kilometers of road networks across the country. By considering the importance of timely database management, number of human resources and specialized knowledge required for this task, a group of professionals who are familiar with database system is urgently needed for DRVN to manage and keep database system (or road information system) up-to-date.

(5) Many of the data relevant to the national road maintenance and management have yet to be computerized, but these data have been preserved in the hard copy format. Among the data which have been computerized are only related to pavement management system which are needed for planning software for formulating long-term and mid-term road maintenance plans. Also, little attention has been paid to computerizing the fundamental data including road inventory (road asset), maintenance work history, and disaster restoration work records. These data play an important role in road infrastructure asset management from the broad concept of asset management.

(6) As per the current practice of national road maintenance, big repair works including new constructions have been administered by PMUs and medium, routine and unscheduled maintenance works have been administered by RRMUs. Therefore, original design documents (hardcopy) which are necessary for updating database have been preserved in different locations (i.e. in PMU and RRMU and in some cases in then RRMC). In principle, DRVN itself does not input data in database but collect from regional administration agencies (i.e. RRMUs, PDOTs). Therefore, when RRMU is requested to input data in database, RRMUs should collect original hard copy data from DRVN/PMU by following formal procedure to get the hard copy data and it takes relatively longer time.

(7) In the prevailing regulation of DRVN, there are no specific provisions for inputting/updating existing data in the database when there will be some repair works or new construction works in the road network. Lacking of these types of provisions in the regulation is also one of the reasons that large volume of data have been kept as a hardcopy yet. Therefore, updating of some basic road inventory data have not been done after 2007 though there are changes in road alignment, existence of new bypasses, improvement / upgrading of road sections etc. in number of locations.

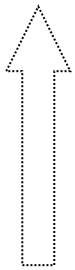
5.3 OVERSEAS PRACTICES (PRACTICES IN JAPAN)

1) Responsible Organization

In Japan, Ministry of Land, Infrastructure, Transport and Tourism (hereinafter referred to as "MLIT") is the responsible ministry for operation and management of national roads. The total length of national roads is 54,981km (as of 2011) which accounts 4.5% of total road networks of Japan. Construction, operation and management of expressways are undertaken by Nippon Expressway Company Limited (hereinafter referred to as "NEXCO"). MLIT has Expressway Division under Road Bureau (hereinafter referred to as "RB") to look after expressways in the entire nation. Under RB, there are eight (8) Regional Development Bureaus (hereinafter referred to as "RDB"), namely Tohoku, Kanto, Hokuriku, Chubu, Kinki, Chugoku, Shikoku and Kyushu Regional Road Bureaus. In addition to these eight (8) RDBs, there are two Special Regional Development Bureaus, namely Hokkaido Regional Development Bureau and Okinawa General Bureau, which under take construction, operation and management of national roads also. There are numbers of Work Offices (hereinafter referred to as "WO") and Branch Offices (hereinafter referred to as "BO") under each RDB.

As for road database, Road Construction / Maintenance Company (hereinafter referred to as "RCMC"), WO, RDB and National Institute for Land and Infrastructure Management (hereinafter referred to as "NILIM") are involved in data inputting database operation and database management. The role of various organizations and flow of data for road database management are shown in **Table 5.3.1** and **Figure 5.3.1**.

Table 5.3.1 Role of Organizations for Road Database Management

Name of Organization	Data Flow	Responsibility
National Institute for Land and Infrastructure Management (NILIM)		▪ Development of Data Input Format and System ▪ Operation and Management of Database System
Road Bureau (RB)		▪ Data check and verification ▪ Data Storage ▪ Data forwarding to NILIM
Regional Development Bureau (RDB), Work Office (WO) and Branch Office (BO)		▪ General data check and verification at local level ▪ Data forwarding to Road Bureau ▪ Providing existing database in case of data updating to RCMC
Road Construction / Maintenance Company (RCMC)		▪ Data Input ▪ Detailed Data Check

2) Data Flow

According to Road Act (Article 28), road administrators shall prepare road inventory and keep them updated always. Also, provision of updating of road inventory database is included in contract package for both new construction and improvement of existing road structures and facilities. Therefore, it is RCMC's obligation to input data and submit them to concerned WO. A detailed data flow is shown in **Figure 5.3.1**. As illustrated in **Figure 5.3.1**, for new road construction project, RCMC downloads data input sheet from MLIT homepage and input the data in the prescribed data input format. Similarly, for road maintenance project, RCMC receive

data from WO and updates the existing data. It is RCMC's responsibility to check the inputted data in detailed. After inputting and detailed check of data, data shall be submitted to WO. WO checks the data provided by RCMC and either forward to RDB or send back to RCMC based on result of data check. When all data are thoroughly checked and verified, data are sent to RB for data storage in the road database system. NILIM provides support in data input format design, system development and inputted data check. Data input, data check and data transition is shown schematically in **Figure 5.3.2**. As illustrated in **Figure 5.3.2**, data have been inputted and preserved in three media, namely road structure / facility data (inventory data) in .csv file format, drawings and photographs of the road structure / facility.

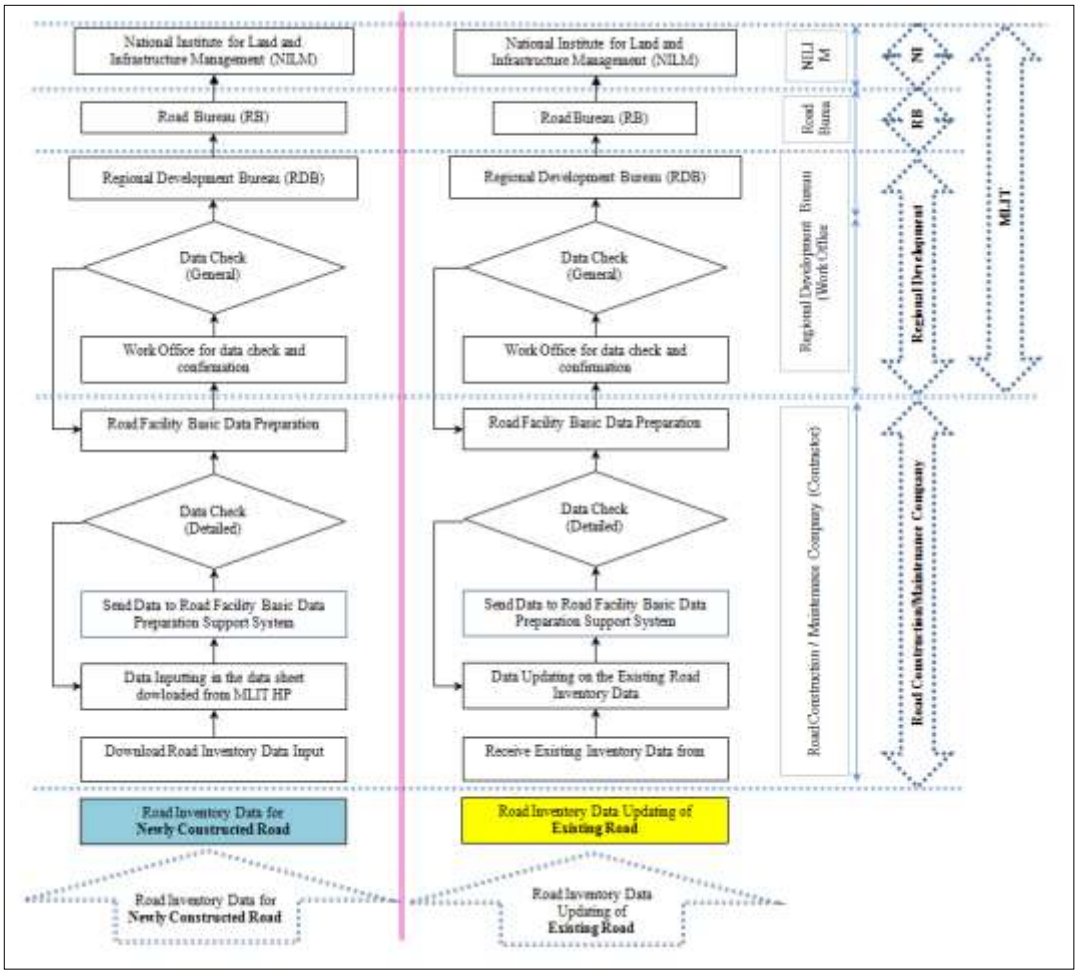


Figure 5.3.1 Schematic of Data Flow for Database Management

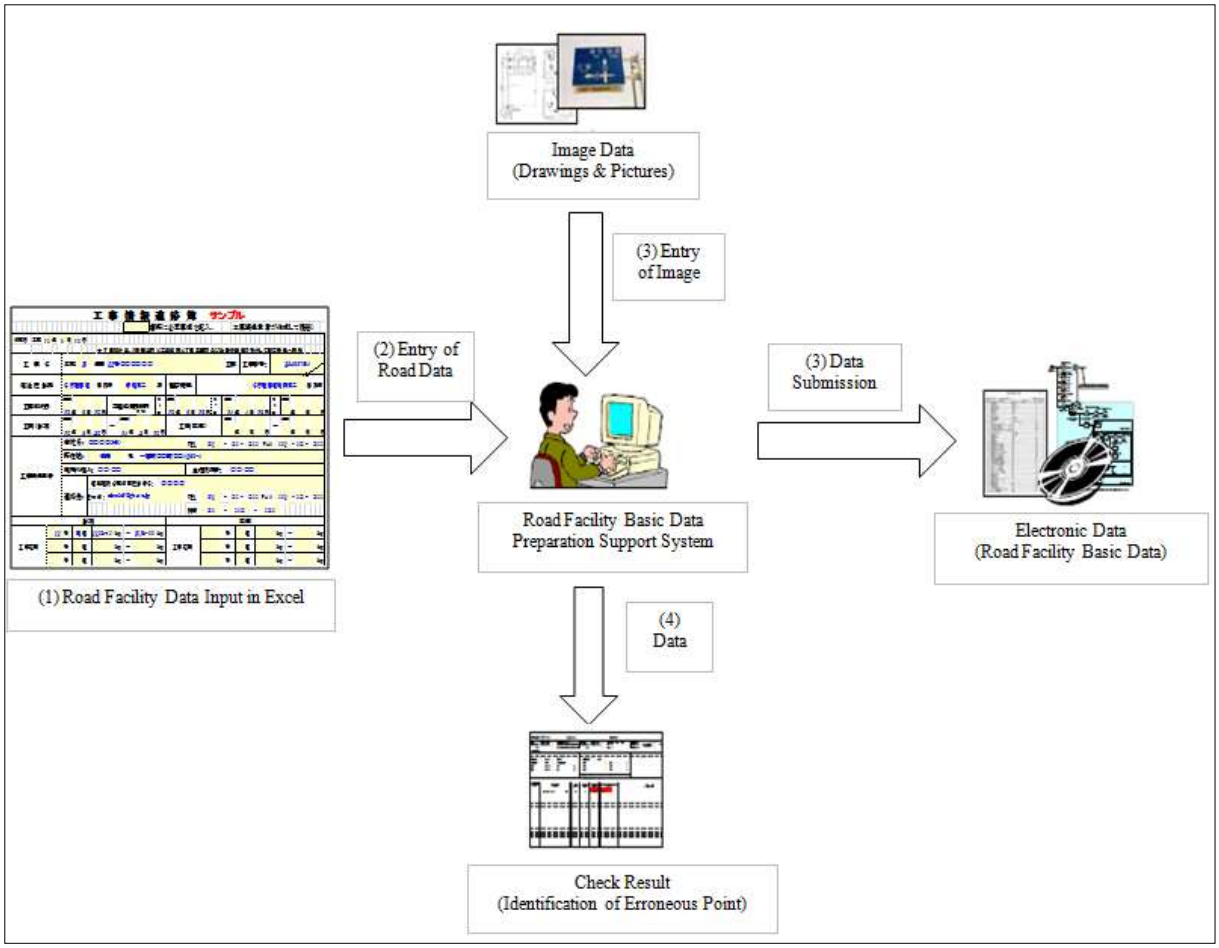


Figure 5.3.2 Data Input, Data Verification and Data Transition

3) Folder Structure of Database

Folder structure of MLIT road database is shown **Figure 5.3.3**. As illustrated in **Figure 5.3.3**, several folders have been provided by data type such as pavement, bridge, road intersection and tunnel and information has been stored in three formats, namely comma separated value format (.csv file), drawing and photo.

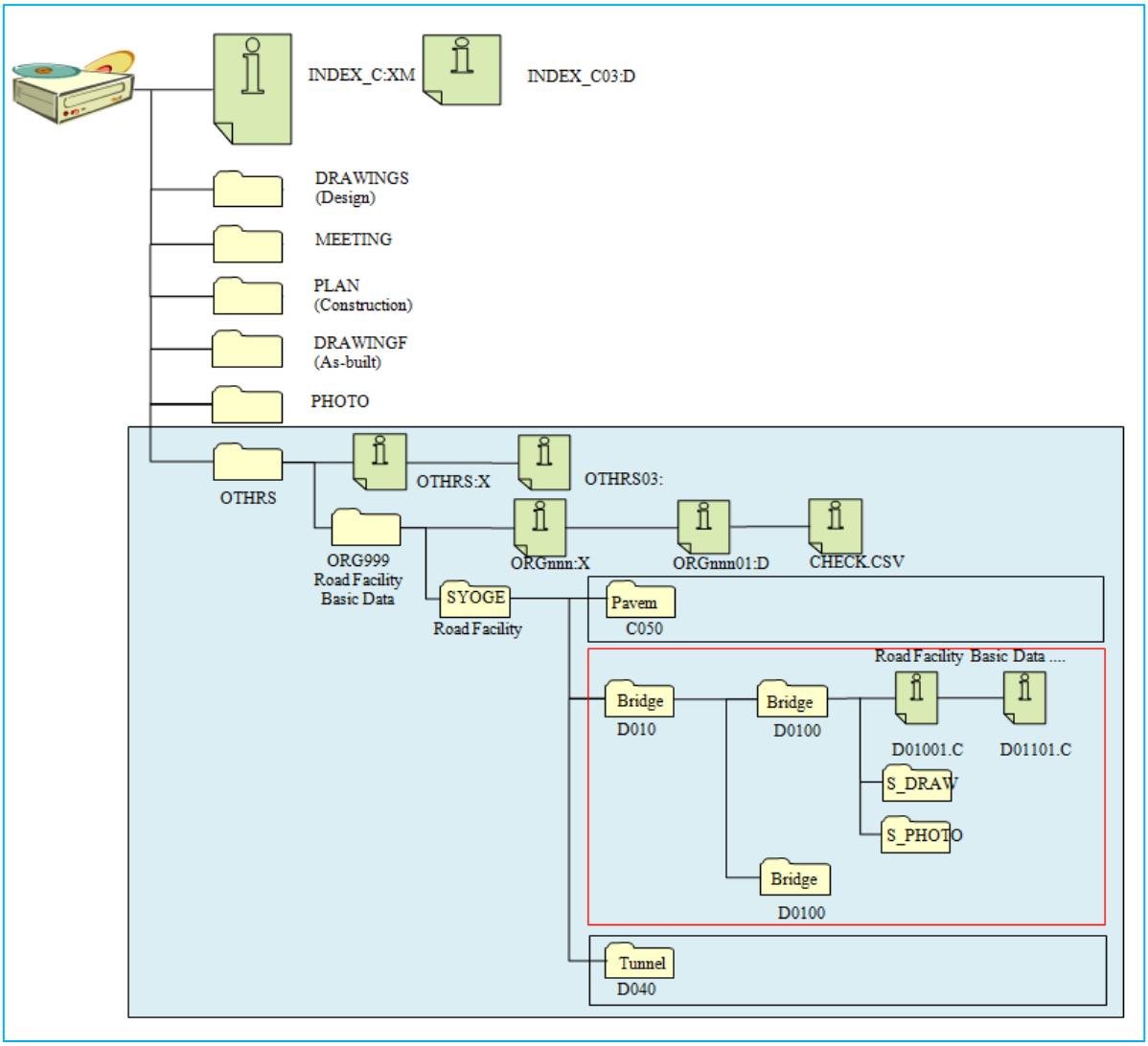


Figure 5.3.3 Folder Structure

4) Database Related Documents

Database related documents such as database user's manual, data definition, explanatory note of data coding with illustration, data input sheet with real sample data, data check manual and system description materials are well documented. A screen-shot of list of database related documents, which are available only in Japanese, is shown in **Figure 5.3.4**.

Figure 5.3.4 Database Related Documents (Japanese)

5.4 RIMS STRUCTURE UNDER CONSIDERATION BY DRVN

DRVN has highly realized the necessity of a comprehensive road information management system and making utmost efforts from DRVN and Ministry level. **"Project on Transportation Information System for Road Sector"** (hereinafter referred to as "PTISRS") is being implemented in DRVN. The project (PTISRS) is managed by PMU-2 and the consultant of the project is "National Institute of Information and Communications Strategy", an institute under the Ministry of Information and Communication. This project (i.e. PTISRS) aims to develop transportation information system by incorporating seven (7) components as shown in **Table 5.4.1**.

Table 5.4.1 System Components in PTISRS

SN		Structure of PTISRS under Consideration by DRVN	Remarks
1	Road Infrastructure Management System		
	1.1	Bridge Information Management System	Under JICA Loan Project
	1.2	Road Information Management System (Road Database)	Under JICA Tech. Coop. Project
	1.3	Local Road Information System	
2	Transportation Management System		
3	Vehicles and Drivers Management System		
4	Road Construction and Repair Management System		
5	Specialized Map Administration System		
6	System Operation Management and Information Portal		
7	Open Users' Database		

DRVN regards road database formulated within this JICA Project as sub-component "1.2" (Road Information Management System) in their PTISRS.

5.5 FRAMEWORK OF ROAD DATABASE DESIGN

5.5.1 Basic Principle of Designing Road Database

The following four basic principles are considered while designing the road database. Details of each principle are described in **Section 1** through **4** from hereafter.

(1) Concentration on Road Asset Data

Road database is designed by taking road facility inventory database system of MLIT, Japan and Road Infrastructure Management System (RIMS) proposal prepared by DRVN into consideration. Since road facility inventory database prepared by MLIT, Japan has too much details and particularly prepared for Japanese context, only relevant data items are taken from MLIT database. Data items proposed in DRVN proposal are tried to incorporate as much as data. However, some data items in DRVN proposal are not related to road asset and thus excluded in the road asset data items. **Table 5.5.1** shows the data items proposed in proposal prepared by Road Infrastructure and Traffic Safety Department of DRVN and corresponding measures taken by the JICA Project on Capacity Enhancement in Road Maintenance in Vietnam.

Table 5.5.1 Data Items Proposed in DRVN Proposal

SN	Data Items	Inclusion of Data under the Category					
		RM	RA	PC	RH	TV	GM
1	General information about Road Section	√					
2	Detail Information about Road Bed	√					
3	Detail Information about Shoulder	√					
4	Information of Road Repair Projects				√		
5	Pavement Layers		√		√		
6	Hydraulic and Geological Condition						√
7	Detailed Information on Geological Type						√
8	Road Profile Gradient		√				
9	Curvature		√				
10	Intersections/Junctions		√				
11	Pavement Strength		√		√		
12	International Roughness Index			√			
13	Routes under Ongoing Project						√
14	Violation Objects within ROW						√
15	Treatment measures for Violation of ROW						√
16	Damages Caused by Floods/Storms		√				
17	Landsliding Points		√				
18	Flood Points		√				
19	Road Classification for Specifying Road Transportation Fee						√
20	Asian Highway (AH) Routes		√				
21	Overlap Section of Different Routes	√					
22	Road Sign		√				
23	Pavement Marking		√				
24	Lighting Facility		√				
25	Retaining Wall		√				
26	Submersible Drainage Facility		√				
27	Guard Rail/Fence		√				
28	Culvert		√				
29	Ditch		√				
30	Office of Road Maintenance Unit/Toll Office/Vehicle Weight Control Station		√				√
31	Ferry Landing		√				
32	River Crossing Facilities		√				
33	Road Maintenance Equipment						√
34	Tunnel		√				
35	Bridge		√				
36	Pontoon-Bridge		√				
37	Traffic Data		√			√	
38	Road accident						√
39	Black Spots						√
40	Contingent Warehouse and Materials/Equipment for Securing traffic and Flood & Storm Prevention		√				
41	Traffic flow instruction (detour) in case of flood & Storm		√				
42	Special Vehicle Operation License						√
43	Control of Overweight Vehicle Operation						√
44	Control of Oversize Vehicle Operation						√
45	Construction License for Indispensable construction work/Construction work on road under operation						√
46	Local Transportation						√

RM: Road Main Details RA: Road Asset PC: Pavement Condition RH: Repair History TV: Traffic Volume GM: General Management

(2) Database Structure

Road database structure is described in detailed in **Section 5.5.5**.

(3) Inclusion of Asset Data Element

It is considered that unless road administrators acknowledge the value of road structures and facilities as assets (expressed in terms of monetary form), maintenance management might not be effective because life cycle cost analysis without fully consideration of asset value will be incomplete. Therefore, to calculate asset value of road structures and facilities, road asset elements are included in detailed data sub-items. Following three types of asset data elements will be inputted together with other data;

- Construction / Installation Cost
- Construction / Installation Year
- Service Life of Structure / Facility

(4) Layer-by-Layer Pavement Data

Since pavement performance depends on pavement structure, and pavement structure comprises number of layers, layer-by-layer information of pavement such as material type, thickness, loading capacity and binder type are included in both pavement inventory / asset and pavement maintenance history data.

5.5.2 Purposes of Formation of Road Database

The purposes of formation of road database are;

- To provide necessary data for PMS and PMoS developed under this Project
- To provide necessary data for road asset management not only for pavement management but also for other road structures and facilities management (except bridge management system)
- To recognize the road structures and facilities as road assets and estimate value of road asset
- To provide data for road and traffic operation management in some extent
- To provide supporting data for making decision on expansion of road network and facilities
- To provide data for various purposes including research activities

Upon completion of data collection and data input successfully, this database can be used for various purposes including asset inventory, asset valuation, asset maintenance & management and road & traffic operation management.

5.5.3 Road Database Users

Road database users presumed in the development of road database system comprise concerned departments of DRVN's Headquarters (Road Infrastructure and Traffic Safety Department, Information Center, Science, Technology and International Cooperation Department, Planning and Investment Department, Road Maintenance and Management Department, Road Construction Management Bureau, etc.), RRMBs, PDOTs, Sub-bureaus and RTCs. However, as this Project focuses only on the road network under RRMB I jurisdiction as a pilot region, technology transfer of the road database system is primarily carried out for DRVN, RRMB I, and concerned RRMB I Sub-bureau staff within the RRMB I's management area. It is anticipated that the same database system will be expanded in other RRMBs and PDOTs in the near future. In these circumstances, DRVN and RRMB I can transfer their knowledge acquired through this project to the other RRMBs and PDOTs. Therefore, it is anticipated that all RRMBs and PDOTs will be the users of the road database system eventually.

(1) Departments in the DRVN Headquarters

It is anticipated the Departments in the DRVN headquarters can use the data stored in road database for the following purposes;

- To utilize data for formulation of strategic plans for road structure and facility maintenance (Road asset maintenance)
- To operate and maintain central database by gathering data from RRMBs and PDOTs.
- To upload selected data on the web and manage them accordingly if decided to upload data on the web
- To share data among management systems which are being used or to be developed in the future in DRVN
- To provide data for research (if any)

(2) RRMBs

It is anticipated the RRMBs can use the data stored in road database for the following purposes;

- To utilize data for formulating annual road asset maintenance plans
- To utilize data for formulating annual budget proposal
- To share data among management system at regional level
- To utilize data for road and traffic operation management

(3) Sub-bureaus

It is anticipated the SBs can use the data stored in road database for the following purposes;

- To utilize data for maintenance and traffic operation if assigned by RRMBs
- Utilize data for updating database if assigned by RRMBs

5.5.4 Target Data Types

Since DRVN has intended to develop a comprehensive transportation information system comprising of seven (7) system components and some components are already in progress, this Project has focused only on road asset related database to be used particularly for road asset management. Therefore, the following five (5) types of data are considered under the scope of this project;

- Road Asset (Road Inventory)
- Pavement Condition
- Pavement Repair History
- Traffic Volume
- General Road Management

Note: General road management data are solely used by road administrators for their management purpose and these data are internal data of road administrator. Therefore, it is DRVN's responsibility to work on related activities such as data items and sub-items selection, preparing data definition, development of data input sheet, software development, data collection, and data inputting. General management data are out of scope of JICA Project Team.

List of road assets included in road database is presented in **Table 5.5.2**.

Table 5.5.2 List of Road Assets included in Road Database

SN	Road Structure / Facility	Name of Road Asset	Remarks
1	Road Reference	Road Main Details	
2	Road Structures	Horizontal Alignment	
3		Road Gradient	
4		Pavement	
5		Road Intersections	
6		Railway Crossings	
7		Median Strip	
8	Road Facilities	Bridge	
9		Tunnel	
10		Slope including drainage	
11		Retaining Wall	
12		Culvert	
13		Pipe Culvert	
14		Submersible Drainage Facility	
15		River Crossing (Ferry, etc.)	
16		Pontoon Bridge	
17		Pedestrian Crossing Bridge	
18	Traffic Operation Facilities	Pavement Marking	
19		Road Lighting	
20		Guard Fence	
21		Road Sign	
22		Vehicle Weighing Station	

SN	Road Structure / Facility	Name of Road Asset	Remarks
23		Noise Barrier	
24		Shade Fence	
25		Kilometer Post	
26	Others	Roadside Plantation	
27		Road Damage Inventory	
28		Disaster Response Storage House	
29		Overlap Section	

5.5.5 Database Structure

The database structure is divided into three hierarchies considering the data collection & inputting mechanism and database utilization. Since primary data are stored in SBs and data inputting work is also presumably carried-out by SBs, data are collected from each SB and forwarded to respective RRMB and eventually to DRVN to store data into the central database. Each RRMB administers national roads under their own jurisdiction only and thus database in RRMB level stores data of their own region only. At DRVN level, data from all RRMBs are collected into the central database. Database hierarchy is shown in **Figure 5.5.1**.

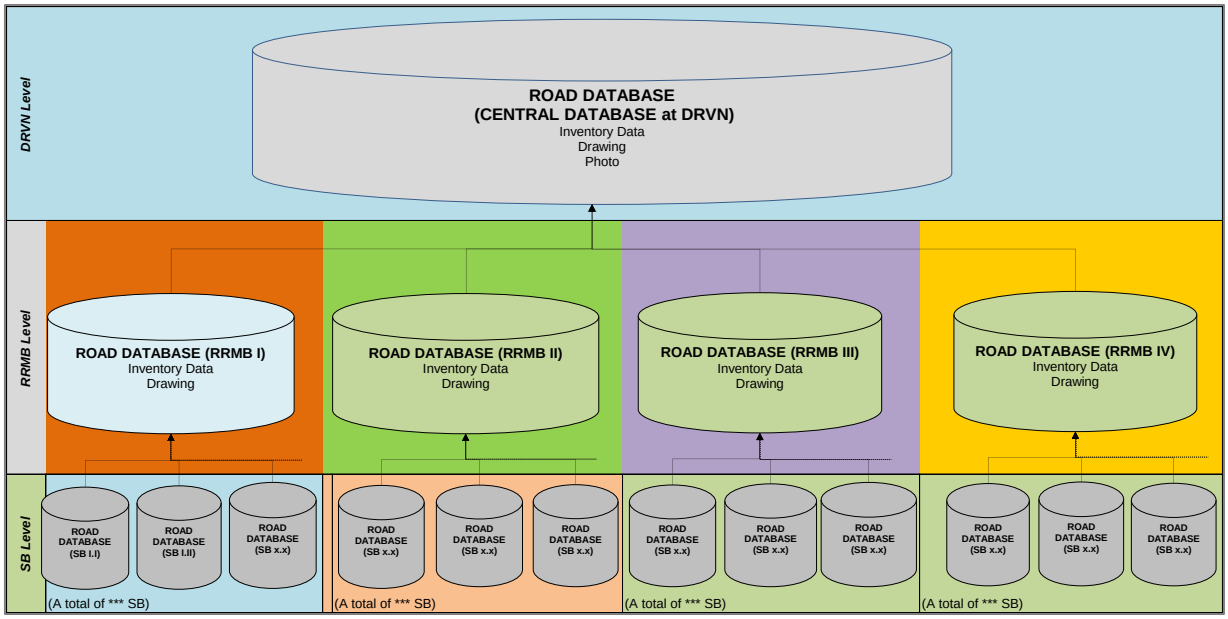


Figure 5.5.1 Database Hierarchy

The Road Database structure comprises five (5) types of data; general road management, road asset (road inventory), pavement condition, maintenance history and traffic volume data. However, general road management data are different from road asset data and solely use by road administrators for their internal management purposes. Thus, general road management data has been dealt separately from the data related to road asset. Database structure is shown in **Figure 5.5.2**.

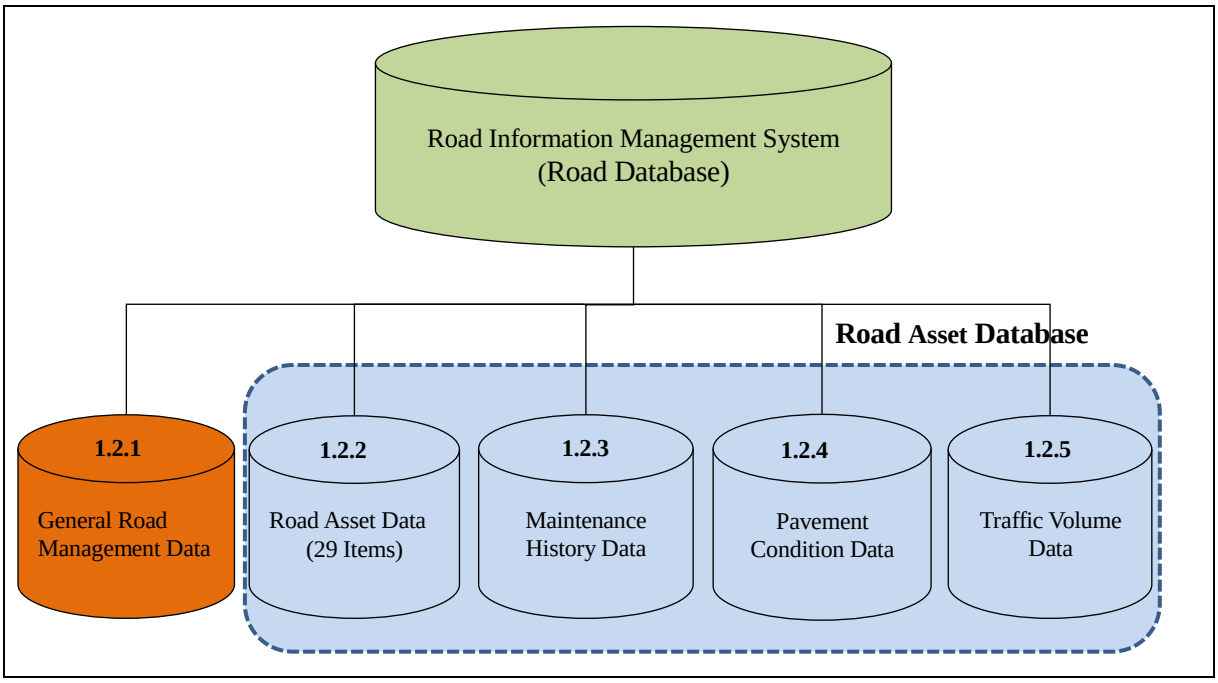


Figure 5.5.2 Road Database Structure

Folder structure is shown in **Figure 5.5.3**. Five (5) separate folders are provided for five (5) types of data type as shown in **Figure 5.5.2**. Similarly, separate folder and subfolders are provided for provinces. Also, subfolders are provided for three (3) types of data formats, namely inventory data, drawing data and photo (including videos) data.

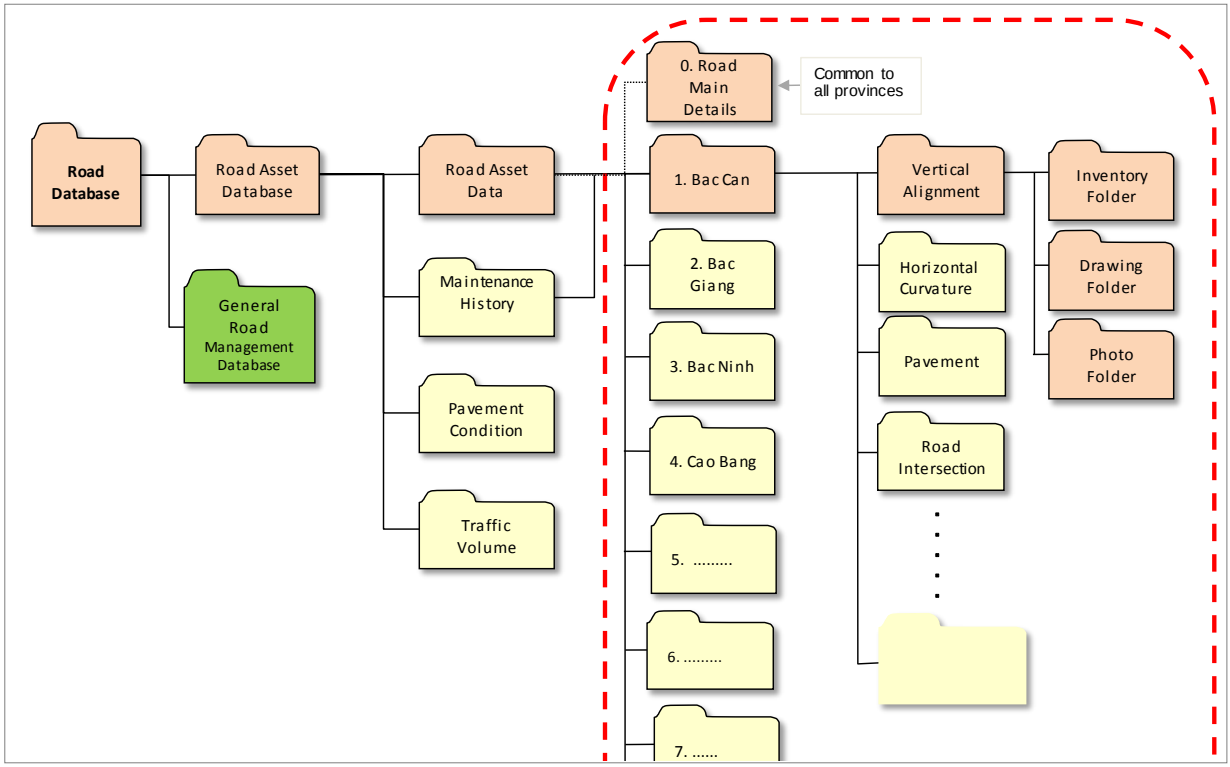


Figure 5.5.3 Database Folder Structure (for RRMB I Jurisdiction)

It is strictly prohibited to change any folder names to avoid losing / mismatching any paths or links inserted between interface file and database folders.

5.5.6 System Interface and Data Storage

In database system, system interface file (program system file) and data storage system (pivot table, photo folder and drawing folder) are kept separately though both tasks are done in MS-Excel platform. Data storage component consists of large number of files including photos and drawings and thus requires a large space. Also, if a single file contains a large volume of data, it is not convenient to work because it needs large memory and takes a long time in processing. It is not necessary to revise the structure of data storage system so often. In contrast, system interface file may need revision time to time to fix the problem which generally occurs in the system file. Therefore, system interface file and data storage system have been designed separately. However, both systems are linked by Excel VBA. If there are any changes in system interface file, only system interface file can be provided to all users and users can just replace the old system file by the new one. The new system interface file will support all data storage system without any technical problem.

Figure 5.5.4 shows the inter-relationship between system interface file and data storage system. As illustrated in the figure, the system interface save all data in data storage system and whenever necessary data or information will extract to system interface file especially for checking data validation, data displaying, data printing, data editing / updating, and creating reports.

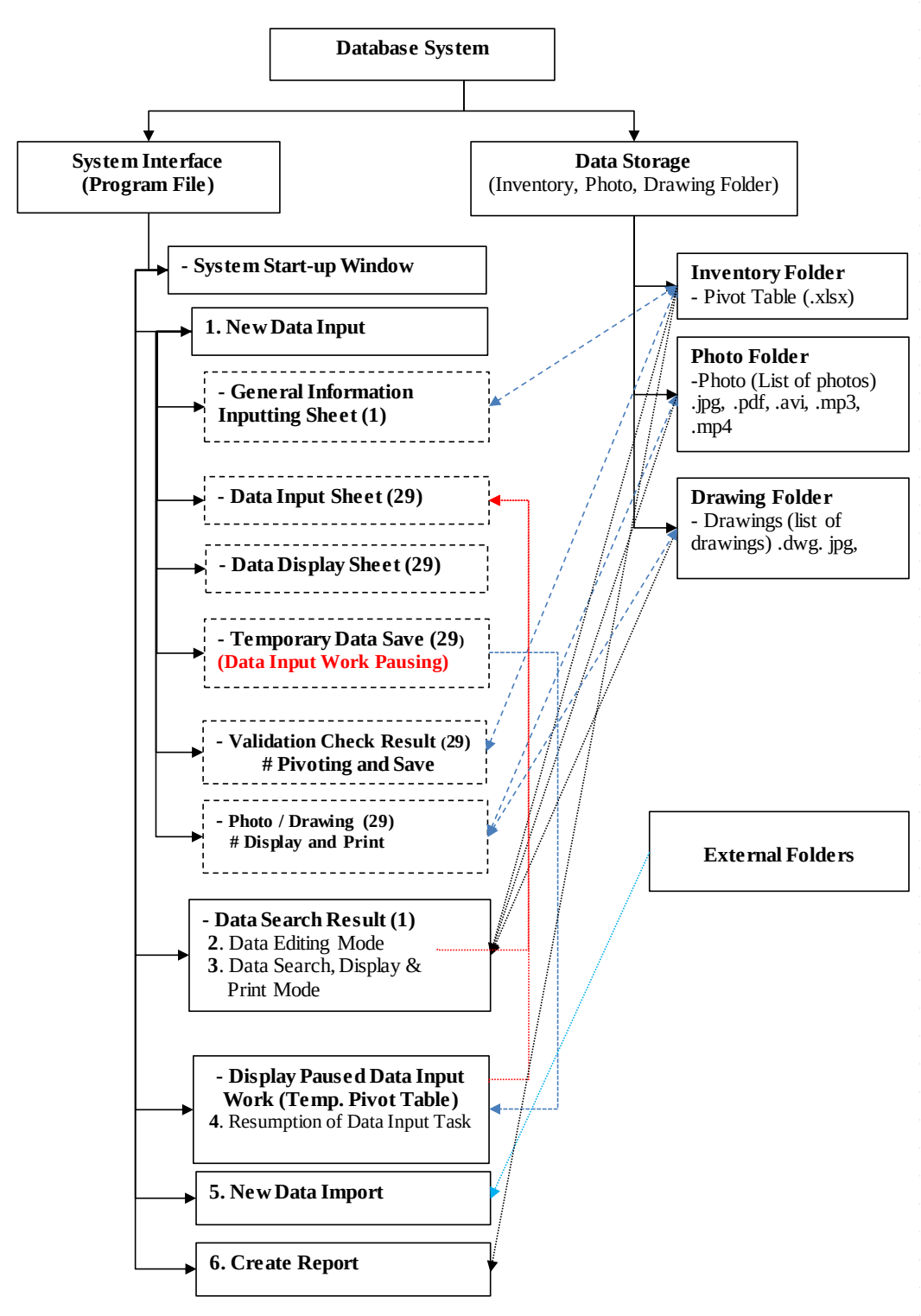


Figure 5.5.4 System Interface and Data Storage Relationship

5.5.7 Road Asset Data Items, Expected Utilization and Data Input Priority (1.2.2)

A total twenty nine (29) road asset data items are selected by taking reference of DRVN proposal and MLIT database system. Road asset data items, expected utilizations and data input priorities are shown in **Table 5.5.3**. Priorities are set by considering the importance and urgency

of data required for management purpose. For example, priority-I data are required for PMS and PMoS urgently.

Table 5.5.3 Road Asset Data Items, Expected Utilization and Data Input Priority (1.2.2)

SN	Data Items	Data Input Priority	Expected Utilizations						Other
			PMS	PMoS	AI	AM	RTOM	SD	
1	Road Main Details	I	√	√	√	√	√		
2	Pavement	I	√	√	√	√			
3	Overlap Section	I				√	√		
4	Bridge (VBMS Inventory Module)	II			√	√	√		
5	Road Intersection	II			√	√	√		
6	Railway Crossing	II			√	√	√		
7	Submersible Drainage Facility	II			√	√	√		
8	River Crossing (Ferry, etc.)	II			√	√	√		
9	Pontoon Bridge	II			√	√	√		
10	Tunnel	II			√	√	√		
11	Slab and Box Culvert	II			√	√			
12	Pipe Culvert	II			√	√			
13	Vehicle Weighing / Measuring Facility	II			√	√	√		
14	Road Damage Inventory (by Disaster)	II					√	√	
15	Pavement Marking	II			√	√	√		
16	Road Gradient	II					√		√
17	Horizontal Curvature	II					√		√
18	Slope	III			√	√			
19	Pedestrian Crossing Bridge	III			√	√	√		
20	Retaining Wall	III			√	√			
21	Road Lighting	III			√	√	√		
22	Roadside Plantation	III			√	√			√
23	Guard Fence	III			√	√	√		
24	Disaster Response Storage Warehouse	III			√	√	√		
25	Median Strip	IV			√	√	√		
26	Road Sign	IV			√	√	√		
27	Kilo Post	IV			√	√	√		
28	Noise Barrier	V			√	√	√		
29	Shade Fence	V			√	√	√		

Note:
PMS: Pavement Management System PMoS: Pavement Management Monitoring System AI: Asset Inventory
AMM: Asset Maintenance Management RTOM: Road and Traffic Operation & Management SD: Statistical Data

5.5.8 Data Sub-Items

(1) Road Asset Data Sub-Items (1.2.2)

Detailed road asset data sub-items have been prepared and provided to DRVN for their review. Data items were finalized by series of discussions in working group and revisions. There are approximately 700 data sub-items. Since data sub-items shall match with the local practices, DRVN had been kindly requested to provide their comments/revisions so that data sub-items would be highly customized. DRVN reviewed data sub-items number of times, and requested additional data sub-items to supplement in the data sub-items list. Therefore, it is believed that data sub-items have been customized to suit with Vietnamese context. JICA Project Team has proposed to exclude some of the data items/sub-items which are not applicable at present for

Vietnamese national roads, however, DRVN side has requested not to exclude those data items/sub-items by believing that those data items will be available in the future and needed them eventually sooner or later.

(2) Pavement Condition Data Sub-Items (1.2.3)

Pavement condition data has been selected by taking consideration of requirements of PMS and PMoS to be developed under this project. Pavement condition data of 2012 have been collected by Pavement Condition Survey Team, a separate JICA project (hereinafter referred to as "Pavement Condition Survey Team"). Pavement Condition Survey Team (2012) collected only pavement surface condition data which are particularly required for PMS and PMoS which were developed under JICA Project. However, not to limit the scope of data only for designed PMS and PMoS, additional pavement surface condition information such as pavement edge break, small cracks, and texture which might be necessary for other purposes, are also included in data sub-items. Therefore, in addition to pavement condition data sub-items collected by Pavement Condition Survey Team, additional pavement condition data sub-items, road reference data sub-items, some basic inventory data sub-items and pavement loading capacity related data sub-items such as FWD, and loading plate are considered in pavement condition data sub-items.

(3) Pavement Repair History Data Sub-Items (1.2.4)

Pavement repair history data sub-items have been prepared by considering the data items which are actually being used in Vietnam ranging from small to big repair works. Since pavement data has been considered layer-by-layer, pavement information after repair works have also been considered in the similar manner. Pavement repair history data comprises general information of road sections (reference and inventory), general information of repair project, existing pavement condition, information on repair method, and information on technical work effects.

(4) Traffic Volume Data Sub-Items (1.2.5)

There is no change in traffic data items and collection methods which have been being used for several years in DRVN. It is requested to preserve daily traffic volume data in soft copy also so that data can be analyzed and utilized for multiple purposes. Some minor internal computations are done and traffic volume data will be produced to comply with the PMS dataset requirement. Since traffic volume data are collected as point data in the unit of vehicle/day, a provision of traffic volume conversion as sectional data are also considered.

5.5.9 Data Input Format

Data will be inputted and stored in three formats as;

- Asset Inventory Data in the form of Pivot Table
- Drawings
- Photos(including videos)

(1) Asset Inventory Data in the form of Pivot Table

Data input formats for all data items except for pavement condition data are prepared in MS-Excel. Separate data input sheet is prepared for each data item. Therefore, there will be a total of 30 data input sheets for road asset data (28 items; excluding bridge because bridge inventory data will be imported from VBMS by interface), pavement condition data (1 item), and pavement repair history data (1 item). Data input sheet for pavement condition data are prepared by Pavement Condition Survey Team and already used for data collection and preparation in 2012. After receiving pavement condition data from Pavement Condition Survey Team, additional adjustment in data input sheet is necessary to supplement data sub-items which are not included in pavement condition data collection and preparation format. To minimize data input error and maintain consistency in information, a provision of data coding is adopted as much as possible. Also, for multiple choices of data, combo boxes are inserted wherever possible. After inputting data in data input sheet, all data will be converted into Pivot Table. Sample data input sheet and pivot table are shown in **Figure 5.5.5** and **Figure 5.5.6** respectively.

(2) Drawings

Available drawings of road assets will be uploaded into the database system. During data inputting process in data input sheet, data input process will prompt to upload drawing file of the corresponding location/section at the same time with the inventory data, and drawing file will be saved either in PDF or image format in the corresponding drawing folder.

(3) Photos

Similar to drawing data, available photos of road assets will be uploaded into the database system. During data inputting process in data input sheet, data input process will prompt to upload photo file of the corresponding location/section at the same time with inventory data, and photo file will be saved either in PDF or image format in the corresponding drawing folder. Uploading videos are also possible in Photo folder if video file format is selected.

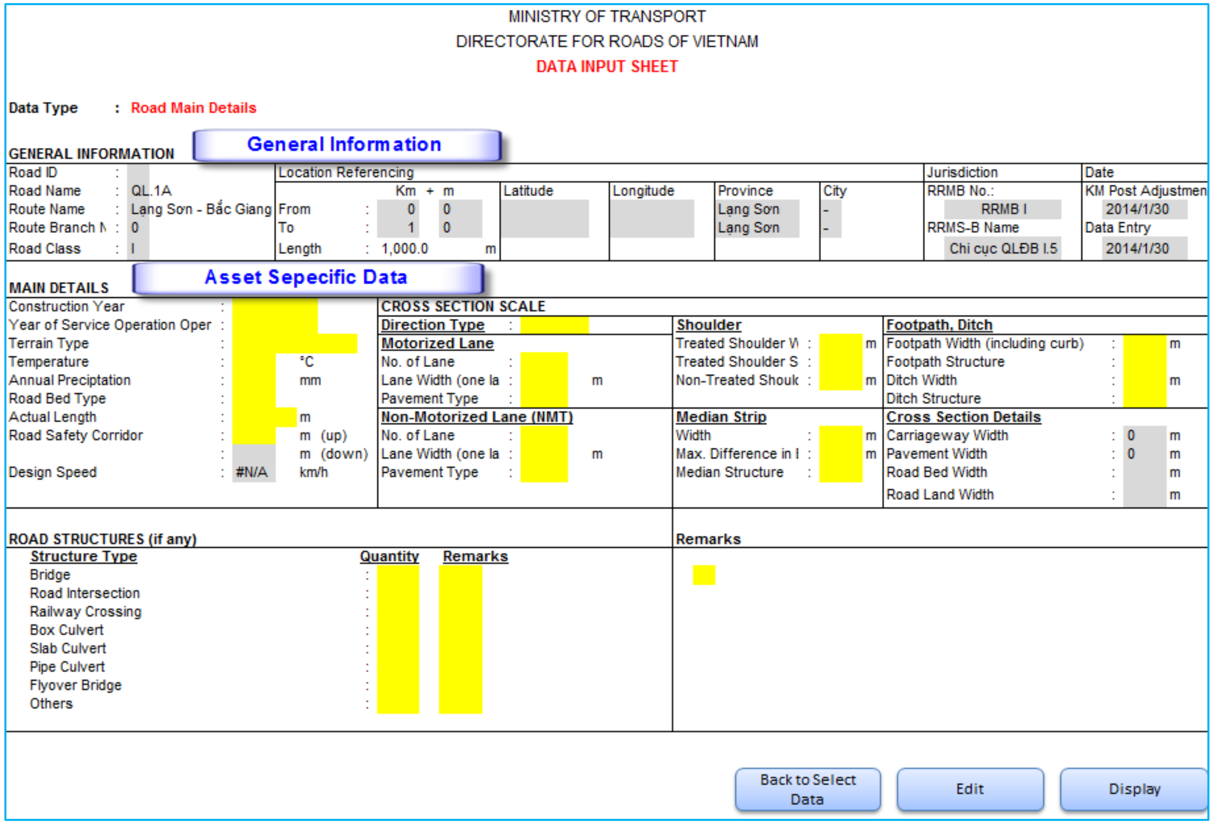


Figure 5.5.5 Sample Data Input Sheet

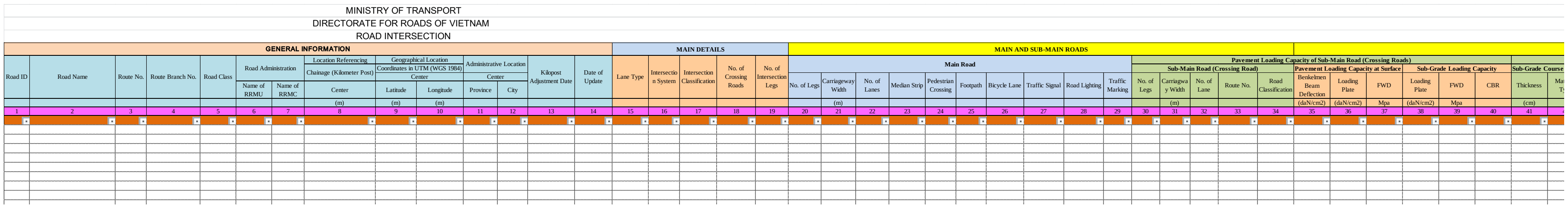


Figure 5.5.6 Sample Pivot Table

5.6 ROAD DATABASE SYSTEM

5.6.1 System Features

(1) The key for the system development is to ensure easy data handling including data input, data editing, database upgrading and database management even for non-professional users, because these databases will be mainly managed and used by regional road maintenance agencies like RRMBs, PDOTs and other organizations alike. With these reasons, database system is developed in MS-Excel as a core system of the project for its available features such as easy management, high inter-operability and expandability.

(2) Data input will be started with offline basis upon development of database system. Potentiality and feasibility of web-based data input and storage system is under examination. DRVN has strongly requested to store the data in specialized database administrative system such as SQL server and MySQL rather than in MS-Excel from the beginning. JICA Project Team has explained the reason of proposing MS-Excel as a core system of the database to DRVN and the reasons are; easy data management, easy data check, high inter-operability, expansibility, etc.

(3) For easy data input, data gathering and data management, number of folders are provided in database system. Though there is a possibility of assigning SB for inputting data, database folders are created by province name because work scopes of SB are mainly governed by condition of contract to be signed between RRMB and SB and management area of SB is also keep on changing. The folder structure is shown in **Figure 5.3.3.** List of provinces under the jurisdiction area of RRMB I is shown in **Table 5.6.1**.

Table 5.6.1 Province under Jurisdiction Area of RRMB I

SN	Province Name	SN	Province Name	SN	Province Name	SN	Province Name
1	Bac Can	7	Ha Nam	13	Lang Son	19	Son La
2	Bac Gaing	8	Ha Noi	14	Lao Cai	20	Thai Nguyen
3	Bac Ninh	9	Hai Duong	15	Nam Dinh	21	Thai Binh
4	Cao Bang	10	Hai Phong	16	Ninh Binh	22	Tuyen Quang
5	Dien Bien	11	Hoa Binh	17	Phu Tho	23	Vinh Phu
6	Ha Giang	12	Hung Yen	18	Quang Ninh	24	Yen Bai

As shown in **Figure 5.6.1**, folders are provided for each province. Similarly, folders are provided for each data format type (i.e. three (3) types of data formats, namely inventory data, drawing data and photo (including videos)) in corresponding folders for each asset type under the province folder.

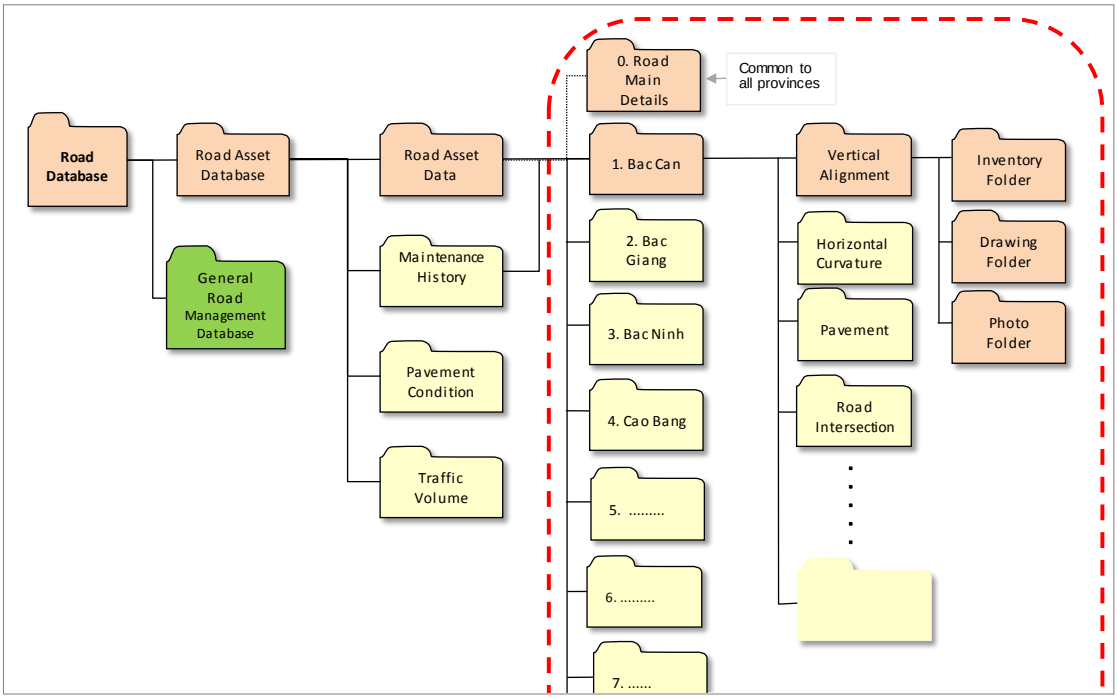


Figure 5.6.1 Database Folder Structure (for RRMB I Jurisdiction)

It is prerequisite to save all folders and interface file (Program system file) in a common folder. If related folders and interface file are saved in different folders, the system interface prompts error message indicating "C**annot find Pivot Table file**" as shown below. This error occurs because a particular path has been specified in VBA code.

Also, if any changes made on folder names, the system may not work properly because it may lose/ mismatch paths or links inserted between interface file and database folders.

5.6.2 System Requirements

Road database system requirements are presented in **Table 5.6.2**.

Table 5.6.2 Road Database System Requirements

System Requirements	Description
Operation System	The system shall be installed in Windows XP or later version of Windows.
Microsoft Office	The system shall run in MS-Excel installed computer. Considering the data volume, future expansion of database, and maximum utilization of MS-Excel functions including VBA-Excel, MS-Excel 2007 or later version of MS-Excel shall be installed on the computers. Macro shall be enabled while working on the database system.

System Requirements	Description
Anti-virus software	It is recommended to install security software (anti-virus software) on the computers where this database system will be installed to protect from harmful computer viruses. Any functions of the database system shall not be disabled by anti-virus or firewall securities either fully or partially.
System Operation	The system shall be operable by DRVN's administration and engineering staff. The system shall be simple and necessary manuals shall be provided with sufficient explanation.
System Flexibility	The system shall be a flexible which supports future system upgrade and system expansions. The system upgrade and expansion need to be manageable by DRVN. Only for critical technical problems, technical supports from IT specialized agencies such as UTC,RTCs, and private IT companies shall be taken.
Collaboration with DRVN during System Development	The system development shall be carried out in close collaboration with DRVN and JICA Project Team by taking account of technology transfer (capacity enhancement in database development and management), system sustainability, etc.

5.6.3 File Naming System

In order to make file names consistency, file naming system has been developed in the system. The system will automatically create file name for inventory data, photo and drawings in the following format.

(1) Inventory Data

Database		Data Type		Data Source		Stage of Data		Asset Name		RRMB Number		Province Name		Data Version	.xlsx
DB	_	RA	_	DRVN	_	OR	_	AssetName	_	RRMB X	_	Province Name	_	Year	.xlsx
Example (AssetData): DB_RA_DRVN_OR_Pavement_RRMB-I_Hanoi_2013.xlsx															
DB	_	MH	_	DRVN	_	OR	_			RRMB X	_	Province Name	_	Year	.xlsx
Example (Maintenance History) : DB_MH_DRVN_OR_RRMB-I_Hanoi_2013.xlsx															

(2) Photos and Videos

RRMB Code		Road Name		Province Code		Asset Name		Section Chain age[4]	Lane Type		Data Version		Multiple Photo/ Video	File Extension
RRMB I	_	QL.1A	_	Hanoi	_	Road Main Details	_	35+000	Up	_	2013	_	(1)	.jpg .pdf .avi .mp4 .3gp .mkv .flv .mpg
Example: RRMB-I_QL.1A_Hanoi_RoadMainDetails_35+000_Up_2013(1).jpg Example: RRMB-I_QL.1A_Hanoi_RoadMainDetails_35+000_Up_2013(2).jpg														

[4]Starting chainage in case of sectional (interval) data

(3) Drawings

RRMB Code		Road Name		Province Code		Asset Name		Section Chain age[5]	Lane Type		Year		Multiple Drawings	File Extension
RRMB I	_	QL.1A	_	Hanoi	_	Road Main Details	_	35+000	Up	_	2013	_	(1)	.dwg .pdf .jpg
Example: RRMB-I_QL.1A_Hanoi_RoadMainDetails_35+000_Up_2013(1).dwg Example: RRMB-I_QL.1A_Hanoi_RoadMainDetails_35+000_Up_2013(2).dwg														

5.6.4 Main Functions

The following functions have been developed in the database system. Trial runs were conducted number of times and necessary amendments were also done when necessary. Road Main Details data (priority-1) data were inputted using the functions provided in the newly developed database system. Detailed operation procedures of all functions provided in Road Database System are explained in ***Road Database User's Manual***.

(1) New Data Input

New data input function is provided in Data Input Sheet in MS-Excel platform with embedded Excel VBA. Road asset data and maintenance history data shall be inputted by using data input sheet. Without inputting inventory / asset data, photos and drawings cannot be inputted in the Road Database system. However, photos and drawings are not mandatory always like inventory / asset data (i.e. only available photos and drawings can be inputted). Data storing / saving function for inventory / asset data, drawing and photo is provided to save data in inventory folder (as pivot table), drawing folder and photo folder respectively. Functions for importing multiple photos and drawings are provided considering that multiple photos and drawings are necessary or available for a single section of the road. Also, upon selection of specific photo or drawing, system will display the preview of the selected photos (applicable only for image format files (i.e. jpeg, tiff, etc.)).Data input controls are provided in data input sheet. Input sheet is protected by password to prevent from any damages. Functions provided in Data Input Sheet are further explained in **Section 5.6.5**.

[5]Starting chainage in case of sectional (interval) data

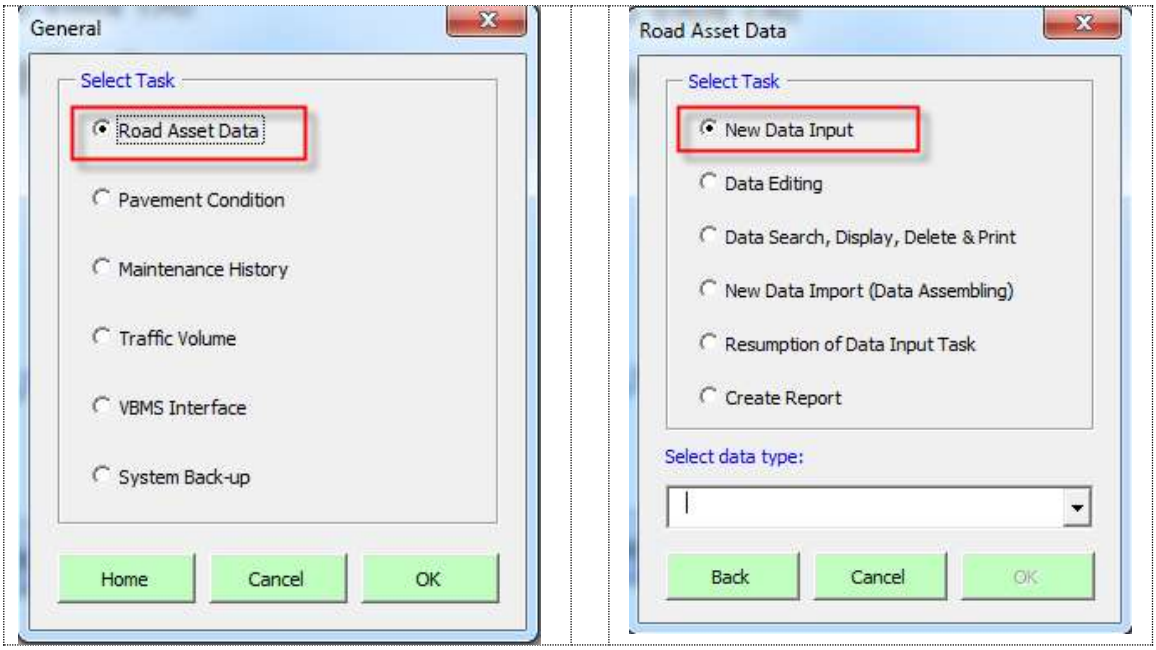


Figure 5.6.2 New Data Input

(2) Data Editing and Updating

Data editing and updating function is provided to amend the stored data whenever necessary. During data editing and updating, this task shall pass through data validation check also. If necessary, adjustments in adjacent sections shall also carried out whenever the data editing and updating work is performed. If target section for editing is shorter or longer than the original, user shall edit adjacent sections manually to prevent from data overlapping. Functions are provided to preserve past data as a time series data inside the database system. All old data (past data) will be moved to history folder automatically by the system by comparing version of pivot table file (i.e. indicated "**year"** in the file name).If the editing is done within the same year, pivot table file will be overwritten only.

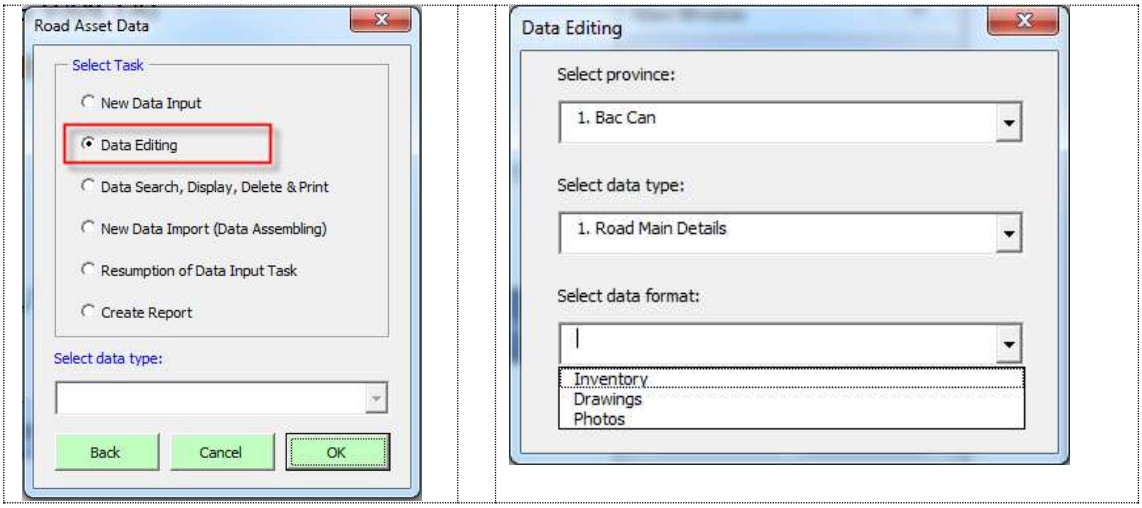


Figure 5.6.3 Data Editing and Updating

(3) Data Search, Display, Delete and Print

Data search and display function is provided in the Road Database system. Firstly, data is searched and listed up. Upon displaying the results of search operation, stored data can be deleted (in necessary) or displayed in details. Also, data will be displayed before converting data from input sheet into pivot table to reconfirm the entered data.

The intended data can be printed out from display mode as necessary by setting page setup and printer. As a default setting, a default printer is activated and page set up is automatically selected either A4 or A3.

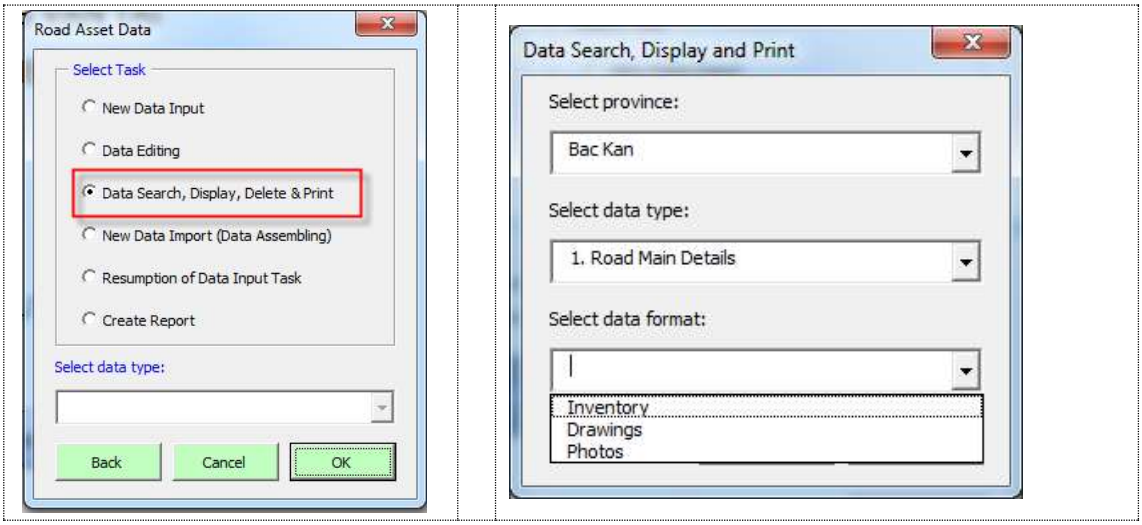


Figure 5.6.4 Data Search, Display and Print

(4) New Data Import (Data Assembling)

New data import function is provided specially for RRMB and DRVN to assemble data in a single database system. It is necessary for collecting data at regional (i.e. at RRMB) and central (i.e. at DRVN) level. RRMB collects data from various SBs and DRVN collects data from all RRMBs. Data duplication is checked in every data import and it prevents from data duplication if attempts are made to import data two or more times.

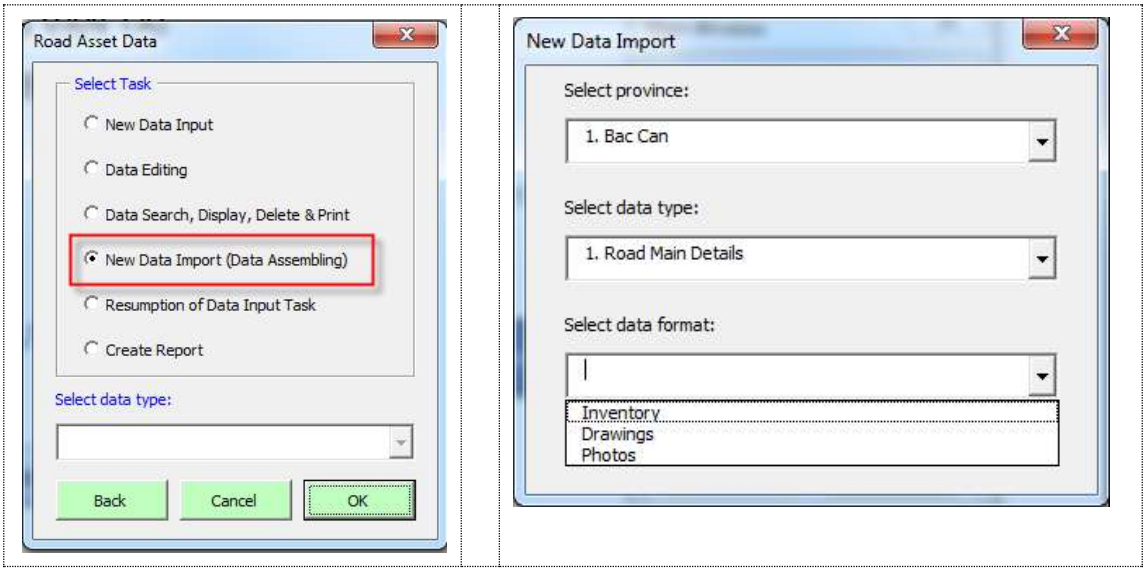


Figure 5.6.5 New Data Import

(5) Resumption of Data Input Work

This function is provided for resuming the data input work if any of the data inputting work is temporarily saved without performing data validation check. This function is specially provided by taking into consideration of possibility of not completing the data inputting work from start to the end, particularly when data inputting work is paused before performing data validation check. This function extracts temporarily saved data into input sheet and follows the same procedure as in ordinary case of new data input work.

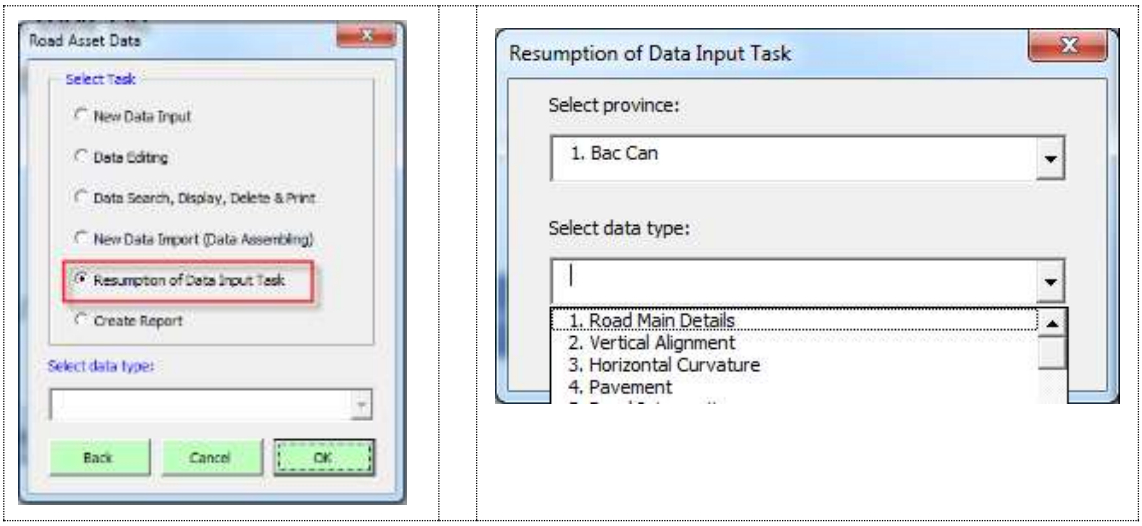


Figure 5.6.6 Resumption of Data Input Work

(6) Create Report

This function is provided to export pivot table file(s) and create dynamic report required for DRVN for their reporting and management purpose. The data export function will export whole pivot table file from selected provinces at once. The dynamic report function generates in the users' desired format. The system searches the related data from the database and creates the

dynamic report. User can customize or design the final desired format using functions of MS-Excel. In addition to the dynamic report, this function can also export the selected data stored in the database.

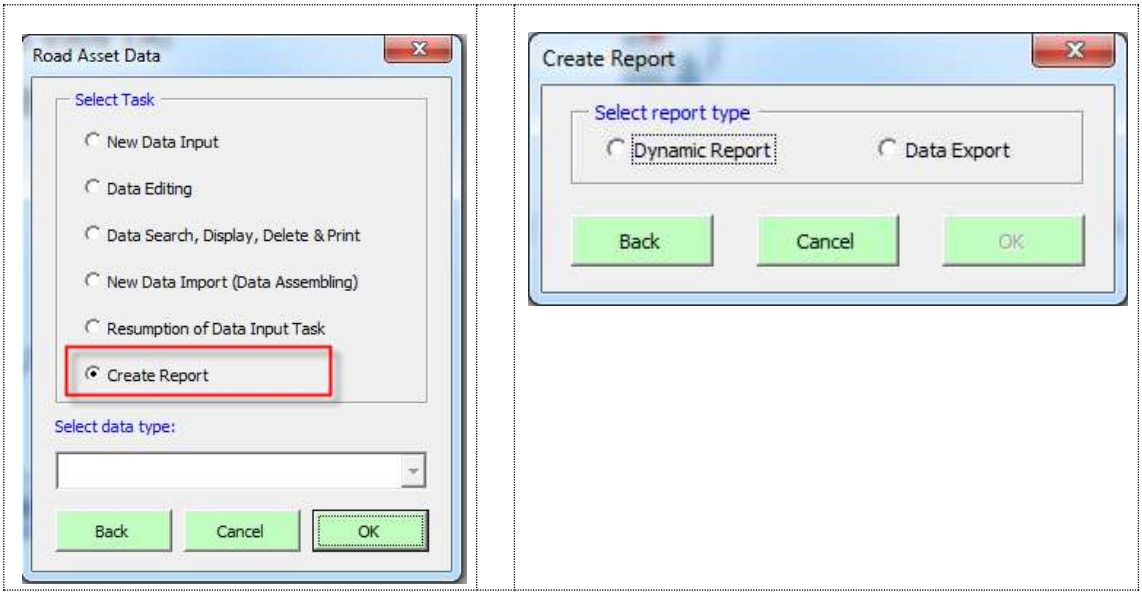


Figure 5.6.7 Create Report

5.6.5 Functions in Data Input Sheet

(1) Data Input Control

To avoid data input error, data input control functions are inserted using MS-Excel's available tools and Excel VBA. As shown in **Figure 5.6.9**, only yellow color cells are allocated for data input. Except yellow color cells, all cells are locked with password. Therefore, data can be inputted only in yellow color cells. Also, wherever possible, data are coded and selection option is provided with drop down list / combo-box. A provision of displaying error / caution message is provided if attempt is made to input data wrongly or in different format. In those cells where dropdown list are inserted, information shall be selected from within the list. Any attempts to inputting new information except listed-up in dropdown list, cause error message. Data items which can be computed internally based on inputted data, formulas have been inserted in those cells. Also, prevailing Vietnamese standards and regulation such as geometric design guide, pavement design and other standards for road facilities have been incorporated as much as possible.

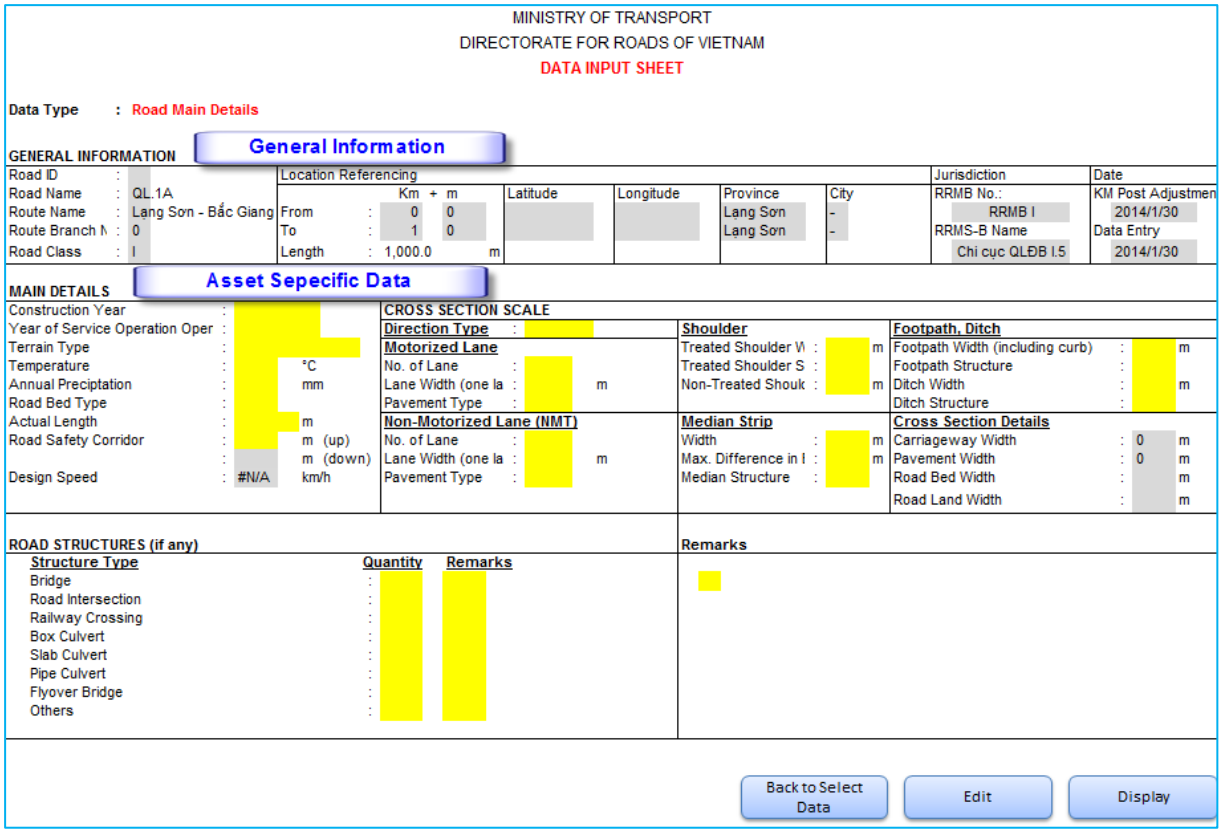


Figure 5.6.8 Data Input Sheet

Moreover, general information data are inputted from the common platform because some of the information are fixed and shall be common to all types of data. Management agencies, road names, province etc. are common to all types of data and thus such information are inputted from general information inputting sheet. Data Input sheet for inputting general information is shown in **Figure 5.6.9**.

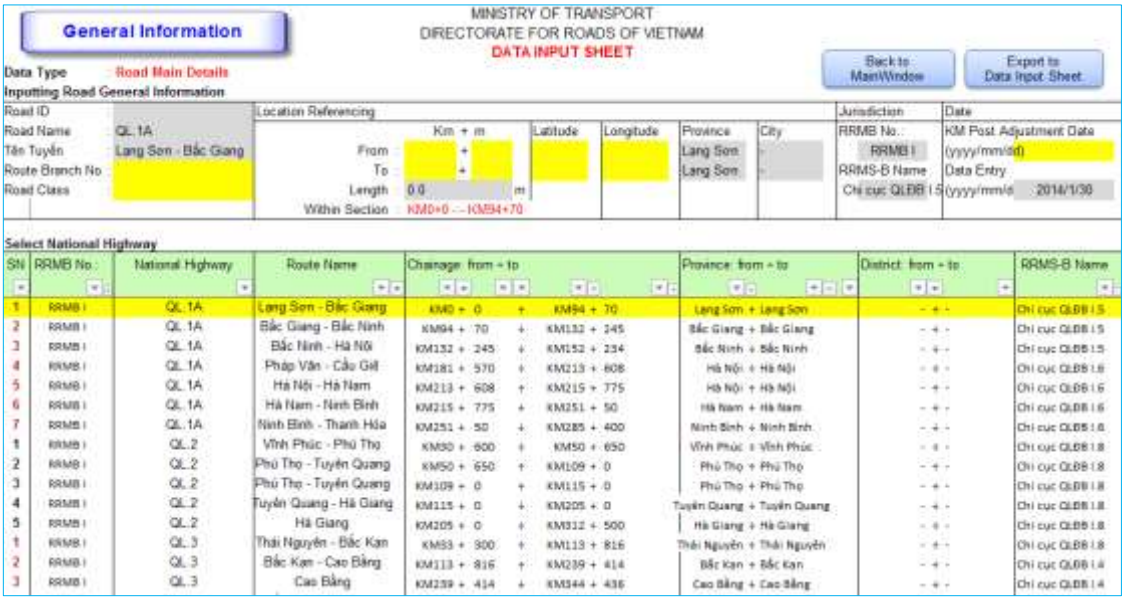


Figure 5.6.9 Data Input Sheet (General Information Only)

(2) Data Displaying Before Pivoting

Before proceeding to validation check, entered data are displayed as shown in **Figure 5.6.10** for reconfirmation of inputted data. In a quick review, if any of the inputted data are found wrong or missing, data inputting work can be returned back to main data input sheet and necessary modification can be made. Modification on display mode is not allowed.

MINISTRY OF TRANSPORT
DIRECTORATE FOR ROADS OF VIETNAM
DATA CONFIRMATION

Data Type : **Road Main Details**

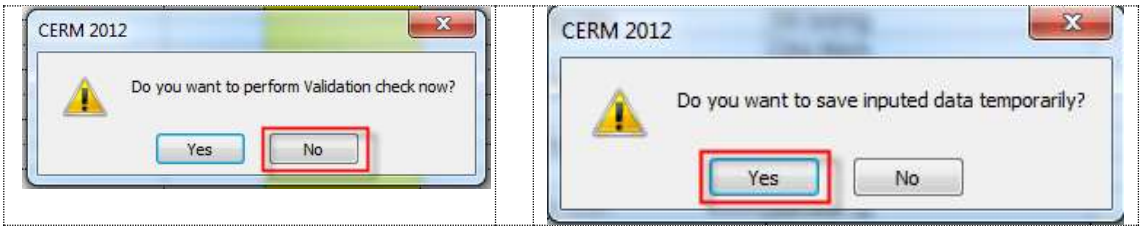
SN	Item		Sub-Item	Unit	Value	Remarks
1.1	**General Information**		Road ID			
			Road Name		QL.1A	
			Route Name		Hà Nội - Hà Nam	
			Route Branch No.		0	
			Road Class		III	
		Jurisdisction	RRMU No.		RRMU-2	
			RRMC No.		RRMC234	
		KM Post	From	km	3	
				m	100	
			To	km	4	
				m	100	
		From	Latitude		200000	
			Longitude		1000000	
		To	Latitude		200000	
			Longitude		1000000	
		From	Province		Bac Can	
			City		x	
		To	Province		Bac Giang	
			City		x	
		Date	Kilopost Update	YY	4/2/2013	
			Data Entry	YY	4/2/2013	
		Length		m	1000	
		Actual Length		km	1000	
1.2	**Main Details**		Construction Completion Year	YY	11/11/1990	
			Year of Service Operation Open	YY	12/12/1990	
			Terrain Type		1	
			Temperature	°C	25	
			Annual Preciptation	mm	80	
			Road Bed Type		1	
			Design Speed	km/h	60	
		Roadway Lane Details	Lane Type		Down	
			Right of Way	m	15	
			Carriageway Width	m	7	
			Pavement Width	m	9	
		Motorized Lane	No. of Lane		2	
			Width of Lane	m	3	
			Pavement Type		3	
		Non-Motorized Lane	No. of Lane		1	
			Width of Lane	m	2	
			Pavement Type		1	
	Shoulder	Left Side	Width	m	1	
			Type (Pavement)		6	
		Right Side	Width	m	1	
			Type (Pavement)		5	
	Footpath	Left-side	Width	m	1	
			Type (Pavement)		5	
		Right Side	Width	m	1	
			Type (Pavement)		4	
	Road Structures	Structures (I)	Structure Type		1	
			Start Point	km	50000	
				m		
			End Point	km		
				m	50200	
			Center Point	km		
				m	50100	
			Location Name		HN	
1.3	**Remarks**					

Back to Select Data | Print | Edit | Check Validity

Figure 5.6.10 Data Display

(3) Temporary Saving of Inputted Data

Temporary saving function is provided to save inputted data temporarily before performing data validation check. Therefore, a window before entering into validation check as shown below is appeared to confirm whether to perform validation check now. If "No" button is clicked, the system prompts the message "Do you want to save inputted data temporally" to let user to decide whether inputted data needs to be saved. If "Yes" button is clicked, the system will save the inputted data temporarily within the interface system file automatically in the pivot table format.



(4) Data Validation Check

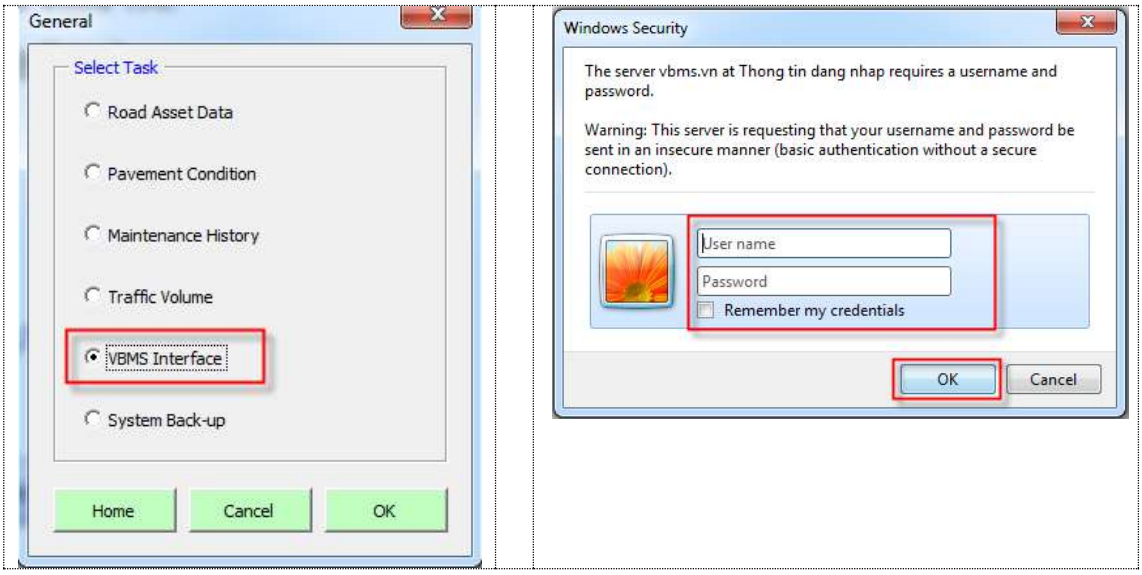
Data validation check function is provided to check inputted data thoroughly with the set criteria. Validation check function for checking items such as section overlap, data range, blank data and data format type (number & text) is provided. Validation check starts from checking section overlap. If validation check identifies the section overlap, checking of other check items are stopped and the process is backed to data input sheet automatically for necessary alteration in designated section. Section overlap is not allowed in any case. The result of validation check will be displayed and check-boxes for declaration of validity results (except for section overlap) whether to stop data pivoting based on validation result of a particular validation check item or converting data to pivot table by ignoring that particular validation check result. This declaration option is necessary to allow database operator for saving data even if all validation criteria do not meet. **However, it is highly recommended to input data and pass all validation check items successfully**. This option is included by considering the possibility of occurrence of blank data for some data items because some information / documents might have already lost.

5.6.6 Additional Functions

(1) Interface for VBMS

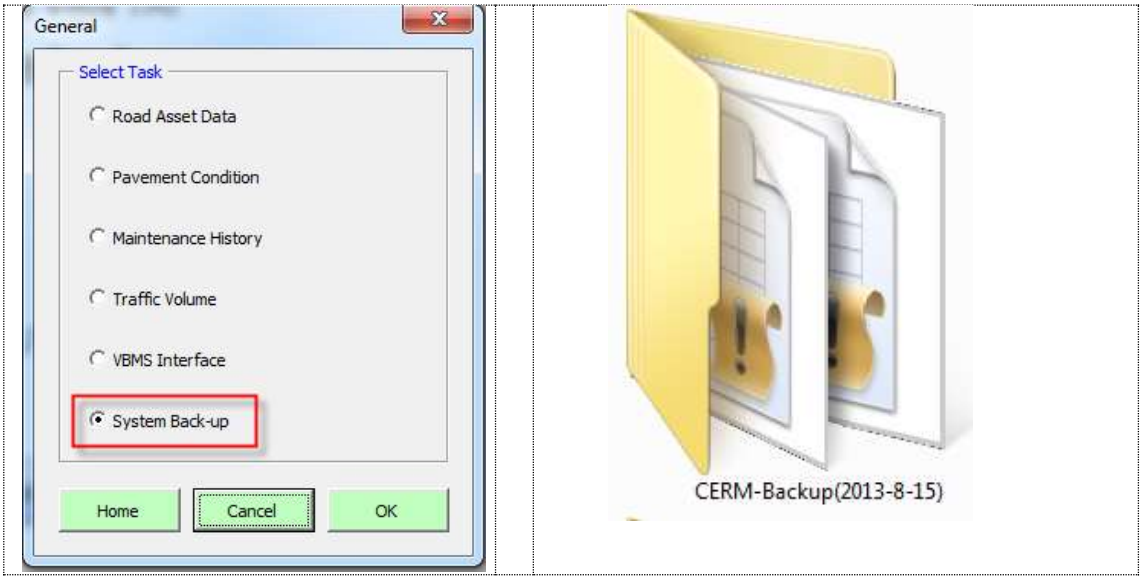
Interface for VBMS is provided to link the Road Database system and VBMS system. The current VBMS interface needs to login manually by inputting VBMS user ID and Password issued by VBMS team because automatic login is not allowed because of internet security system of VBMS. VBMS system stores bridge data in four modules and this interface is designed to import bridge inventory data only from the inventory module of VBMS system into the Road Database system.

Since VBMS has developed a more comprehensive bridge database system, the interface will directly access to VBMS website and follow the general procedure of data searching and exporting data in VBMS database. A specific port (access point) is designed in VBMS system so that data stored in inventory module can be downloaded at one-click.



(2) Data Back-up System

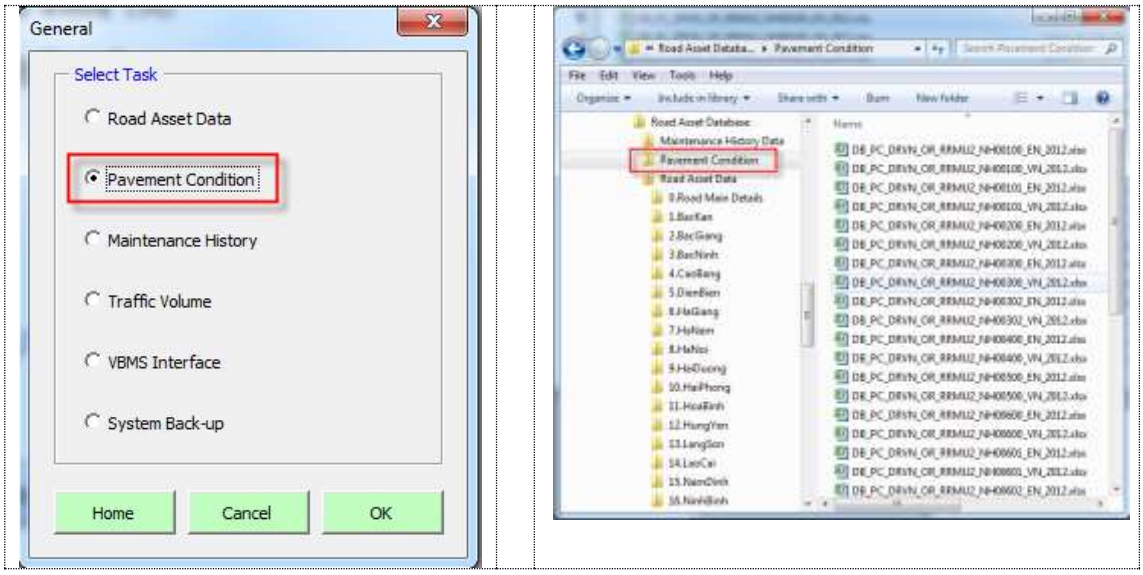
Data back-up function is provided to preserve the data and system interface from any accidental data losses or system troubles. Data back-up system stores the data in the folder defined by the user. The system will create name of system back-up folder and date automatically.



(3) Access to Pavement Condition Data

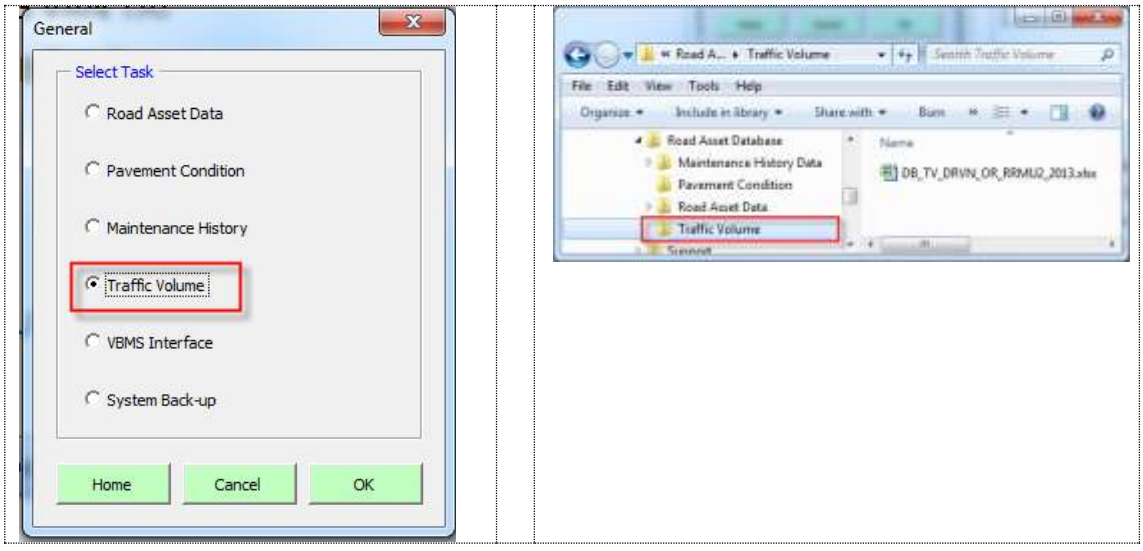
This function is provided to access the pavement condition data stored in the road database. Since pavement condition data are (to be) collected by special survey team using survey vehicle

and analysis software, it is not necessary to input data using data input sheet. Therefore, the final product (i.e. data) of the survey team can be saved directly in the pavement condition folder provided in the road database structure. Pavement condition data can be accessed by clicking the "**Pavement Condition**" button.



(4) Access to Traffic Volume Data

This function is provided to access traffic volume data stored in the road database. Since DRVN is collecting traffic volume data regularly and processed in the specified format, it is not necessary to input data using data input sheet. Traffic volume data can be saved directly in the traffic volume folder provided in the road database structure. Traffic volume data can be accessed by clicking the "**Traffic Volume**" button.



5.6.7 Data Collection and Input

Data collection and data input is RRMB's responsibility. Therefore, it is kindly requested to RRMB I to input data in the provided data input software in accordance with data input priority indicated in **Table 5.5.3**.Since data collection and inputting task is time consuming, RRMB I

staff might not be able to accomplish these tasks by themselves. Therefore, WG-4 has recommended for outsourcing of data collection and inputting tasks for the data items which need longer time in data collection and inputting. Further explanation on data collection and input is explained under section institutional arrangement (**Section 5.7**).

5.6.8 Data Sharing/Transmission among DRVN, RRMB and Sub-bureau

Since data will be inputted as offline basis, data transmission method shall be either by email or CD-ROM or USB. Based on the size of the data, data from SB to RRMB I and DRVN can be transferred via email or other media. There will be no problem due to data transformation method because data importing functions is provided in the database system. Main responsible organization for database and access control (i.e. administrating rights) to database system will be the organization to be assigned by DRVN. It is presumed that Information Center of DRVN will be the responsible for managing and operation of newly developed database system.

5.6.9 System Configuration

The system configuration (architecture) is illustrated in **Figure 5.6.11**.

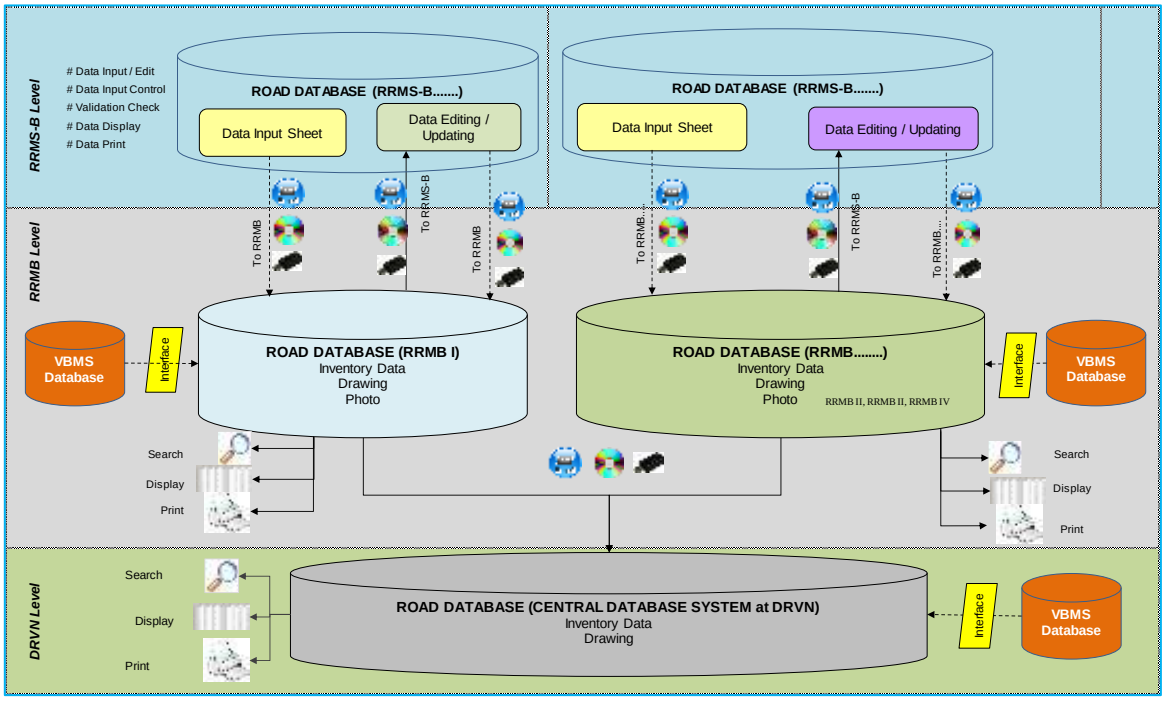


Figure 5.6.11 Road Database System Configuration

5.7 INSTITUTIONAL ARRANGEMENT FOR DATABASE SYSTEM DEVELOPMENT, UPGRADE AND EXPANSION

5.7.1 Data Input

(1) Road Asset Data (Inventory Data)

Inputting of road asset data can be managed by two ways as;

a. New National Roads

Inputting of road asset data of new roads (to be constructed) can be included in the construction contract so that upon completion of new construction road asset database will also updated. This provision in the contract commits the task of an initial data input to the existing construction contracts and obliges contractors to input data. Alternately, an independent contract after the facilities is taken over to the maintenance sectors and to commit the tasks of an initial data input to the consultants specialized for data processing.

b. Existing National Roads

For existing national roads two data input cases need to be taken into consideration; (1) initial data input, and (2) future information update. By taking reference from foreign practices, it is recommended that data input tasks can be outsourced to consultants specialized for data processing in order to not to impose much workloads to government officials and to ensure data reliability. If difficulty exists in outsourcing data input, it is necessary make obliges to RRMBs, and SBs to input data in priority basis.

(2) Maintenance History

From the current status survey conducted at the beginning of this project, it is found that data f national road maintenance and repair works have been preserved in hard copy formats and never been computerized yet, so that initial data input should be managed by RRMBs and relevant sub-bureaus directly involved in daily road maintenance and repair works. As for future update of information needed on the occasions of road maintenance and repair works, outsourcing of data input to maintenance and repair work companies (i.e. inclusion of data updating of the target section in maintenance and repair work contract) would be more practical than direct data management by DRVN / RRMB staff.

(3) Pavement Condition

Pavement condition survey has not been standardized yet in the current DRVN Routine Maintenance Technical Standards. DRVN is recommended to include this pavement condition survey as a regular inspection method and implement it regularly. Measurement of IRIs and rutting depths can be automatically performed by a special vehicle equipped with advanced technologies. Also, crack ratio can be calculated by analyzing images taken during pavement

condition survey. With these, DRVN is recommended to put a professional technical organization, RTC Central, in charge of implementing pavement condition surveys, analyzing data and inputting data into databases. In addition, vehicle maintenance and operation should belong to the responsibility of RTC Central.

(4) Traffic Volume

The traffic volume database has been developed by DRVN and is currently available as an off-line database in MS-Excel. SBs are currently in charge of inputting data into the database. The same arrangement can continue unless there would not be any changes in the Technical Standard on Road Routine Maintenance 2003.

5.7.2 System Development, Upgrading and Expansion

Road database system has been developed on the basis of the framework agreed between DRVN and JICA Project Team. The Database system is not much complicated because it has been developed in MS-Excel platform with some embedded VBA tools, all procedures of database system development have been explained to concerned staffs of DRVN and RRMB I through Working meeting and trainings. Technology transfer specifically for database system development has also carried-out to the concerned staff of DRVN, RRMB I, RTC Central and RTC 2.

For sustainability of the database system, proper institutional arrangement for system maintenance, upgrading and expansion of system is necessary. Therefore, it is recommended that a professional engineering organization like Information Center of DRVN should take responsibility for managing and operating the road database system. Similarly, for critical system problems or significant system upgrading, a provision of acquiring technical supports from IT specialized agencies such as RTC, UTC and private IT companies shall also be considered. In particular, RTC Central is requested to play a key role in managing technical issues of software systems nationwide including system maintenance, system upgrade and technical supports to PDOTs and subordinates organizations.

5.8 PRACTICAL APPLICATION OF ROAD DATABASE SYSTEM

The road database system developed under JICA Project has been tested by number of trial runs. Trial runs are conducted in a group as well as in person. Trial run in group was performed in WG meeting and technical training. Trial runs by specialized persons from DRVN and RRMB I in-charge for database management were performed to confirm the each function of database system. The system has been updated time to time to incorporate all reasonable comments provided by DRVN and RRMB I.

The new database system has been used for inputting the real data of "Road Main Details" of national roads under RRMB I Jurisdiction. All eight (8) Sub-bureaus were mobilized to input

"Road Main Details" data. Since RRMB II Field Offices have been using this newly developed system practically first time, a careful analysis of the inputted data has been done to check the quality of data inputted in the database. The summary of data inputted by RRMB I is illustrated in **Table 5.8.1**.

Table 5.8.1 Summary of Data Inputted by RRMB I (as of October, 2013)

SN	RRMU	Road Name	Total Lengh (km)	Data Inputted by RRMB I								Percentage (%) Coverage
				Lengh of Inputted Data (km)				No. of Sections				
				Both	Up	Down	Total	Both	Up	Down	Total	
1	RRMU-2	QL.1A	256.064	255.064	0.000	0.000	255.064	38	0	0	38	99.61%
2	RRMU-2	QL.2	281.900	260.650	20.050	0.000	280.700	0	12	0	12	99.57%
3	RRMU-2	QL.3	311.136	0.000	75.660	230.620	306.280	10	0	25	35	98.44%
4	RRMU-2	QL.3B	129.000	0.000	0.000	0.000	0.000	0	0	0	0	0%
5	RRMU-2	QL.4E	44.200	44.200	0.000	0.000	44.200	3	0	0	3	100%
6	RRMU-2	QL.5	81.325	81.325	0.000	0.000	81.325	5	0	0	5	100%
7	RRMU-2	QL.6	345.207	66.032	0.000	278.815	344.847	9	0	40	49	99.9%
8	RRMU-2	QL.10	166.750	0.000	8.880	121.420	130.300	0	1	25	26	78.14%
9	RRMU-2	QL.15	20.000	0.000	0.000	20.000	20.000	0	0	6	6	100%
10	RRMU-2	QL.18	46.300	42.300	0.594	0.773	43.667	9	4	2	15	94.31%
11	RRMU-2	QL.38	82.195	67.490	0.000	0.000	67.490	22	0	0	22	82.11%
12	RRMU-2	QL.38B	17.690	0.000	0.000	17.690	17.690	0	0	8	8	100%
13	RRMU-2	QL.43	53.715	0.000	0.000	53.715	53.715	0	0	12	12	100%
14	RRMU-2	QL.70	198.050	198.050	0.000	0.000	198.050	8	0	0	8	100%
15	RRMU-2	QL.279	116.000	116.000	0.000	0.000	116.000	16	0	0	16	100%
16	RRMU-2	HCM Route	65.000	65.000	0.000	0.000	65.000	3	0	0	3	100%
Total			**2,214.53**				**2,024.33**				**258**	**91%**

After careful checking of data inputted by RRMB I, it is found that data has been inputted for a total of 258 sections which covers approximately 91% of total national road length under RRMB I jurisdiction. Since different versions of software have been provided in the course of system development to check and confirm the system by DRVN side, some of the SBs have used other than the latest version. However, in overall, the quality of inputted data is quite satisfactory because all data are inputted in the similar format as requested.

5.9 TECHNICAL TRAININGS DURING THE PROJECT (ACTIVITY -1)

5.9.1 Introduction

As described in the previous sub-chapters, under Acitivity-1 of the Project, a new road database system has been developed in collaboration with DRVN. The number of counterpart members in the working group – 1 is limited; seven persons from DRVN and one (1) person from RRMU II, because of technical and other administrative reasons. However, it is presumed that data inputting task will be assigned to local and regional organizations in the near future. There is only one (1) working group member from such regional organization (i.e. from RRMU II) and no member from other regional and local organizations at present. Also, it is anticipated that database system might need upgrading / revision in the course of time to incorporate any additional demands that may occur in the future. Therefore, it is necessary to train officials of DRVN and their regional and local agencies who will be the potential trainers / users of this database system in the future. Also, technology transfer is one of the main objectives of the Project and it can be achieved only by disseminating the technology (i.e. project output) to as many as users so that the technology transferred through the Project will be more effective and sustainable.

5.9.2 Training Plan

Training plan has been prepared for both "During the Project" and "After the Project" cases by discussing with counterpart members of the working group -1. "During the Project" training has been implemented within the Project period and JICA Project Team experts are the main trainer of the training. The training plan prepared for "During the Project" training is shown in **Table 5.9.1**. As shown in **Table 5.9.1**, the training courses for "During the Project" training are divided into three consecutive courses, and each training course consists of both classroom lecture and computer practice.

The ultimate objective of the "During the Project" training is to develop trained trainers for road database development, operation and management.

5.9.3 Implementation of Trainings

The technical trainings were implemented on 6th June, 20th June, 28th August, 2013 and 4th March 2014, as per the plan as shown in **Table 5.9.1**. The successive trainings were implemented by reviewing the previous trainings and considering the feedback of the trainees on the road database system. Trainees were evaluated after each training to measure the level of knowledge or skills they gained thorough the training program. The detailed training report of each training are explained in **Appendix-A1.**

Table 5.9.1 Training Plan for "During the Project" Training

Training	Training Style	Date / Duration/ Frequency	Objectives	Curriculum	Trainee	Training Material
1st Training	Classroom	Date: June, 201.3 Duration: 1 day	To make familiar with; ▪ Overall Database System ▪ System Algorithm ▪ Database Structure ▪ Data Input Format ▪ Database Operation and Management (data input, validation check, data storage, etc.) ▪ User Manual	**Session – I** · Overall Database System · System Algorithm · Database Structure · Data Input Format (including data input control) **Session - II** · Database Operation and Management (Data input, validation check, data storage, editing, importing, data assembling / collection from various agencies, etc.) · Utilization of Users' Manual	DRVN: 7 RRMU II: 4 RRMC: 12 RTC Central: 1 RTC 2: 1 **(Total = 25 participants)**	· Database Software with User Manual (Draft) · PPT hand-outs · Sample Data (draft data/hard or soft copy)
	OJT (Computer Practice)			**Session – III** **Practicing** · System Installation · Data input**(1st Priority Data Items)** · Validation check · Data storage and Editing · Data Search, Display and Printing · Resumption of Data Input Task	Total Participants: 25 (5 Groups) Total participants will be divided into 5 groups (5 participants in each group) and practicing will be done in turn.	
2nd Training	Classroom	Date: June, 2013 Duration: 1 day	To make familiar with; ▪ Database Operation and Management (Data Input, Data editing, data assembling / collection, data storage, etc.) ▪ System Upgrading and Editing ▪ VBMS Interface ▪ Importing Pavement Condition Survey	**Session – I** · Database Operation and Management (Data Editing, Data Assembling /Collection from various agencies) · System Upgrading and Editing · VBMS Interface	DRVN: 7 RRMU II: 4 RRMU II Field Office: 8 RTC Central: 4 RTC 2: 4 **(Total = 27 participants)**	· Database Software with User Manual (Draft) · PPT hand-outs · Sample Data (draft data/hard or soft copy)
	OJT (Computer Practice)			**Session – II** **Practicing** · Data Input / Validation Check **(2nd Priority Data Items)** · Extracting data form VBMS · Data assembling /collection from various agencies · Simple editing of database system	Total Participants: 27 (4 Groups) Total participants will be divided into 4 groups (7 participants in each group) and practicing will be done in turn.	
3rd Training	Classroom	Date: Sep, 2013 Duration: 1day	To make familiar with; ▪ Database Operation and Management (Data Input, Data Backup, system, etc.) ▪ System Upgrading and Editing (Particularly for Future Expansion)	**Session – I** · Database Operation & Management · Data Backup system · System Upgrading and Editing	DRVN: 7 RRMU II: 4 RRMU II Field Office: 8 RTC Central: 4 RTC 2: 4 **(Total = 27)**	· Database Software with User Manual · PPT hand-outs · Sample Data (draft data/hard or soft copy)
	OJT (Computer Practice)			**Session – II** **Practicing** · Data Input / Validation Check **(3rd -5th Priority Data Items)** · Database Backup System · System upgrading (future expansion)	Total Participants: 27 (4 Groups) Total participants will be divided into 4 groups (7 participants in each group) and practicing will be done in turn.	
Intensive Training	Class Room	Date: 4 March, 2014 Duration: 1 day	All of Above (Training 1st, 2nd, and 3rd)	**Session-I**: Lecture; All of Above (Training 1st, 2nd and 3rd)	DRVN RRMB I Sub-bureaus RTC Central, RTC 2	-ditto-
	OJT			**Session-II**: Practicing; All of Above (Training, 1st, 2nd and 3rd)		

CHAPTER 6 ENHANCEMENT OF PLANNING CAPACITY FOR ROAD MAINTENANCE

6.1 GENERAL

A total road network in Vietnam is reached to approximately 279,928 kilometer (as of 2009) in length. The share of national road is about 6% which is equivalent to 16,758 kilometers. A road infrastructure is a national asset to be taken over the next generation and taking over is possible only if road infrastructures are maintained properly. Therefore, systemic road maintenance planning is necessary to shift from ex post fact maintenance to strategic planned maintenance. For strategic maintenance planning a systematic / scientific planning tool and reliable updated pavement data are necessary. For fulfilling these requirements of planning system, JICA project on "Capacity Enhancement in Road Maintenance in Vietnam" has included the four (4) components in the project framework; (1) Collection of the latest pavement condition data, (2) Development of road asset database, (3) Data conversion software to convert data from road database to PMS dataset, and (4) Maintenance planning software.

Activity 2: Enhancement of Planning Capacity for Road Maintenance under the JICA project on "Capacity Enhancement in Road Maintenance" consists of the following two sub-activities; i) Activity 2-1: Conducting Pavement Condition Survey and ii) Activity 2-2: Development of PMS Dataset (i.e. development of Conversion Software), Planning Software and Formulation of a Mid-term Road Maintenance Plan. Activities of Pavement Condition Survey are explained in **Section 6.2**. Development and features of conversion software are explained in **Section 6.3**. Similarly, development of planning software and mid-term and annual pavement maintenance plans of RRMB I jurisdiction are explained in **Section 6.4**. Maintenance plan to be referred hereinafter is pavement maintenance plan only.

6.2 PAVEMENT CONDITION SURVEY

6.2.1 General

The pavement maintenance planning software developed under the Project requires three types of pavement defects indices; (1) Cracking, (2) Rutting depth, and (3) International Roughness Index (IRI). The software requires at least two time series pavement condition data for evaluating pavement deterioration speeds and estimation of pavement defect indices for the future. Among the two time series data, one set of time series data is the pavement condition level at the present time. The pavement condition data are the key data for success of road asset management system.

The pavement condition surveys were conducted in national roads of Vietnam in 2004 and 2007 for running HDM-4 software for preparing road maintenance plan of national roads of Vietnam.

However, it is preferable to have the actual pavement condition of the year of pavement deterioration evaluation and budget planning. Therefore, JICA has provided support to DRVN for collecting pavement condition data in 2012 in the national roads of RRMB I jurisdiction. The collected data were utilized for pavement maintenance planning

6.2.2 Current Practices in DRVN

Pavement condition survey equipment such as ARAN, FWD, and IRI measuring equipment were provided by various donors in the past in DRVN under the ODA projects. However, most of them are not in operational condition at the moment either by lack of spare parts or operation manual or technical problems on the equipment. The latest data collection by using the available equipment in DRVN was in 2007. However, the quality of data collected and inputted in 2007 is very low and thus DRVN has requested not to use those data for the maintenance planning purpose.

6.2.3 Overseas Practice (Practice in Japan)

In Japan, pavement condition survey has been conducting since 1970s. As for national highways, pavement condition survey is conducted in every three (3) years interval. Pavement condition surveys are conducted with special vehicles for identifying repair sections and repair work method. Since national roads in Japan have been managed by central and local government, the planning software and pavement condition survey vehicles may varies province by province to comply with their planning software. Also, the list of data items to be collected by the special vehicle depends upon the planning system that has been used for the planning purposes.

6.2.4 Implementation of Pavement Condition Survey under JICA Project

JICA has dispatched a team specialized in pavement condition survey and data processing between February 2012 and March 2013. Pavement condition survey and data processing has been implemented as described below.

(1) Implementation Schedule

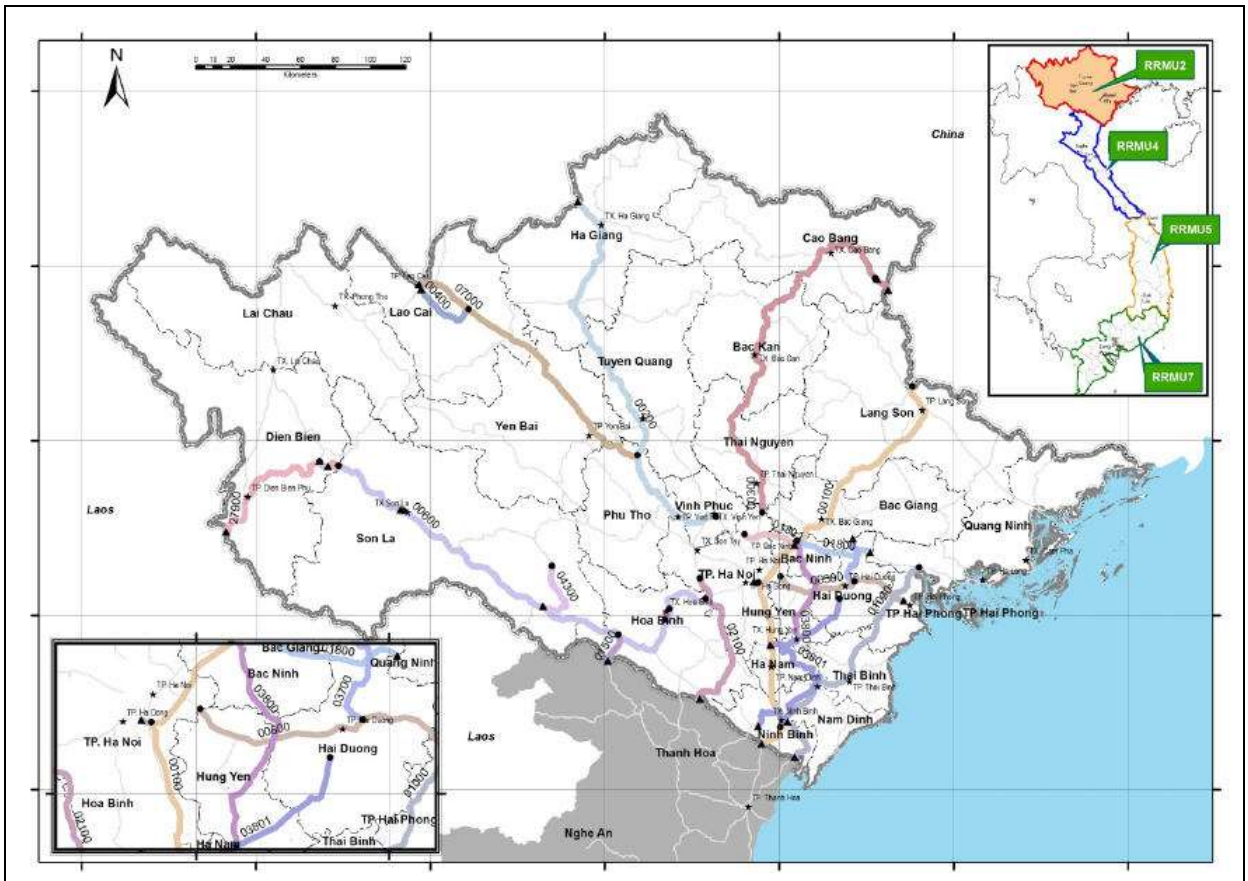
The activities of pavement condition survey were broadly divided into three main activities as shown in **Table 6.2.1**. The Pavement condition survey basically has been implemented as below;

Table 6.2.1 Implementation Schedule

SN	Activities	Date	Remarks
1	Field Reconnaissance	April, 2012 ~ June, 2012	
2	Pavement Condition Survey (Field Survey)	July, 2012 ~ November, 2012	
3	Data Analysis (Office Work)	July, 2012 ~ December, 2012	

(2) Target Routes

Survey routes cover RRMB I in the north of the country with total length of 2,303 km and in both directions totaling 4,606 km, which is under the jurisdiction of the RRMB I. Locations of the survey routes are shown in **Figure 6.2.1**.



National Highway 1 (570.8km)	National Highway 1with Ninh Phuc port (12.83 km)
Southern Ring Road No.3 to Cau Dau (5.4 km)	National Highway 15 (40.0 km)
National Highway 2 (563.8 km)	National Highway 18 (92.6 km)
National Highway 3 (622.2 km)	National Highway 37 (74.4 km)
National Highway 4E (88.4 km)	National Highway 38 (169.0 km)
National Highway 5 (162.8 km)	National Highway 43 (107.4 km)
National Highway 6 (690.6 km)	National Highway 70 (396.2 km)
National Highway 6-1 (Old Bypass Road)	National Highway 279 (232.0 km)
National Highway 6-2 (Old Bypass Road)	Route Noi Bai - Bac Ninh (62.2 km)
National Highway 6-3 (Old Bypass Road)	Ho Chi Minh Route (188.0 km)
National Highway 10 (346.6 km)	National Highway 38B (240.0 km)

Source: Pavement Condition Data Collection Survey Report (2013)

Figure 6.2.1 Target National Roads for Pavement Condition Survey

(3) Vehicle / Equipment

Various types of equipment such as Laser Profiler (LP), Laser Displacement Sensors (LDS), Inertial Measurement Unit (IMU), Front Camera (FC), Road Camera (RC), and Control Devices (CD) were installed on the vehicle as shown in **Figure 6.2.2** and **Figure 6.2.3**. In addition to these equipment, trip meter was used in field reconnaissance survey. The specification of key measurement devices is shown in **Table 6.2.2**. The road condition survey vehicle is registered in NETIS (New Technology Information System, the Ministry of Land, Infrastructure and Transport: No.KT-110060-A).

Table 6.2.2 Specification of Measurement Devices

Item	Survey Precision
Length	Within ±0.5% of the actual value of tape measurement
Crack	A crack with of two millimeters wider can be identifiable.
Rutting-Depth	±6 ㎜ of the measured values of the section profile graphs
IRI	Class 2 (Pavement Study and Testing Guideline)
Forward View Image	Full High Vision CCD Camera (1,920 (W）×1,080 (H）)

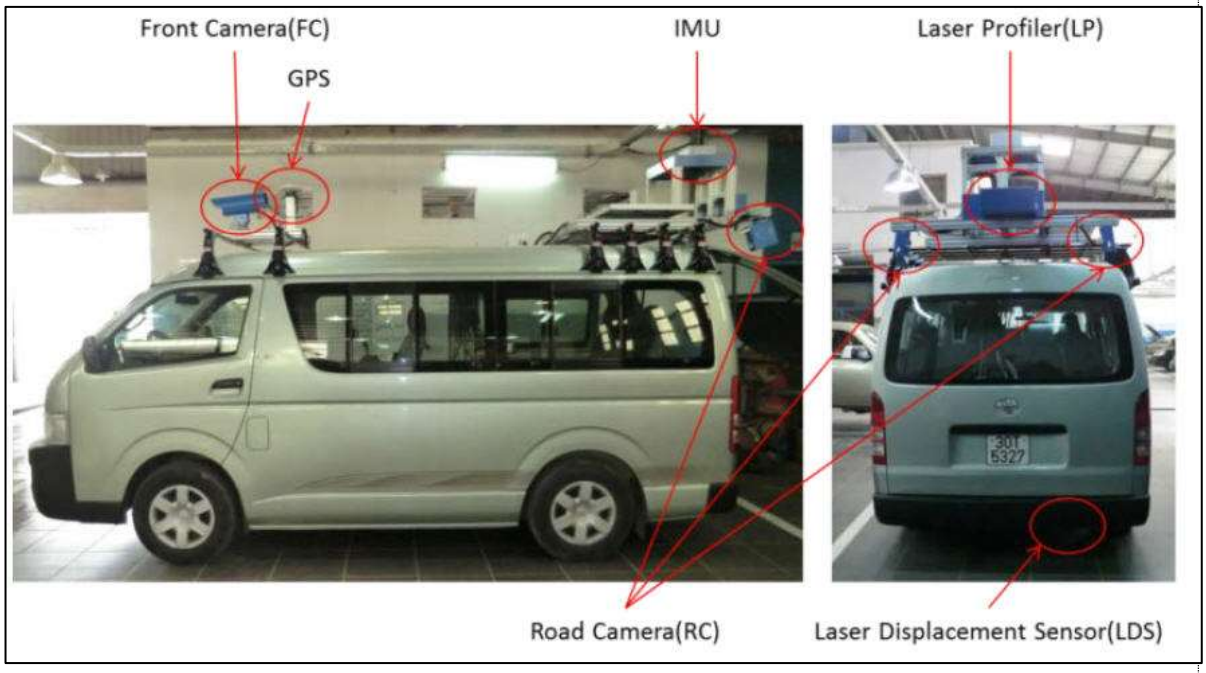


Figure 6.2.2 Pavement Condition Survey Equipment and Vehicle

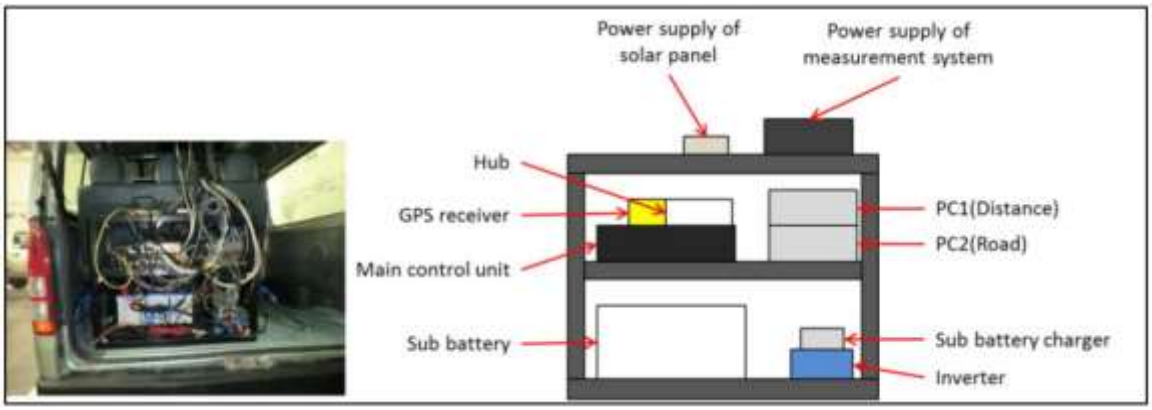


Figure 6.2.3 Control Devices of Pavement Condition Survey

Source: Pavement Condition Data Collection Survey Report (2013)

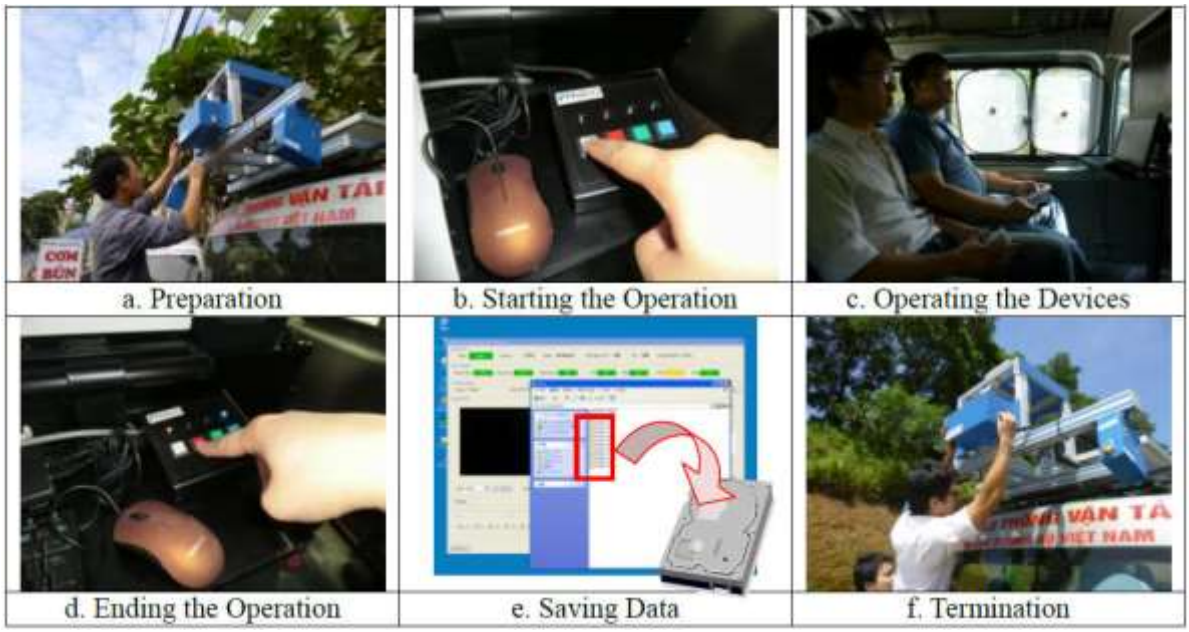
(4) Survey Methodology

1) Field Reconnaissance Survey

The field reconnaissance work recorded the checking points required for the pavement condition survey and pavement damage interpretation / analysis and pavement condition data file preparation. The major checking items were locations and conditions of: starting and ending points; distances between kilometer posts; major road structures; and locations of administration changes. Before conducting the measurement of each rout, a trip meter calibration was done to check the accuracy of the devices and necessary adjustment has been done.

2) Pavement Condition Survey

Pavement condition survey methodology is illustrated in **Figure 6.2.4**.

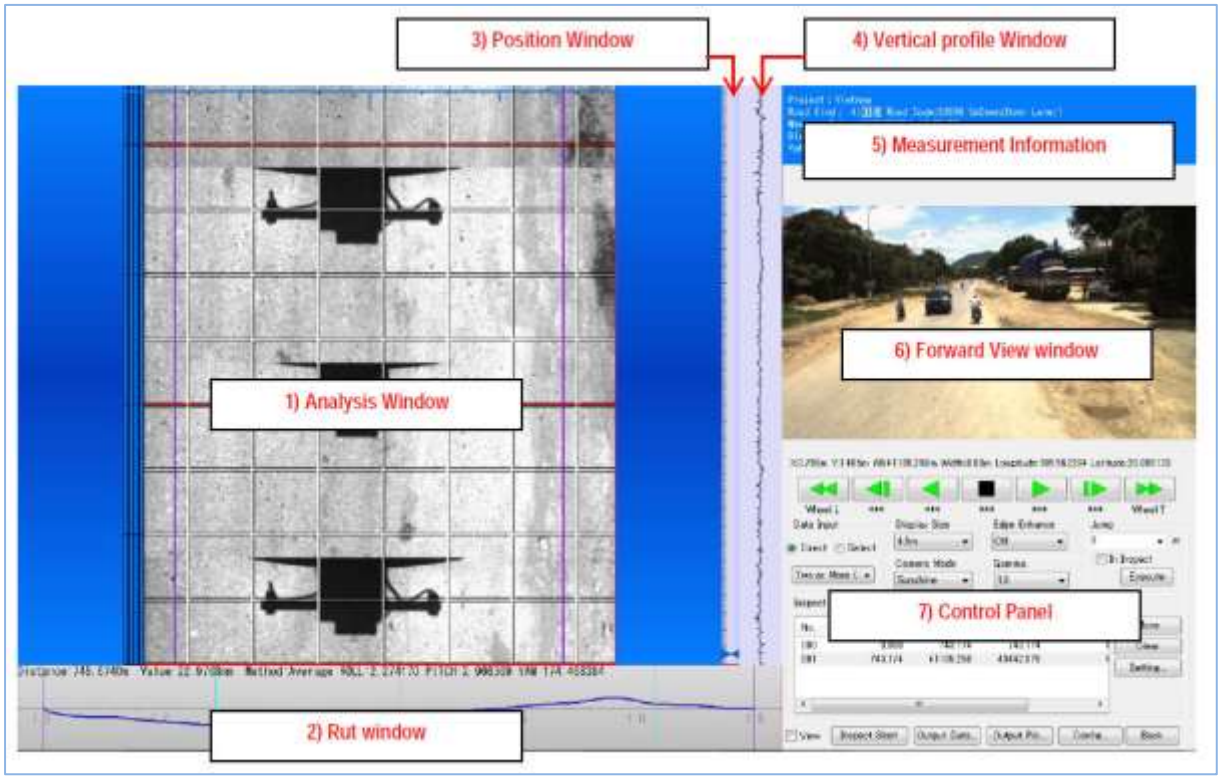


Source: Pavement Condition Data Collection Survey Report (2013)

Figure 6.2.4 Pavement Condition Survey Methodology

3) Data Processing / Analysis

A special computer program was developed to interpret and analyze the pavement damages. The program basically analyzes the images taken during the pavement condition survey. A set of rules has been developed to interpret the images. The features of the Pavement Damage Interpretation/Analysis Program are shown **Figure 6.2.5**.



Source: Pavement Condition Data Collection Survey Report (2013)

Figure 6.2.5 Pavement Damage Interpretation / Analysis Program

(5) Output

The final output of pavement condition survey consists of pavement defects data, general information data of the road sections, location of major road structures, pavement type, etc. Three types of pavement defect indices; cracking, rutting depth and IRI are presented in the table. In addition to data in pivot table, images taken by the high definition camera installed on the vehicle are also provided as the output of the survey. Data in pivot table are presented by direction of road (i.e. Up-bound and Down-bound). A sample pivot Table is shown in **Figure 6.2.6**. In general, pavement condition data are prepared for every 100m interval.

■Pavement Conditions

Geographical Area	Jurisdiction	Maintenance Company	Route Number	Branch Number	Route Name	Kirometer Post				Section Length (m)	Analysis Area (m2)	Structure	Intersection	Overlapping	Number of Lane		Survey Lane		Surface Type	Condition (Distress)									Note
						From (km,m)		To (km,m)												Date (yyyy/mm)		CrackingRatio/ Cracking Index(%/㎡/m²)				Rutting Depth(mm)		IRI (mm/m)	
															U	D	U/D	Path Lane				Cracking	Patching	Pothole	Total	Max	Ave		
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	0	0	10	10	*****				*	*	D	*	**	****	**	*****	*****	*****	*****	***	***	*****	Impassable(International Border Area)
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	10	0	100	90	340.2				2	2	D	1	AC	2012	10	0	0	0	0	31	9	10.25	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	100	0	200	100	344				2	2	D	1	AC	2012	10	0	0	0	0	13	6	5.5	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	200	0	300	100	327				2	2	D	1	AC	2012	10	0	0	0	0	10	6	2.93	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	300	0	400	100	324				2	2	D	1	AC	2012	10	2.9	0	0	2.9	15	7	2.95	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	400	0	500	100	328				2	2	D	1	AC	2012	10	0	0	0	0	11	8	2.3	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	500	0	600	100	327				2	2	D	1	AC	2012	10	0	0	0	0	10	7	2.91	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	600	0	700	100	331				2	2	D	1	AC	2012	10	0	0	0	0	16	7	3.14	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	700	0	800	100	354				2	2	D	1	AC	2012	10	0	0	0	0	20	11	2.66	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	800	0	900	100	362				2	2	D	1	AC	2012	10	0	0	0	0	20	10	2.39	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	0	900	1	0	100	373				2	2	D	1	AC	2012	10	0	0	0	0	12	7	2.41	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	0	1	100	100	376				2	2	D	1	AC	2012	10	0	0	0	0	13	6	2.35	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	100	1	200	100	348				2	2	D	1	AC	2012	10	0	0	0	0	13	7	4.08	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	200	1	300	100	358				2	2	D	1	AC	2012	10	0	0	0	0	11	6	3.28	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	300	1	400	100	351				2	2	D	1	AC	2012	10	0	0	0	0	12	7	2.57	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	400	1	500	100	346				2	2	D	1	AC	2012	10	0	0	0	0	17	9	2.23	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	500	1	600	100	339				2	2	D	1	AC	2012	10	0	0	0	0	15	8	2.36	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	600	1	700	100	344				2	2	D	1	AC	2012	10	0	0	0	0	15	7	2.01	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	700	1	800	100	358				2	2	D	1	AC	2012	10	0	0	0	0	14	7	1.96	
NORTHERN AREA	RRMU2	RRMC236	1	0	NATIONAL HIGHWAY1	1	800	1	900	100	372				2	2	D	1	AC	2012	10	0	0	0	0	28	13	2.28	
NORTHERN																												

Down Up

Source: Pavement Condition Data Collection Survey Report (2013)

Figure 6.2.6 Output of Pavement Condition Survey (Pivot Table)

6.2.5 Institutional Arrangement

Pavement condition survey needs a specialized knowledge to carry out field survey as well in data analysis in the office. The reconnaissance survey is also very important to locate the roads properly and input the data in right place after data analysis. Measurement of IRIs and rutting depths can be automatically performed by a special vehicle equipped with advanced technologies. Also, crack ratio can be calculated by analyzing images taken during pavement condition survey however, it needs specialized knowledge in image analysis. With these, DRVN is recommended to put a professional technical organization, RTC Central, in charge of implementing pavement condition surveys, analyzing data and inputting data into databases. In addition, vehicle maintenance and operation should belong to the responsibility of RTC Central.

A set of pavement condition survey vehicle together with data analysis software has already provided to DRVN by JICA in March 2014. RTC Central is assigned by DRVN to operate and maintain the vehicle.

6.2.6 Technical Training

Technology transfer on pavement condition data collection survey and data analysis has been made to DRVN staff, RRMB I staff and RTC Central staff. On the job training and workshop were organized to transfer the technology to Vietnamese engineers. The following trainings were organized to enhance the capacity on pavement condition survey.

Table 6.2.3 Technical Training

SN	Training Type	Date	Remarks
1	On-the-Job Training on Reconnaissance Survey	9 Apr. ~ Jun. 2, 2012	By Survey Team
2	On the Job Training on Pavement Data Collection Survey	23 Jul. ~ 21 Dec., 2012	By Survey Team
3	On the Job Training on Data Analysis	23 Jul. ~ 21 Dec., 2012	By Survey Team
4	Workshop	28 Feb., 2013	By Survey Team
5	On the Job Training on Pavement Data Collection Survey and Data Analysis	25 – 26, Feb., 2014	

6.2.7 Analysis of Pavement Condition Data

Data submitted by pavement data collection survey team was analyzed to check the overall pavement condition in RRMB I jurisdiction. The results of analysis are summarized in **Figure 6.2.7**. Some key findings of the analysis are shown below.

- Approx. 70% of total length of National roads has average cracking less than 5%.

- Approx. 80% of total length of National roads has average rutting depth between 5 and 20mm.
- Approx. 62% of total length of National roads has average IRI between 2 and 5 m/km.
- Approx. 72% of total length of National roads has average Maintenance Control Index (MCI) between 6 and 9.

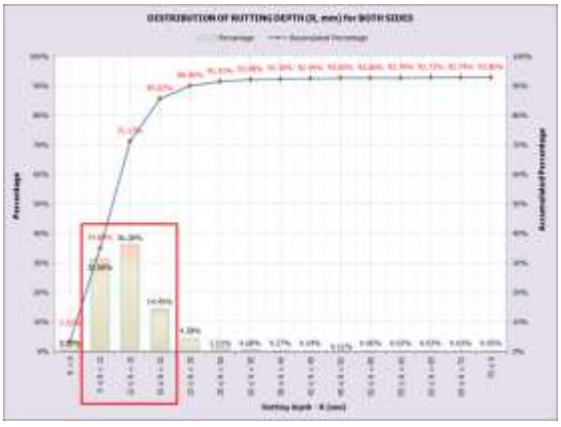
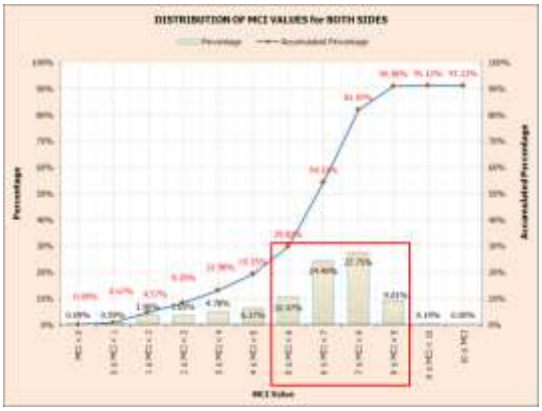
	
Overall Pavement Condition in terms of Cracking	Overall Pavement Condition in terms of IRI
	
Overall Pavement Condition in terms of Rutting Depth	Overall Pavement Condition in terms of (MCI)

Figure 6.2.7 Results of Pavement Data Analysis (as of 2012)

6.3 PMS AND PMOS DATASET DEVELOPMENT

6.3.1 Rationale of PMS and PMoS Dataset Development

Road database is a heart of any management system and it contains various types of data of road asset such as bridge, pavement, culverts, traffic management facilities, facilities for pedestrians, and road side facilities. Pavement Management System (PMS) which deals only with the pavement requires basically the pavement related data including some road inventory data. A set of input data requires for running PMS is defined as PMS Dataset. Similarly, Pavement Monitoring System (PMoS) requires pavement related data including some inventory data. A set of input data requires for running PMoS is defined as PMoS Dataset. Required data for PMS and PMoS are stored in Road database however these data are not integrated into a single file. Therefore, there are two options; (1) direct input of PMS dataset into PMS and PMoS software manually, and (2) import the required data from road database by the computer software and integrate them into a single file. Based on the experiences in DRVN in the past, either of the options was not worked as expected and eventually the planning software could not operate successfully. Therefore, a computer software (hereinafter referred to as "Conversion Software) was developed to create PMS and PMoS datasets automatically by the computer software to eliminate the manual data inputting into the PMS and PMoS. The data flow from road database to PMS and PMoS is shown in **Figure 6.3.1**.

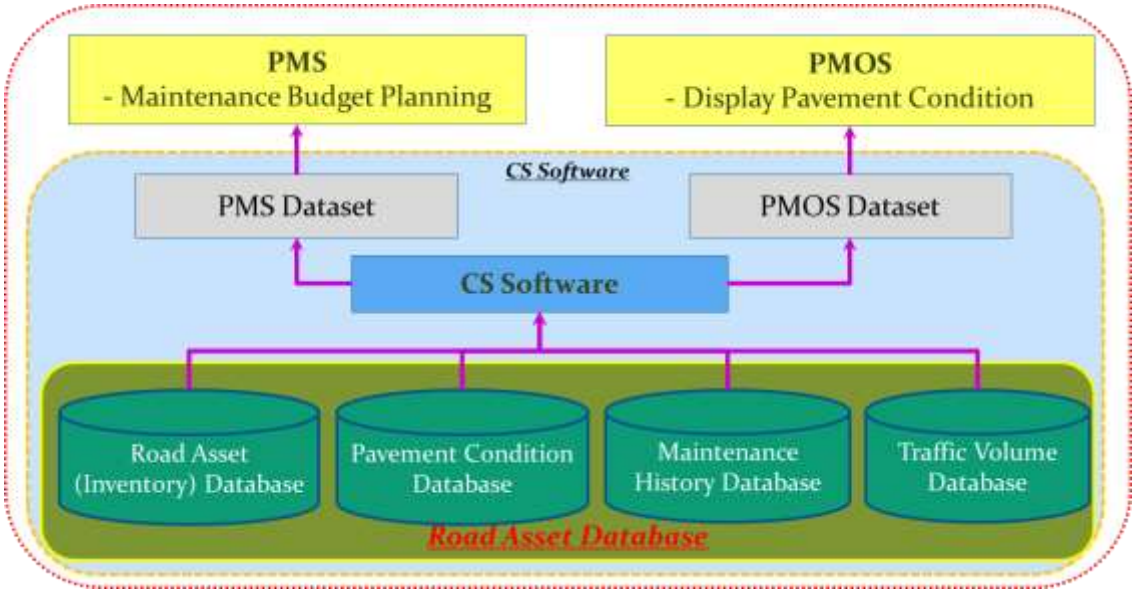


Figure 6.3.1 Road Database, Conversion Software and PMS & PMoS

6.3.2 Purpose of Applying Conversion Software

The main purpose of applying conversion software is to prepare error-free datasets by importing the required data from road database for operating PMS and PMoS software. In addition to data importing, conversion software will convert point data of traffic volume into

section data. Also, synchronization of location data and homogenous sectioning are also done by the conversion software.

6.3.3 Conversion Software Users

The users of conversion software are basically the PMS and PMoS software users because PMS and PMoS datasets users are exclusively used by them only.

6.3.4 Development of Conversion Software

1) System Objectives

Conversion software has been developed for fulfilling the following objectives;

- Data import from road database
- Convert point data into section data (for traffic volume data)
- Synchronization of location information among road asset, maintenance history, traffic volume and pavement condition data
- Homogenous sectioning of all four types of data
- Data integration into a single table
- Data validation check

(2) Main Functions

a. Data Importing from Road Database

This function extracts the selected data items of PMS and PMoS from the main details pivot table of Road Asset (RA), Maintenance History (MH), Pavement Condition (PC) and Traffic Volume (TV). The data structure (i.e. pivot table), file name, and location of main details of each data type are already fixed inside the road database structure. If main details pivot table of any of the data type is not created using the latest data, users shall update the main details pivot table using the tools available in road database system.

b. Location Synchronization and Sectioning

Data in road database are not in homogenous sections. Moreover, traffic volume data are stored as point data. Synchronization of location referencing and preparing data in homogenous section (i.e. 100m) is done in this stage internally by the system. Location synchronization is done based on kilometer post. Point (station) traffic volume data are also projected into section data.

c. Validation Check of Imported Data

To prevent from any system error in the PMS and PMoS by the reason of improper data, validation check is performed to ensure that data to be extracted into PMS / PMoS dataset are

in proper format and structure. This function will check the validation of data at source file (i.e. CS input file).

d. Data Distribution to Output Dataset Structure

Upon synchronization among road asset data, maintenance history, pavement condition, and traffic volume and homogeneous sectioning, these four types (i.e. RA, MH, PC, and TV) of data are distributed to a common output dataset structure which is already fixed and stored inside the system. Output dataset structure for PMS dataset and PMoS dataset are different.

e. Final Validation Check of Distributed Data

The final confirmation of data (i.e. right data distributed in right column) is carried-out before exporting the dataset as an output of the Conversion Software.

f. Final Output Dataset (PMS / PMoS)

If final validation of data in output dataset is passed successfully, output can be exported as PMS and PMoS dataset. The output file can be saved in the user's desired location.

The system window which shows various function buttons and features of the system is shown in **Figure 6.3.2.**

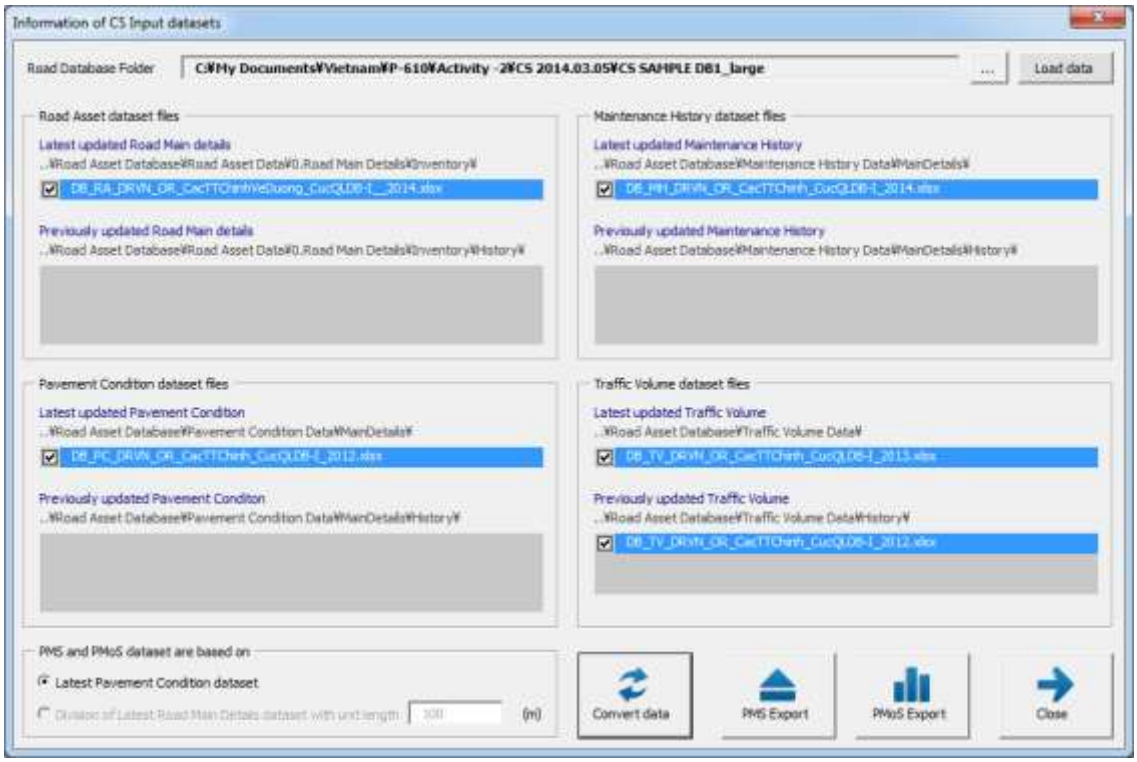


Figure 6.3.2 System Window

(3) Pre-requisite Conditions

(i) It is required to have updated main details pivot tables of road asset data, maintenance history data, pavement condition data and traffic volume data.

(ii) Structure of main details pivot table should not be changed unless proper modification has been made in the Conversion Software. If structure of pivot table structure of main details are changed and the Conversion Software is used for data integration the Conversion Software either may import different data taking into account of the original pivot table structure or may display error message.

(iii) If location and file name of main details in road database changed, the Conversion Software should also be updated accordingly otherwise system may display error message.

(iv) The Conversion Software is a kind of Excel VBA Add-Ins application. For this reasons, VBA Enabled state must be set for Excel environment.

(4) Computation Flow

The general conversion software computation flow is shown in **Figure 6.3.3**.

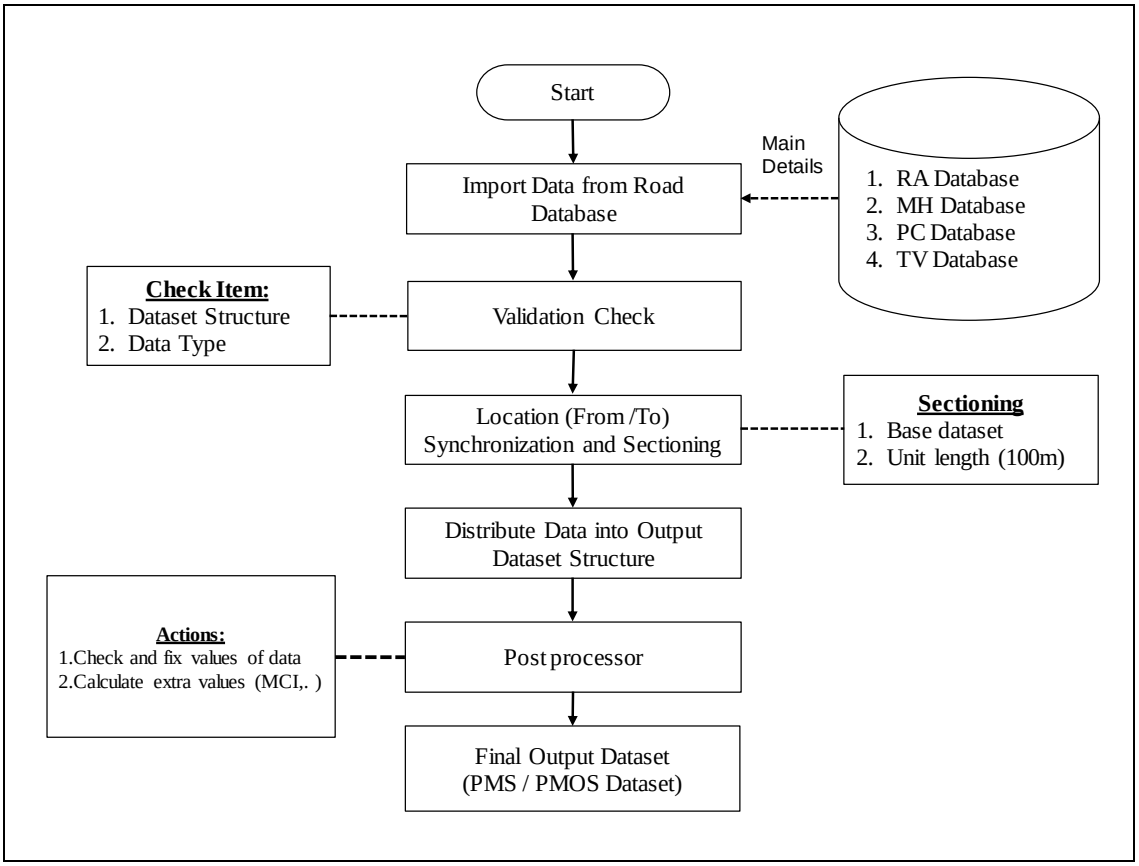


Figure 6.3.3 General Computation Flow

The system processes the data step by step and informs the user whether the process has been completed successfully. If there will be any error in the computation, system will display the error of particular step so that error check can be carried-out easily.

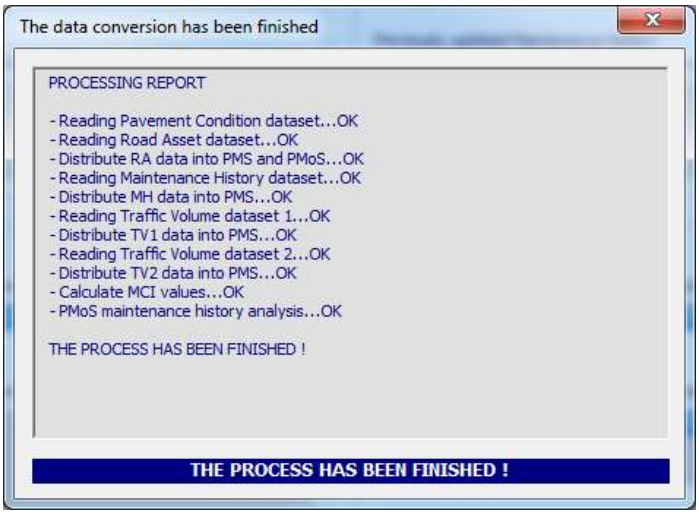


Figure 6.3.4 Data Processing Report

(5) System Structures

System structure is shown in **Figure 6.3.5**. System interface has been developed by incorporating a number of modules and class modules as described below;

- **ProgramCS**: It defines the overall functions for main usage scenarios.
- **LibCS**: It defines special functions of Conversion Software as well as shared data of Conversion Software.
- **LibGLB_ExcelServices**: It defines functions relating to built-in Excel features such as workbook, worksheet, and range of data.
- **LibGLB_FSO_Services**: It defines functions relating to file manipulation by FSO library (File System Object)
- **LibGLB_GenServices**: It defines functions for general solutions of data such as sorting, and interpolation of data.
- **Class modules:** It defines data model as well as method for solving data based on object oriented model. The following class modules have been provided for specific purposes as described below.
    - ***clsDB_PathInfo***: It is used for modeling the location of input datasets.
    - ***clsRouteNet***: It is used for modeling data of route system as a whole of source data (RA, MH, PC).

- ***clsRouteNetTV***: It is used for modeling data of route system as a whole of source data (TV).
- **clsRoutNetPMS**: It is used for modeling data of route system as a whole of destination data (PMS and PMOS dataset).

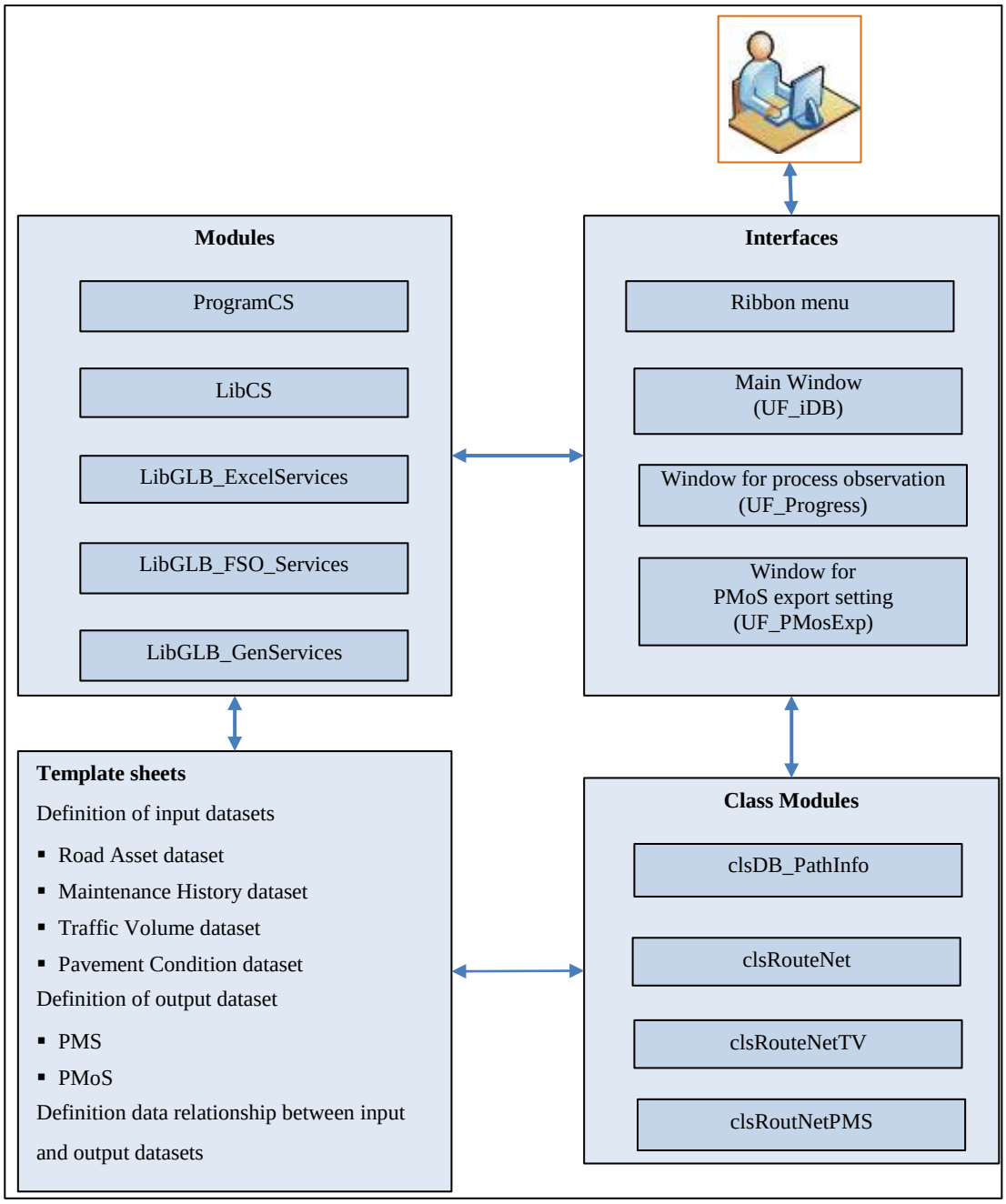


Figure 6.3.5 Conversion Software System Structure

(6) Outputs

The outputs of the Conversion Software are PMS dataset and PMoS dataset. Since source of data for PMS and PMoS datasets are common, both PMS and PMoS datasets can be prepared simultaneously and user can export either of them. The output formats of both PMS and PMoS

datasets have been fixed because these will be the input files for PMS and PMoS software. The output files are MS-Excel files.

6.3.5 PMS Dataset

PMS dataset contains 61 data items in total as shown in **Table 6.3.1**.

Table 6.3.1 PMS Dataset

Road Asset Data							Pavement Condition Data												
							Latest Condition Survey										2nd Latest Condition Survey		
Pavement Width (m)	Pavement Thickness (m)	Climate		Terrain Type	Road Class	<Dummy>	Year/month of survey	Lane position surveyed	Pavement type	Crack Rate				Rut Depth		IRI (mm/m)	Year/ month of survey	Lane position surveyed	Pavement type
		Annual Precipi-tation	Temper-ature	Flat/Rolling/Moun-tainous						Cracking %	Patching %	Pothole unrepaired %	Total %	Maximum (mm)	Average (mm)				
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Road Asset Data							Pavement Condition Data												
							Latest Condition Survey										2nd Latest Condition Survey		
Pavement Width (m)	Pavement Thickness (m)	Climate		Terrain Type	Road Class	<Dummy>	Year/month of survey	Lane position surveyed	Pavement type	Crack Rate				Rut Depth		IRI (mm/m)	Year/ month of survey	Lane position surveyed	Pavement type
		Annual Precipi-tation	Temper-ature	Flat/Rolling/Moun-tainous						Cracking %	Patching %	Pothole unrepaired %	Total %	Maximum (mm)	Average (mm)				
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40

Pavement Condition Data									Maintenance History						Traffic Volume Data					
2nd Latest Condition Survey							MCI	<Dummy>	Latest Repair				<Dummy>	<Dummy>	Latest Survey		2nd Latest Survey		<Dummy>	<Dummy>
Crack Rate				Rut Depth		IRI (mm/m)			Year / Month of the latest repair	Repaired Lane	Repair Method	Repair Classification			Total traffic volume	Heavy traffic volume	Total traffic volume	Heavy traffic volume		
Cracking %	Patching %	Pothole unrepaired %	Total %	Maximum (mm)	Average (mm)										AADT (24 hour data)	AADT (24 hour data)	AADT (24 hour data)	AADT (24 hour data)		
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61

6.3.6 PMOS Dataset

PMoS dataset contains 35 data items in total as shown in **Table 6.3.2**.

Table 6.3.2 PMoS Dataset

Road Asset Data														Pavement Condition Data				
							Location							Road condition				
Road ID	Road Name	Route No	Route Branch No.	Direction	Lane Position	Date of update	from		to		Pavement type	Structure type	Crossing type	Year/month of survey	Crack Rate (%)			
							Km	m	Km	m					Cracking	Patching	Pothole unrepaired	Total
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

Pavement Condition Data						Maintenance History Data									
Road condition						2013		2012		2011		2010		2009	
Rut Depth (mm)		IRI (mm)	FWD (mm)												
Average	Maximum		Year/month of survey	D_{0max}	D_{150max}	Repair Method	Repair Classification	Repair Method	Repair Classification	Repair Method	Repair Classification	Repair Method	Repair Classification	Repair Method	Repair Classification
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35

6.3.7 Institutional Arrangement

The Conversion Software was developed to fulfill the data requirement of PMS and PMoS frameworks which were agreed between DRVN and JICA Project Team. The system was developed by a professional group specialized for developing the computer software which consists of JICA experts, DRVN staffs, RRMB I, RTCs and UTC staffs.

In general, it is recommended to operate the Conversion Software by the same persons who operate PMS and PMoS software. Alternatively, the road database operators can also operate this software because the input files for this software is database.

Since the Conversion Software is very crucial in operating PMS and PMoS, it is recommended that a professional engineering organization like Information Center of DRVN or RTC, and UTC should take responsibility for any updates in the future.

6.3.8 Technical Trainings

An intensive training was conducted on 5th of March, 2014 to make familiar with the operation of the Conversion Software using newly developed conversion software and operation manual. Participants from concerned organization have been participated.

6.3.9 Conversion Software in Operation

This conversion software is already in operation. Dataset required for PMS and PMoS software is created by the Conversion Software.

6.3.10 Conversion Software User Manual

User manual for operating conversion software has been development separately by describing the details of operation procedures.

6.4 THE DEVELOPMENT OF VIET NAM PAVEMENT MANAGEMENT SYSTEM

6.4.1 Rationale of Developing Planning System for Road Pavement Maintenance

A road infrastructure is a national asset to be taken over to the next generations, so that road functions need to be carefully maintained for a long duration of road maintenance. The basic principle of road maintenance is to select "right **w**orks", "right places" and "right timings" of maintenance and repair works in order to ensure the best economy over the long course of road maintenance. With this, road operators are encouraged to shift from the current *ex post fact* maintenance to strategic planned maintenance.

The planning system now under study in the Project is focused on the road pavement on the Vietnamese national roads (Hereinafter tentatively called as "Vietnam Pavement Management System; VPMS") and can help assist road operators to formulate annual and mid-term pavement maintenance plans on the basis of the survey results of the pavement surface conditions and statistically analyzed data of future pavement deterioration.

6.4.2 DRVN's Practices

(1) Road maintenance plans

DRVN has responsibility to develop the following national road maintenance plans.

1) 3-Year Maintenance Plan

A three year plan for national road maintenance is an official plan for DRVN. DRVN promulgated the correspondence, No.1481/TCDBVK-KHDT dated on April 12th 2013, giving instruction of development of mid-term plan in 2014-2016 for road infrastructure maintenance to RRMBs and authorized PDOTs. The correspondence was issued upon receiving MOT Decision No.438/QD-BGTCT dated on March 6th 2013.

2) Annual Plan

Annual road maintenance plan is the prevailing means of formulating a budget plan. Regional agencies, including RRMBs and PDOTs, play a key role in organizing the annual plan. Annual plan includes the budget plans for routine maintenance and periodic maintenance consisting of medium repair and big repair. The annual plan is absolutely based on the accumulation of maintenance costs following predetermined maintenance norms and standards. In formulating annual plans, much effort has been directed to planning repair works rather than routine maintenance plans, since works for the routine maintenance are prescribed in the maintenance norms and standards and a simple formula of budget estimate is presented.

(2) Planning systems

1) HDM-4

HDM-4 was developed by the World Bank and used for over a decade to combine and economic appraisals of road projects and to analyze road network strategies. The various versions of the models have been widely used in a number of countries. The model was used to investigate the economic viability of road projects and to optimize economic benefits to road users under different levels of expenditures. **Table 6.4.1** shows HDM trial studies on the national roads in Vietnam. Since its first introduction to the national roads in 1988, there have been many trials made up to 2006 by the World Bank and the Asian Development Bank. However, HDM-4 is currently not operable.

2) RoSyBASE

In 2007 VRA disseminated decision on the use of RoSyBASE as official database software trying to convert data from RoSyBASE database to HDM-4 dataset. This is because the HDM-4 should take either way of preparing its dataset, one by directly constructing datasets into HDM-4 formats, and the other by converting and importing data from an external database and creating a dataset for HDM-4 analysis. RoSyBASE was expected to play a role as an external database for data conversion. However, due to low reliability of registered data and system problems, RoSyBASE is currently in operable.

With these reasons, the system development for planning road maintenance plans is urgently needed by DRVN.

Table 6.4.1 Past Trials of Long-Term and Mid-Term Road Maintenance Plans

Year	Name of System	Fund / Consultant	Database Length	Remarks
1998 — 2000	RoSy	World Bank / Parkman & Nedeco	1,962 km	▪ Data necessary to convert into HDM-4 is not available and data conversion is practically impossible.
1998 — 2000	HDM-III	ADB / Booze Allen Hamilton	1,936 km	▪ Analyses performed on these data would never result in a realistic evaluation of the entire road network
2001	HDM-4	World Bank	7,005 km	▪ The data was used for formulation of 10 year strategic maintenance plan prepared by Luis Barger in 2003
2003	HDM-4	World Bank / Louis Barger Group	481 km	▪ Louis Berger could not prepare 2nd and 3rd year work program due to lack of network data to be provided by VRA
			15,565 km	▪ 10-year maintenance cost between 2004 and 2013 with 3 scenarios were estimated.
2004	HDM-4		15,395 km	▪ LEA International has utilized VRA data for preparation of 2nd and 3rd year program under Road Network Improvement Project with financial assistance of World Bank
2004-2005	HDM-4	World Bank / LEA International	1,762 km	▪ Second year work program with total length of 656 km was prepared. However, the result was not officially approved.
2005	RoSyBASE	ADB / SMEC International and Carl Bro	11,034 km	▪ ISDP provided 8 full version of RoSy Systems to VRA head office and 4 RRMUs. ▪ Trial conversion of RoSy data into HDM-4

Year	Name of System	Fund / Consultant	Database Length	Remarks
		Pavement		was not successful due to data inconsistency.
2006	HDM-4	WB/BCEOM	11,586 km	▪ Preparation of 2nd and 3rd year work program was not completed due to unidentified reason.
2007	RoSyBASE	VRA(own fund) / RRMUs, PDOTs, RTC	11,032km	▪ Data was compiled from data gathered by RRMUs and PDOTs.

Source: JICA SAPI-II Study

6.4.3 Overseas Practices – Practices in Japan

The Project introduces three cases of PMS management in Japan shown below, as foreign PMS case studies.

- Central Government practice; MLIT PMS practice
- Local Government practices; Nagasaki Prefecture and Kumamoto Prefecture

Outlines of these practices are shown as follows;

(1) MLIT PMS Management in Japan

The idea of asset management has been partially introduced into nationwide comprehensive pavement management for national highways managed by the central government in Japan, i.e. proactive maintenance. So far there are no nationwide comprehensive guidelines on pavement asset management issued for national highways managed by the central government.

Compared with some advanced local governments, the current status of central government's activity is more conservative as follows.

Table 6.4.2 MLIT PMS Management

Item	Current Status
1. Data Collection, Accumulation, Update	
(1) Pavement Condition Data	• Pavement condition surveys with special vehicles are conducted periodically for identifying repair sections and repair work method. • In principle, the data is accumulated by Work Offices. • Method of survey is simply summarized as a survey guideline.
(2) Repair History Data	• Repair history data is collected as one of the construction works' document • There are no nationwide comprehensive pavement asset management systems using repair history data, however some systems using it may be introduced by work offices level.
(3) Road Inventory Data	• Road Act requests all road administrators to prepare road inventory and keep them updated always in its Article28. • There are no nationwide comprehensive pavement asset management systems using road inventory data, however some systems using it may be introduced by work offices level.
(4) Traffic Volume Data	• Nationwide traffic volume survey at approximately 37,000 points is conducted twice per 5 years.

Item	Current Status
	• Continuous traffic volume data (24 hour, 365 days) is also collected at approximately 700 points nationwide. • There are no nationwide comprehensive pavement asset management systems using traffic volume data, however some systems it may be introduced by work offices level.
2. Mid and Long Term Planning	• Mid and Long Term Planning is not formulated.
3. Annual Budget Planning	
(1) Selecting Method of Candidate Repair Sections	• "Guideline for Selecting Candidate Repair Sections and Repair Work Selection" is referred.
(2) Judge Criteria of Repair	• Some road administrators define the criteria as follows. MCI is 5.0 or higher: Preferable Condition MCI is 4.0 or less: Repair Needed MCI is 3.0 or less: Repair Urgently Needed (Note: The definition of MCI is in Appendix-2)
(3) Site Supplemental Survey	• Deterioration condition (type, severity, area etc.) are grasped by visual check etc. and measured if necessary.
(4) Repair Work Selection	• "Guideline for Selecting Candidate Repair Sections and Repair Work Selection" is referred.
(5) Making List of Candidate Repair Sections	• It is not disclosed for outside.
(6) Budget Proposal, Budget	• It is not disclosed for outside.
4. Demarcation between Relevant Organizations by Task	• Road Maintenance Division of Road Department is in charge of these activities in Regional Development Bureau. • Road Maintenance Division is in charge of these activities in Work Office. • Pavement Condition Survey is usually conducted by Technical and Engineering Office of Regional Development Bureau, MLIT. Actual data collection works are outsourced.
5. Maintenance of each System	• There are no nationwide systems dealing with pavement asset management. Some road administrators have their own system. Those systems are maintained by each road administrator itself by the method of outsourcing.
6. Training	• Some training courses on road maintenance, asset management etc. are prepared by some organizations including College of Land, Infrastructure, Transport and Tourism under Ministry of Land, Infrastructure, Transport and Tourism (MLIT). • However, there are no training opportunities dedicated to specific computer software and systems.

(2) Prefectural Government (Nagasaki/Kumamoto Prefecture) PMS Management in Japan

In recent years, many local governments in Japan are also tackling to development pavement management systems for their national and prefectural road management to pursue more economy under constrained budget conditions in the regions. The Project introduces the outline of PMS development implemented by local Government in Japan, taking pavement management systems being developed by Nagasaki and Kumamoto Prefecture as examples. The outlines are all summarized in **Table 6.4.3** in accordance with the viewpoints shown below

Major Characteristics:

- Term of Mid and Long Term Plan
- Evaluation of Pavement Condition
- Database on Pavement
- Deterioration Forecast of Pavement
- Policy on Evaluation and Management
- Repair Sections
- Budget Plan (Headquarters' Tasks)
- Maintenance of Computer Systems
- New Technologies

Table 6.4.3 Nagasaki and Kumamoto Prefecture PMS Management

Category	Sub Category	Nagasaki Prefecture	Kumamoto Prefecture
a. Major Characteristics		Roads are classified into several groups according to the traffic volume and heavy vehicle traffic volume. The management policy on maintenance is established for each road group.	Roads are classified into several groups according to the traffic volume. Rehabilitation work is strongly recommended at sections which the past surveys reveal that its deterioration speed is fast. Sections which loading capacity of pavement is judged to be damaged are defined as "Critical Management Section". In details, it is a section which deterioration speed is extraordinary quick. For those sections, high priority is given in detail surveys such as FWD and higher attention is kept during the daily patrol. Meetings of officials relating pavement work are held twice per a planned term for sharing information and pending issues.
b. Term of Mid and Long Term Plan		It is revised every 3 years. At the same time, deterioration forecast model is also revised with accumulated pavement database. "Guideline on Pavement Management" is revised every 5 years.	It is revised every 5 years. Critical Management Section and Budget Plan are also revised.
c. Evaluation of Pavement Condition	Evaluation Method	The indicator is MCI. Moreover, 5 ranks of soundness are given according to MCI value.	The indicator is MCI.
	Method of Pavement Condition Survey	All the sections of national highways are surveyed with machine (pavement condition survey vehicle). The sections of prefectural roads are surveyed with machine, visual survey and daily patrol according to the traffic volume of the sections. Frequency of surveys shall be determined according to the importance of road sections. However, detail number is not mentioned in the document.	The surveys are conducted approximately every 5 years for the 11 work offices. The first survey was conducted between 2002 and 2005. The second one was conducted between 2007 and 2009. The method must be surveyed with machine although it is not described in the document There is a common TOR for contract of pavement condition survey works.
d. Database on Pavement		Pavement condition survey result as well as MCI calculated form them, Repair work history, Traffic volume is registered in	Pavement Database: Pavement inspection data etc. are registered in the database. It is

Category	Sub Category	Nagasaki Prefecture	Kumamoto Prefecture
		the database. Unit length is 100 m.	updated during pavement condition survey. Unit length is 100 m. (It is now under study to change it to 20m.) MCI Inventory: The current and next 10 years' MCI value are registered in the database. It is updated during pavement condition survey and update of road inventory. The demarcation of function and data flow between the relevant organizations (including contractors) is also described.
e. Deterioration Forecast of Pavement	Annual Level	Deterministic model is used. + The average values of deterioration progress (constant numbers) according to type of road, heavy vehicle traffic volume, deterioration rank in the year, the last repair work method and method of pavement condition survey are used.	Deterioration forecast is not considered.
	Mid and Long Term Level	Stochastic model is used. + Deterioration forecast curves according to type of road, heavy vehicle traffic volume, the latest repair work method and method of pavement condition survey are used.	Stochastic model is used. The cost for repair work in mid and long term is calculated and then budget plans are examined. + Parameters and algorithm is not described in the document.
f. Policy on Evaluation and Management		Management level for each group is determined and represented by "soundness". The pavement condition survey result is summarized and then achievement ratio is calculated by each group, work office, road route entirely for evaluation.	The pavement condition survey result is summarized and management level is evaluated. Actual cost of repair works registered in the repair work history database is summarized and its transition is checked. The sections with quick deterioration speed are picked up and reasons of quick deterioration are studied. (Benchmark Analysis)
g. Repair Sections	Method of Selection	Site supplemental survey is also used. The repair sections are chosen by the pavement condition survey result in the previous year. (If the survey was not conducted, the current pavement condition is forecasted by the latest survey result.)	The sections which do not satisfy the repair criteria are designated as the sections to be repaired based on MCI inventory. For those sections, repair work method and work area are determined by the site supplement survey and FWD survey for annual planning. (No flow chart of repair work method selection is described in the document.)

Category	Sub Category	Nagasaki Prefecture	Kumamoto Prefecture
	Judge Criteria	Judge criteria (MCI and Soundness Rank) are prepared for each group.	It follows the judge criteria using MCI which are established by Kyushu Regional Development Bureau of Ministry of Land, Infrastructure, Transport and Tourism (MLIT).
h. Budget Plan (Headquarters' Task)	Items to be described in Budget Proposal Document	Detail of repair work, pavement deterioration condition, ordinary people's request and outline of the road section shall be described.	It is not mentioned in the document.
	Fundamental Idea of Budget Allocation	The following two types of sections are highly prioritized. Besides them, priority of the sections for repair works is given according to the importance of roads. + Sections which budget for repair work is allocated but it is not implemented due to some reasons + Sections with extraordinary low soundness	It is not mentioned in the document.
i. Maintenance of Computer Systems		It is not mentioned in the document.	Transaction of data and service fee between government and contractors (construct contractor, pavement condition survey contractor and road inventory revision contractor) are described in the document.
j. New Technologies		For improvement of pavement management, introduction and evaluation of new technologies are declared. The detail name of new technologies is not mentioned.	It is not mentioned.

(Note) Prepared by Mr. Hideyuki KANOSHIMA, JICA Expert

6.4.4 Purposes of Applying VPMS

VPMS will be developed to meet the demand of the following activities.

(1) To formulate a mid-term (3-5 years) pavement maintenance work and budget plans

- To get MOT approval
- To show the vectors of annual road maintenance plans
- To prepare explanatory materials for the annual budget proposal
- For the purposes of research and investigation

(2) To formulate annual pavement maintenance work and budget plans

- To assist RRMBs to formulate annual maintenance budget proposal
- To assist RRMBs to formulate annual maintenance implementation plans
- To assist DRVN to prioritize maintenance budget allocations

(3) To evaluate the effects of pavement maintenance works

- To evaluate the effects of pavement repair works

6.4.5 VPMS Users

System users presumed in the development of VPMS will comprise concerned departments of DRVN's Headquarters, RRMBs, PDOTs and RTCs. However, as this Project focuses the road network under RRMB I jurisdiction as a pilot area, technology transfer of the planning system will be primarily carried out for the DRVN, RRMB I and RTC staffs including RTC central staff.

(1) Departments in the DRVN Headquarters

- To formulate strategic plans for road pavement maintenance
- To prioritize maintenance budget proposal gathered from RRMB I and PDOTs.

(2) RRMBs

- To formulate annual road maintenance plans
- To formulate annual budget proposal
- To formulate implementation plans upon budget allocation

(3) Road Technical Centers

- To maintain, update and renewal of the planning system
- To implement technical supports to the regional organizations.

6.4.6 Road Structures on target

VPMS is developed by targeting only for road pavement. Of road structures listed in **Table 6.4.4**, pavement and bridge deterioration are primarily caused by load of vehicle traffic. On the other hand, deterioration of traffic management facilities and maintenance management facilities is caused by the deterioration of materials and weathering.

Table 6.4.4 Road Facility and Planning System

Structure	Planning System	Measures
(1) Road Pavement	**VPMS**	● **To be focused in the Project.**
(2) Bridges	VBMS	● Out of focus ● Now under development in other projects.
(3) Traffic Operation and Maintenance Facilities	Manual planning based on road asset database	● Out of focus ● The Project will develop the data formats of road asset database.

6.4.7 Road Maintenance Activities on Target

It should be noted that the routine maintenance including non-pavement maintenance and pavement ex post fact maintenance are deemed the activities relevant to restoring service abilities, but not to reducing aging of pavement. It is generally understood that the effects of aging reduction are hardly anticipated in the pavement ex post fact maintenance.

In general, km-based fixed rate maintenance budgets have been widely used in estimating annual maintenance budgets, separately from the pavement maintenance planning system.

In addition, reconstruction in the development works, which comprises widening, realignment and etc., has been carried out mainly for the purpose of increase in road capacity, so that it should be handled separately from the pavement maintenance planning system.

Table 6.4.5 Road Maintenance Activities on Target

Category		Maintenance Activities (2003 Technical Norms on Road Routine maintenance in Vietnam)	Objectives of Measures			
			Increase Capacity	Increase Strength	Reduce Aging	Restore Serviceability
1.	Routine Maintenance					
	1.1 Non Pavement maintenance	• Culvert box cleaning • Side ditch cleaning • Grading • Grass and bush control				X
	1.2 Pavement Ex post fact maintenance (= Reactive Maintenance)	• Pothole patching 12 cm • Pothole patching 30 cm • Edge repair • Gravelling (15 cm thickness)				X
2.	Unscheduled Maintenance	• Emergency works • Disaster restoration				X
3.	**Periodic Maintenance (Proactive Maintenance)**	• **Crack seal** • **Single surface treatment** • **Double surface treatment** • **Asphalt concrete overlay (30mm / 50 mm / 70mm)**			X	X

Category		Maintenance Activities (2003 Technical Norms on Road Routine maintenance in Vietnam)	Objectives of Measures			
			Increase Capacity	Increase Strength	Reduce Aging	Restore Serviceability
4.	Development Works					
	1.1 Rehabilitation	• Structural Overlay (Replacement of pavement)		X	X	X
	1.2 Reconstruction	• Realignment • Widening	X	X	X	X
5.	New Road Construction		X	X	X	X

Table 6.4.6 Focus Points of Road Maintenance

Types of Road Maintenance	Focus Points
1. Routine Maintenance **1.1 Non Pavement Works** ● Culvert cleaning ● Side ditch cleaning ● Grading ● Grass and bush control	● **Out of scope** ● These activities describe maintenance works to non-pavement road assets whose deterioration is not caused by traffic loads, but caused by material deterioration and weathering. ● Maintenance plan is to be manually formulated based on the statistical analysis on the past maintenance records.
1.2 Pavement ex post fact Maintenance ● Pothole patching htb=12 cm ● Pothole patching htb=30 cm ● Edge repair ● Gravelling (15 cm thickness)	● **Out of scope** ● These activities are performed in response to the development of deficiency or deficiencies that negatively impact the safe, efficient operation of the facility and future integrity of the pavement section. Ex post fact maintenance activities are generally reactive, not proactive, and performed to restore a pavement to an acceptable level of service due to unforeseen conditions. ● These activities are considered not strong enough to get pavements to the original strength. ● Maintenance plan is to be manually formulated based on the statistical analysis on the past maintenance records or past trend of investment.
2. Unscheduled road maintenance ● Disaster restoration works, etc.	● **Out of scope** ● Unscheduled maintenance works are to return a road facility back to a minimum level of service while a permanent restoration is being designed. ● Examples of situations requiring unscheduled maintenance include disaster restoration works. ● Maintenance plan is to be formulated based on the statistical analysis on the past maintenance records
3. Periodic Maintenance (Proactive Maintenance) ● Crack seal ● Medium/Big Repair ● Single surface treatment ● Double surface treatment ● Asphalt concrete overlay (30 m / 50 mm / 70mm)	● **To be focused** ● **Periodic Maintenance** is a planned strategy of cost-effective treatments to an existing road system that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system (without significantly increasing the structural capacity). ● Preventive maintenance is typically applied to pavements in good condition having significant remaining service life. As a major component of pavement preservation, preventive maintenance is a strategy of extending the service life by applying cost-effective treatments to the surface or near-surface of structurally sound pavements. Examples of preventive treatments include the measures listed left. ● These maintenance works are considered strong enough to get pavements to the original strength, so that these will be major strategies for mid-term / long-term pavement maintenance plans.

Types of Road Maintenance	Focus Points
4. Development Works **4.1 Rehabilitation** ● **Structural Overlay (Replacement)**	● **<u>To be focused</u>** ● **Rehabilitation** is the replacement of the entire existing pavement structure by the placement of the equivalent or increased pavement structure. Reconstruction usually requires the complete removal and replacement of the existing pavement structure. Reconstruction is required when a pavement has either failed or has become functionally obsolete. ● These maintenance works are considered strong enough to get pavements to the original strength, so that these will be major strategies for mid-term / long-term pavement maintenance plans.
4.2 Reconstruction ● **Widening** ● **Realignment**	● Out of scope
5. New road construction	● Out of scope

6.4.8 Development of VPMS

(1) Objectives

The system is defined as a supporting system to road operators who are wishing to organize maintenance and budget plans, so that it is not intended to provide complete forms of maintenance plans and budget plans. Upon receiving the computation results, road operators are kindly requested to carry out a further investigation like FWD and to try to make their final judgment on the national road maintenance and budget plans.

(2) Feature

VPMS, DRVN's own PMS, was developed with importation of Kyoto Model's analytical theories to VPMS and with customization of these theories to make them comply with national road environment in Vietnam. The theories to be imported from Kyoto Model are as follows;

- Prediction of pavement deterioration based on Markov Transitional hazard model
- Formulation of pavement maintenance work plans and budget plans
- Factor analysis to find out influential elements on pavement deterioration
- Benchmarking method to point out road sections which may need further investigation.
- Others

(3) Main Functions

VPMS is equipped with two main functions shown below;

- Planning functions of annual pavement repair plans
- Planning function of mid-term pavement repair plans
- Outline of these functions are briefly shown below;

1) Planning function of annual pavement repair plans

The planning function of annual repair plans is to plan pavement repair plans for a single year, incorporating the latest pavement condition survey data. Progresses of pavement deterioration

and their forecast are not employed in this function. The planning function is most appropriate when planning pavement repair plans for a year between the latest survey until the next survey, assuming that pavement condition survey is to be implemented every several years. The planning function helps assist in selecting repair work candidate locations, selecting repair works and prioritizing repair work implementation, taking account of budget conditions users specifies. **Table 6.4.7** provides details of this plan.

Table 6.4.7 Planning Function – Annual Pavement Repair Plans

Category	Function
a. Software module	• Repair Work Planning Module
b. Preset criteria and conditions	• Repair criteria which will be the base of decision making on whether repair works are needed. • Prioritization conditions including information to prioritize repair work locations. • A repair work selection flowchart which will show processes to find out the repair works best suited to pavement defects and deteriorations.
c. Source dataset	• Repair work planning dataset
d. Outputs	• Annual repair work plans including the list of repair work type, selected repair work locations and repair costs with priority order by MCI value. • Grouping of road sections by repair classification (i.e. routine maintenance, medium repair and big repair) • List of road sections which may need further FWD surveys (i.e. big repair work candidates).

2) Planning function of mid-term pavement repair plans

Planning function is to develop mid-term pavement repair plans. Mid-term pavement repair plans are developed for years from three (3) to five (5) years after the latest pavement condition survey. The function simulates the progress of pavement deterioration and budget plans over mid-term years and outputs data needed to show three (3) scenarios, changing repair policy (repair standards) and budget conditions one-by-one. **Table 6.4.8** details this plan.

Table 6.4.8 Planning Function: Mid-term Pavement Repair Plans

Category	Function
a. Software module	• Pavement deterioration evaluation module • Budget planning module
b. Preset criteria and conditions	• Pavement deterioration rankings for three pavement deterioration indexes, cracks, rutting depths and IRIs. Pavement deterioration rankings are a sort of deterioration classifications to facilitate computation. Progress of pavement deterioration, including Markov transition probabilities, is to be computed by pavement deterioration ranking and then evaluated.
c. **Source dataset**	• Pavement deterioration evaluation dataset • Budget planning dataset
d. Outputs	• Results of pavement deterioration speed evaluation • Results of pavement deterioration factor analysis • Progress of pavement deterioration based on Markov transition probabilities (Matrices and Transition Figure) • Results of benchmarking (Table / Figure)

Category	Function
	• Repair work cost by repair work type for with and without budget constraint cases (Table / Figure) • Trend of growth of pavement deterioration indices (cracks, rutting depth and IRI) (Table / Figure) • Risk Transition under budget constraint (Table / Figure) • Sample output of three scenarios - Scenario-1: Current budget level scenario (Worst scenario) - Scenario-2: Current pavement deterioration level scenario - Scenario-3: Target management level scenario (Best scenario)

(4) Preset Conditions

1) Road Class in Vietnam

The Vietnam National Standard of TCVN 4054 stipulates requirements for design of the public road network including new construction, rehabilitation and improvement projects. The technical road grading is based on functions and design volume of the road within the road network as shown in **Table 6.4.9.**

Table 6.4.9 Road Class in Vietnam

Road Class	Design Traffic volume (Vehicles/day)	Road Function
Expressway	25,000 ≦ TV	Expressway
Class-I	15,000 ≦ TV < 25,000	National roads
Class-II	6,000 ≦ TV < 15,000	National roads
Class-III	3,000 ≦ TV < 6,000	National roads, Provincial Roads
Class-IV	500 ≦ TV < 3,000	National Roads, Provincial Roads, District roads
Class-V	200 ≦ TV < 500	Provincial roads, District roads, Commune roads
Class-VI	TV ≦ 200	District roads, Commune roads

(Note) TCVN 4054, Highway-Specifications for Design, Third edition, Hanoi 2005

2) Selection of Pavement Deterioration Index

DRVN wishes to apply a comprehensive index which can represent pavement deterioration, rather than apply conventional pavement deterioration indexes, e.g. crack ratio, rutting depth and roughness (IRI). There are currently several comprehensive indexes available, such as Present Serviceability Index (PSI), Pavement Condition Index (PCI) and Maintenance Control Index (MCI). Outline of each of the indexes is briefly described in Appendix.

Upon brief evaluation among above mentioned indices, JICA Project Team has recommended MCI as an index for the planning of road maintenance and repair plans. Therefore, MCI has been considered as a comprehensive index in the planning system development.

3) Criteria of pavement deterioration (Soundness)

The relationship among rank of soundness, pavement condition and MCI value is shown in the following table.

Table 6.4.10 Criteria of Pavement deterioration

SN	Pavement Condition	MCI
1	New and favorable conditions	6 < MCI
2	Not new but favorable	5 < MCI ≦ 6
3	Partly deteriorated	4 < MCI ≦ 5
4	Deterioration progresses	3 < MCI ≦ 4
5	Heavily deteriorated	MCI ≦ 3

4) Physical Ranking of Pavement Deterioration

Physical ranking of pavement deterioration in terms of cracks, rutting's and IRIs has been defined by default as shown in **Table 6.4.11**. Each deterioration index falls into seven (7) rankings. However, user can change the rankings ranges and ranking levels also if he / she has sufficient knowledge to handle these information. Once default value ranking criteria is changed and saved the ranking criteria inside the system, system will display the latest deterioration ranking data as the default ranking when starting the PMS for the next run. Physical ranking of pavement deterioration is to be incorporated in the Pavement deterioration Evaluation Module and used for calculating Markov transitional probability matrices as shown in the flow chart concerned.

Table 6.4.11 Pavement Deterioration Ranking

Deterioration Ranking	Pavement Deterioration		
	Cracks (%)	Rutting Depth (mm)	IRI
1	0 ≦ C < 0.1	0 ≦ R < 5	0 ≦ IRI < 2
2	0.1 ≦ C < 10	5 ≦ R < 10	2 ≦ IRI < 4
3	10 ≦ C < 20	10 ≦ R < 15	4 ≦ IRI < 6
4	20 ≦ C < 30	15 ≦ R < 20	6 ≦ IRI < 8
5	30 ≦ C < 40	20 ≦ R < 25	8 ≦ IRI < 10
6	40 ≦ C < 50	25 ≦ R < 30	10 ≦ IRI < 12
7	C > 50	R > 30	IRI > 12

5) Criteria of the Need of Repair Works

The necessity of repair works is judged by MCI value. If MCI value is greater or equal to 5 (MCI ≥ 5), the planning software will notify to user that "No Need of Repair Work" and recommend for "Continue the Pavement Monitoring Work". If MCI value is less than 5 (MCI < 5), the planning software will go further for selecting appropriate repair work type and corresponding repair cost calculation.

Table 6.4.12 Criteria of the Need of Repair Works

Road Class	MCI
Class I	MCI < 5
Class II	MCI ≦ 5
Class III	MCI ≦ 5
Class IV	MCI ≦ 5
Class V	MCI ≦ 5
Class VI	MCI ≦ 5

(Note) Road classification is based on "Highway – Specifications for Design", TCVN 4054, 2005.

(5) System Structures

Software system for planning the national road maintenance plans consists of four modules and a master database as shown below. The outline of the master database and each module are briefly described below. Further information for each module including a step-by-step description with flowcharts is described in corresponding sections.

- Master (System) Database
- Data Management Module
- Pavement Deterioration Evaluation Module
- Repair Work Planning Module
- Budget Planning Module

1) Master (System) Database

In order to ensure operation efficiency of these modules, the concept of master (system) database (hereinafter referred to as "MASTER_DB" is applied. The master (system) database plays a core role in recording database information as well as conditional information needed for the computation of modules, including those inputted by operator or those automatically generated in the processes of computation. Structure of the master (system) database is shown in **Figure 6.4.1**. It consists of five (5) zones from A to D (E) zone as shown below. Information to be stored in the Master (System) Database is shown under the title of each zone in the **Figure 6.4.1**.

a. **Zone-A**: This zone preserves the system login information which includes list of user IDs, corresponding passwords and administrative rights. Those user IDs which have administrative rights as "TRUE", they have full administrative rights and they can access and modify PMS master data as well. In contrast, those user IDs which have administrative right as "FALSE", they have only limited administrative rights and cannot access and modify PMS master data.

b. **Zone-B**: This zone saves an original PMS dataset developed separately by conversion software. Upon updating PMS dataset into th*e* PMS software, PMS dataset will be stored in this zone.

c. **Zone-C**: This zone stores master data (pre-set condition data) data inputted / modified by users (only full administrative rights holders) through interfaces during software operation. The data stored in the folder "master_data" are very important management data deemed unchanged during computation. It stores data of pavement deterioration ranking, repair work type and unit cost, repair policy, etc.

d. **Zone-D**: This zone saves internally produced data including datasets produced from the original PMS dataset for the computation of each module. Three types of module datasets, namely pavement deterioration evaluation dataset, budget planning dataset and repair work planning dataset are stored in this zone. Also, Markov transition probabilities and

pavement deterioration speed relative values, both of which are produced by Pavement Deterioration Evaluation Module.

a. **Zone-E**: This zone stores partial results of pavement deterioration evaluation module. Data in this zone includes estimated hazard parameters and simulated Markov transition probabilities matrix for different pavement defects indices (i.e. crack, IRI, rutting depth).

2) Sub_DB

The sub database is a provisional data storage which is prepared for software developers. It can be used as a storage of simulation condition data for the future upgrade.

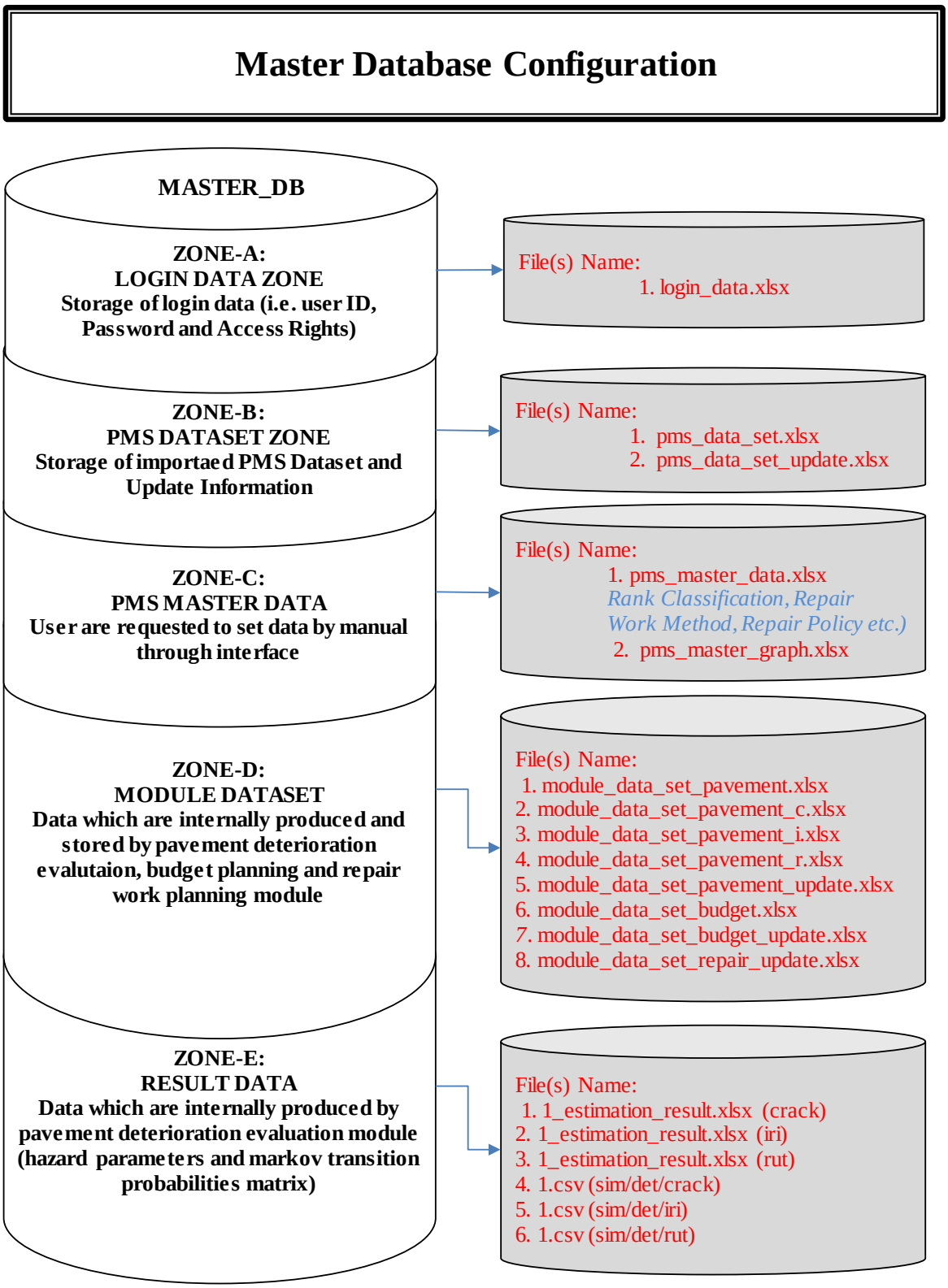


Figure 6.4.1 Master Database Configuration

3) Data Management Module (Herein stating only general Information about 4 modules.

Data Management Module is situated at the gateway of this computer software. Main function of this module is to import and update PMS dataset into the system, select data elements from the imported PMS dataset and internally produced data, and classify and divide them into independent datasets needed for the computation of three modules; (1) Pavement Deterioration Evaluation Module (PE), (2) Repair Work Planning Module (RP) and (3) Budget Planning Module. Data sets are stored in the specified zone of the Master Database.

The other function is to help support user data input through user interfaces and store these data into MASTER_DB. Users are requested to manually input conditional data for simulation following guidance given by user interfaces store data. Further information on these conditional data are shown hereafter in the relevant sections of this report.

4) Pavement Deterioration Evaluation Module

This Pavement Deterioration Evaluation module is to analyze pavement deterioration based on pavement condition survey data which was conducted in 2012 with assistance from JICA and the latest maintenance history data inputted by RRMB I.

At first, factor analysis is applied to the pavement deterioration data to identify the most influential factors to the pavement deterioration. For the factor analysis, the following factors can be taken into account in the analysis; (1) heavy traffic volume, (2) pavement thickness (3) precipitation, (4) pavement type, (5) temperature, (6) topographic conditions, and (7) repair method. This module can compute by considering up to four (4) factors at time to identify the influential factors. Due to limited data availability at the moment, only pavement type and heavy traffic volume can be selected in analyzing. However, the system can analyze up to four (4) factors if data are available. Also, pavement deterioration indicators incorporated in this analysis are; (1) pavement cracks, (2) rutting depths and (3) IRIs which are regarded as representative indicators for pavement deterioration.

In the second stage, the module goes into the analysis of pavement deterioration progress speed. The analysis is done following the pavement deterioration ranking specified in the PMS master dataset by users or by system default (in case of limited administrative rights users) and stored in the MASTER_DB. Markov transition probability theory is applied in the analysis, so that the module calculates the transition probabilities from a certain ranking to other rankings of pavement deterioration based on observed pavement condition and the latest maintenance history data. Markov transition probabilities are produced for all deterioration rankings and for all deterioration indexes including crack, rutting depth and IRI.

In addition, further analysis is made on the variance of pavement deterioration speeds in the form of relative speed (epsilon; ε) from an average deterioration speed, a benchmarking value. The analysis can be performed by road name, RRMUs, RRMU Field Office, Pavement Type and Repair Method. Road sections with $\varepsilon > 1.0$ indicate rapid progress of pavement

deterioration, giving advice to the users to conduct a further in-depth study, such as a FWD test.

5) Repair Work Planning Module (Planning of Annual Pavement Maintenance Plans)

The Repair Work Planning Module formulates annual pavement maintenance plans. The Repair Work Planning Module is one of the four (4) modules in the entire planning software. This module works as an independent module from the medium-term road maintenance planning module (i.e. Budget Planning Module). This module is specially developed for RRMUs and Site office staff who are directly involved in annual budget plans. The software supports planning of annual maintenance plans.

Annual maintenance plans are formulated based on the latest road condition survey data. The software does not apply pavement deterioration prediction in planning annual plans, but uses the latest pavement condition data. The software has an analytical function to select repair work type by considering cracking, rutting depth, and traffic volume. The module will list up the road sections by MCI value and repair classification. Road sections having lower the MCI value gets high priority for repair activities. Similarly, road sections categorized for big repair are candidate sections for FWD survey because road sections under this category might have some structural defects either in subgrade or in other pavement layers.

Computation processes in principle follow the planning flows which are generally undertaken by RRMUs and by site office staff when planning annual budget plans. This makes it convenient for planning staff to understand the software functions. The following are the processes in computation;

To begin with, the users are requested to input the following conditional data, following software guidance. These preset data are stored in the Master Database.

a. Pavement repair work prioritization conditions
b. Repair work selection flow
c. Repair work cost standards
d. Budget conditions for a single year

Referring to the above information and the information on pavement repair policy inputted and stored in the Data Management Module into the Master Database, the module will conduct the following computation for every 100-meter road sections under RRMB I jurisdiction.

a. Evaluate sections on whether repair works are needed
b. Prioritize repair work sections
c. Select road sections which need further FWD surveys
d. Select repair works
e. Estimate repair costs

f. Select road sections which need repair works taking account of budget conditions.

It is noted here that implementation of further FWD surveys is advised to the users on the basis of identified repair classification type and the pavement deterioration relative speeds computed in the Pavement Deterioration Evaluation Module.

6) Budget Planning Module (Planning of Mid-term Pavement Maintenance Plans)

Main function of this Budget Planning Module is to develop mid-term pavement repair plans. Mid-term pavement repair plans are developed for years from three (3) to five (5) years after the latest pavement condition survey. Users are requested to set the conditional data shown below, following the software guidance. These preset data are stored in the MASTER_DB.

a. Repair work unit cost
b. Repair policy
c. Simulation conditions
d. Budget conditions for mid-term years

The module then simulates the progress of pavement deterioration and budget plans over mid-term years and produce the output in the form of repair cost, repair road length, pavement indices transitions (crack, rutting depth and IRI), and risk. User can manually set computation conditions (i.e. defects ranking and budget condition) one-by-one to produce outputs data needed to show the following three (3) scenarios.

a. Scenario-1: Current budget level scenario

To know the progress of pavement deterioration when current budget level is maintained.

b. Scenario-2: Current pavement deterioration level scenario

To know the amount of repair budgets when trying to stop the progress of pavement deterioration at current pavement deterioration levels

c. Scenario-3: Target management level scenario (Best scenario)

To know the amount of repair budgets when maintaining all pavement conditions at target levels (pavement service levels).

(6) Computation Flow

1) General Flow

The general flow of computation is shown in **Figure 6.4.2,** followed by step-by-step explanations in accordance with step names.

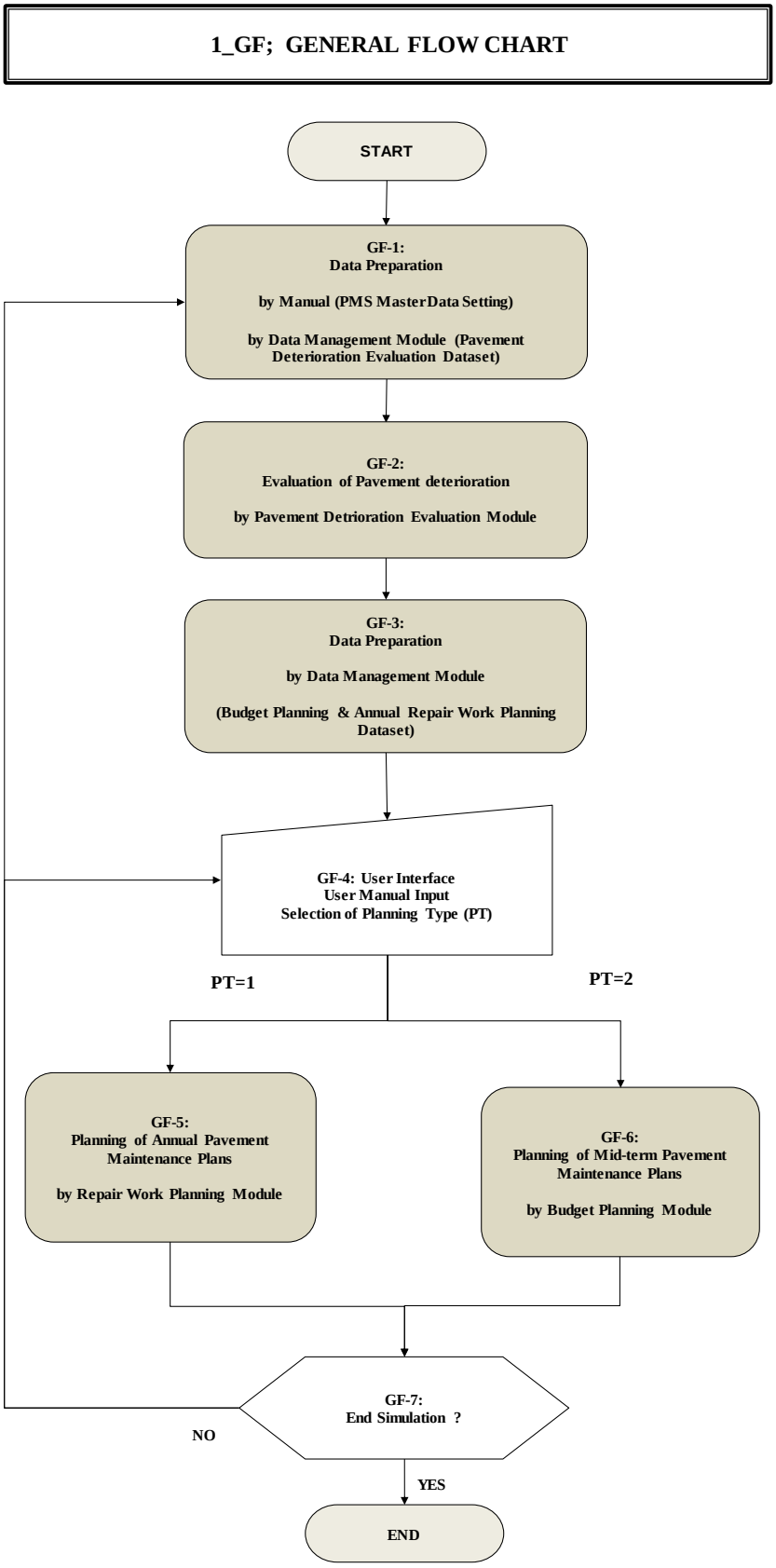


Figure 6.4.2 General Flow Chart

a. GF-1:

The first step of this Data Management Module is to import and update PMS datasets. Before generating pavement deterioration evaluation dataset, user shall confirm PMS master data if preset conditions are different from the default setting. Data Management Module formulates pavement deterioration evaluation datasets needed for the use of pavement deterioration evaluation based on the imported PMS datasets and PMS master data. The PMS datasets need to be developed separately prior to the importing into this planning software. Imported PMS datasets, PMS master data and created datasets for pavement deterioration module are saved in the MASTER_DB into Zone-B, Zone-C and Zone-D respectively.

b. GF-2:

In the second step, the flow goes into Pavement Deterioration Evaluation Module. The main function of this module is to conduct a factor analysis in order to find out the most influential factors to the pavement deterioration. Then, the module goes into the analysis of pavement deterioration progress speed based on Markov transition probability theory. Also, benchmarking evaluation is also performed in this stage by using Pavement Deterioration Evaluation Module. Some internally produced data (intermediate product) are stored in Zone E. The final output such as hazard parameter, and Markov transition probabilities, and benchmarking evaluation data are not stored in the MASTER_DB but saved in different output folders.

c. GF-3:

In the third step, the flow goes to Data Management Module and generates budget planning and annual repair work planning dataset using PMS dataset, PMS master data and result of pavement deterioration evaluation module (particularly benchmarking information). The outputs (i.e. budget planning module dataset and annual repair work planning dataset) are stored in Zone-D of the MASTER_DB.

d. GF-4:

Users are requested to select planning types, either (1) Annual Pavement Repair Plans or (2) Mid-term Pavement Repair Plans.

e. GF-5 and GF-6:

Based on the selected planning type, the software goes into either one of these modules; (1) Repair Work Planning Module for annual pavement repair plans, or (2) Budget Planning Module for mid-term pavement repair plans.

In addition, users are requested to manually input simulation conditional data in accordance with the guidance given by user interfaces. The outputs are stored in outside of the MASTER_DB (i.e. in 3_sim folder).

f. GF-7:

If repeated simulation is necessary, user can return either at GF-1 or GF-4. If master data need to be revised, user shall return to GF-1 and then proceed to remaining steps. Similarly, if repair policy or simulation condition or budget condition or all of them need to be revised, user shall return to GF-4 and then proceed to remaining steps.

2) Data Management Module

The flow chart of the Data Management Module is illustrated in **Figure 6.4.3.** Step-by-step explanation is also shown, in the following the figure.

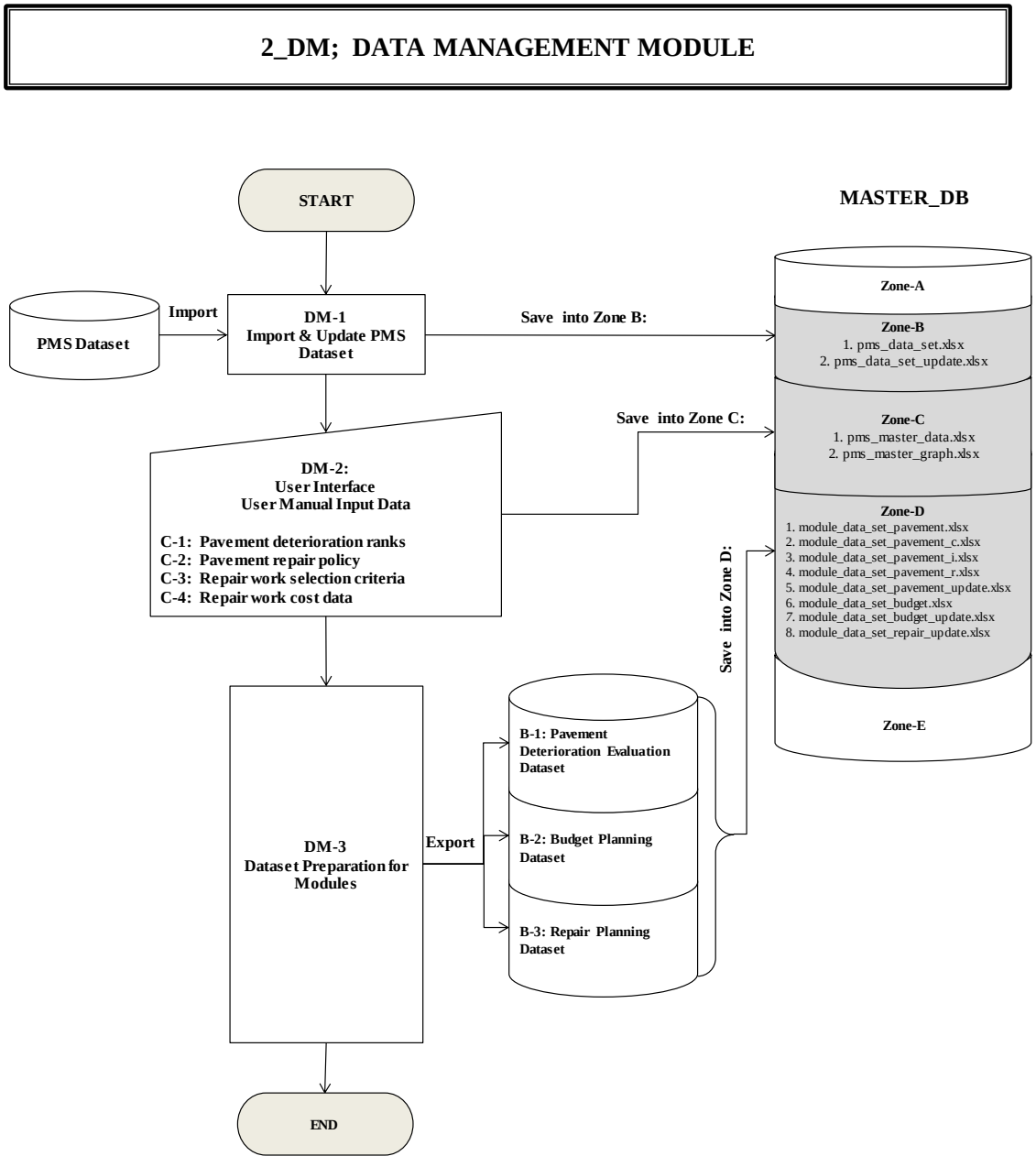


Figure 6.4.3 Flow Chart - Data Management Module

a. DM-1: Import PMS dataset

The first step of this Data Management Module is to import and Update PMS dataset and save it in Zone –B of the MASTER_DB.

b. DM-2: User Interface (Manual data input by user)

Conditional data commonly used in many modules are required to be set in this step, which consist of the following data. The inputted data are saved in Zone-C of the Master Database.

c. C-1: Pavement deterioration ranks

Pavement deterioration rank shows the degree of pavement deterioration. Pavement deterioration ranks can be expressed by three pavement deterioration indicators; (1) crack ratio, (2) rutting depth and (3) IRI. **Table 6.4.13** shows a data input window which save inputted data into MASTER_DB after user's manual data input. Instruction will be given to users through computer interfaces to be displayed.

Table 6.4.13 Data Input Table for Pavement Deterioration Indexes

Rank	Tab-1: Crack Ratio(%)	Tab-2: Rut Depth (mm)	Tab-3: IRI (mm/m)
1	≦CR<	≦RD<	≦IRI<
2	≦CR<	≦RD<	≦IRI<
3	≦CR<	≦RD<	≦IRI<
4	≦CR<	≦RD<	≦IRI<
5	≦CR<	≦RD<	≦IRI<
6	≦CR<	≦RD<	≦IRI<
7	≦CR<	≦RD<	≦IRI<
8	≦CR<	≦RD<	≦IRI<
9	≦CR<	≦RD<	≦IRI<
10	≦CR<	≦RD<	≦IRI<

(Note) Rank: Pavement deterioration ranks

d. C-2: Pavement repair policy ranks

Pavement repair policy rank indicates the status of pavement deterioration which needs repair works with corresponding repair type. The status of pavement deterioration is expressed as a deterioration rank. Users are requested to select rank and corresponding repair work type. The selected repair work type will be displayed by color allocated for each repair work type.

Table 6.4.14 Repair Policy (Sample Only)

Rank	Crack Ratio	Rutting Depth	IRI
1			
2			
3			
4		0	
5		1	
6	1	1	1

(Note) Rank: Pavement deterioration ranks

color	Description
	Cut & Overlay (Non-Structural)
	Cut & Replacement (Structural)

e. C-3: Repair work selection criteria

Repair work selection criteria or conditions are necessary to select the appropriate repair work type by taking account of pavement deterioration indices, traffic volume and road class. The following repair work selection criteria are considered in repair work planning module.

Table 6.4.15 Repair Work Selection Criteria

Road Class	Rutting Depth (mm)	Crack Rate (%)	Heavy Traffic Volume (AADT)
I	RD < 25	CR<5	TV < 100
II	25 <= RD < 40	5 <= CR < 15	100 <= TV < 250
III	RD >= 40	15 <= CR < 35	250 <= TV < 1000
IV		35 <= CR < 50	TV >= 1000
V		CR >= 50	
VI			

f. C-4: Repair work cost data

Repair work cost data are needed for estimating budget. In this Project, cost estimate for pavement repair works are performed in the Annual Maintenance Plan and in Mid-term Maintenance Plan. Repair work types which are practically applied in Vietnam are considered. Also, repair work type such as DBST, SBST, and TBST are not considered because pavement types in RRMB I road networks are either categorized as Asphalt Concrete (AC) or Cement Concrete (CC) and DBST, SBST, TBST, etc. are not recommended on top of AC surface. Same values of repair costs are applied for both repair cost computations.

Table 6.4.16 Repair Work Costs Data

SN	Items	Unit	Unit Cost (1000 VND)	Remarks
1	**Surface treatment**			
	1.1 Crack Seal	m2		
	1.2 Seal Coat	m2		
	1.3 Slurry Seal	m2		
	1.4 Patching with Hot Asphalt Mixture	m2		
	1.5 Patching with Cold Asphalt Mixture	m2		
	1.6 Pavement Partial Replacement	m2		
	1.7 Surface Level Difference Elimination	m2		
2	**Overlay**			
	2.1 Overlay (30 mm)	m2		
	2.2 Overlay (50 mm)	m2		
	2.3 Overlay (70 mm)	m2		
3	**Cut and overlay**			
	3.1 Cut & Overlay (30 mm)	m2		
	3.2 Cut & Overlay (50 mm)	m2		
	3.3 Cut & Overlay (70 mm)	m2		
4	**Surface and Binder Replacement (for standard type)**	m2		
5	**Whole Layer Replacement (for standard type)**	m2		
6	**Subgrade Replacement (for standard type)**	m2		
7	**Strengthening Overlay**	m2		

g. DM-3: Dataset preparation for modules

Based on the imported PMS datasets, three individual datasets are prepared for the operation of three modules shown below and saved in the Zone-D of the MASTER_DB. A list of data requirements for each dataset needs to be prepared and saved in advance in Zone-B of the MASTER_DB. In accordance with the data requirements shown in **Table 6.4.17**, the step distributes datasets needed for the implementation of the modules.

- B-1:Pavement deterioration evaluation dataset
- B-2:Repair work planning dataset
- B-3:Budget planning dataset

Table 6.4.17 Data Requirements for Modules

Data Category	No	Data Items			Unit	Module Name			
						Data Management Module	Pavement Deterioration Evaluation Module	Repair Work Planning Module	Budget Planning Module
ROAD ASSET DATA	1	Road ID						X	
	2	Route Number						X	
	3	Road Name					*	X	
	4	Branch Number.					*	X	
	5	RRMUs					*	X	
	6	RRMU Field Office						X	
	7	Structural Type							
	8	Crossing Type							
	9	Overlap Section							
	10	Geographical Area							
	11	Year / Month of Service Operation Open			yyyy/ mm				
	12	Year / Month of Construction End			yyyy/ mm				
	13	Road Section	From	km	km			X	
	14			m	m			X	
	15		To	km	km			X	
	16			m	m			X	
	17	Section Length			m			X	X
	18	Number of Lanes.						X	
	19	Up or Down						X	
	20	Pavement Type			m		+,*	X	X
	21	Pavement Width			m			X	X
	22	Pavement Thickness			cm		+		
	23	Climate	Annual Precipitation				+		
	24		Temperature				+		
	25	Topographic conditions	Flat / Rolling / Mountainous terrain				+		
	26	"Dummy"							
	27	"Dummy"							
PAVEMENT CONDITION DATA	28	Latest Condition Survey	Year/month of survey		X		X	X	
	29		Lane position surveyed		X			X	
	30		Pavement type		X			X	
	31		Crack Rate	Cracking	%			X	
	32			Patching	%			X	
	33			Pothole	%			X	

Data Category	No	Data Items			Unit	Module Name			
						Data Management Module	Pavement Deterioration Evaluation Module	Repair Work Planning Module	Budget Planning Module
	34	2nd Latest Condition Survey		Total	%		X	X	X
	35		Rut Depth	Max	mm			X	
	36			Average	mm		X	X	X
	37		IRI		X		X	X	X
	38		Year/month of survey				X		
	39		Lane position surveyed						
	40		Pavement type						
	41		Crack Rate	Cracking	%				
	42			Patching	%				
	43			Pothole	%				
	44			Total	%		X		
	45		Rut Depth	Max	mm				
	46			Average	mm		X		
	47		IRI				X		
	48	MCI						X	
	49	"Dummy"							
MAINTENANCE HISTORY DATA	**50**	Latest Repair	Year / Month of the latest repair				X	X	
	51		Repaired Lane					X	
	52		Repair Method				+, *	X	
	53		Repair Classification					X	
	54	"Dummy"							
	55	"Dummy"							
TRAFFIC VOLUME DATA	**56**	Latest survey	Total traffic volume		AADT				X
	57		Heavy traffic volume		AADT		+	X	X
	58	2nd Latest Survey	Total traffic volume		AADT				
	59		Heavy traffic volume		AADT				
	60	"Dummy"							
	61	"Dummy"							

Note:

X: Needed Data Items

**: Specific identifier for benchmarking analysis*

+: Items considered for factor analysis

3) Pavement Deterioration Evaluation Module

The flow of Pavement deterioration Evaluation Module is illustrated in **Figure 6.4.4.** Step-by-step explanation is also shown, following the figure.

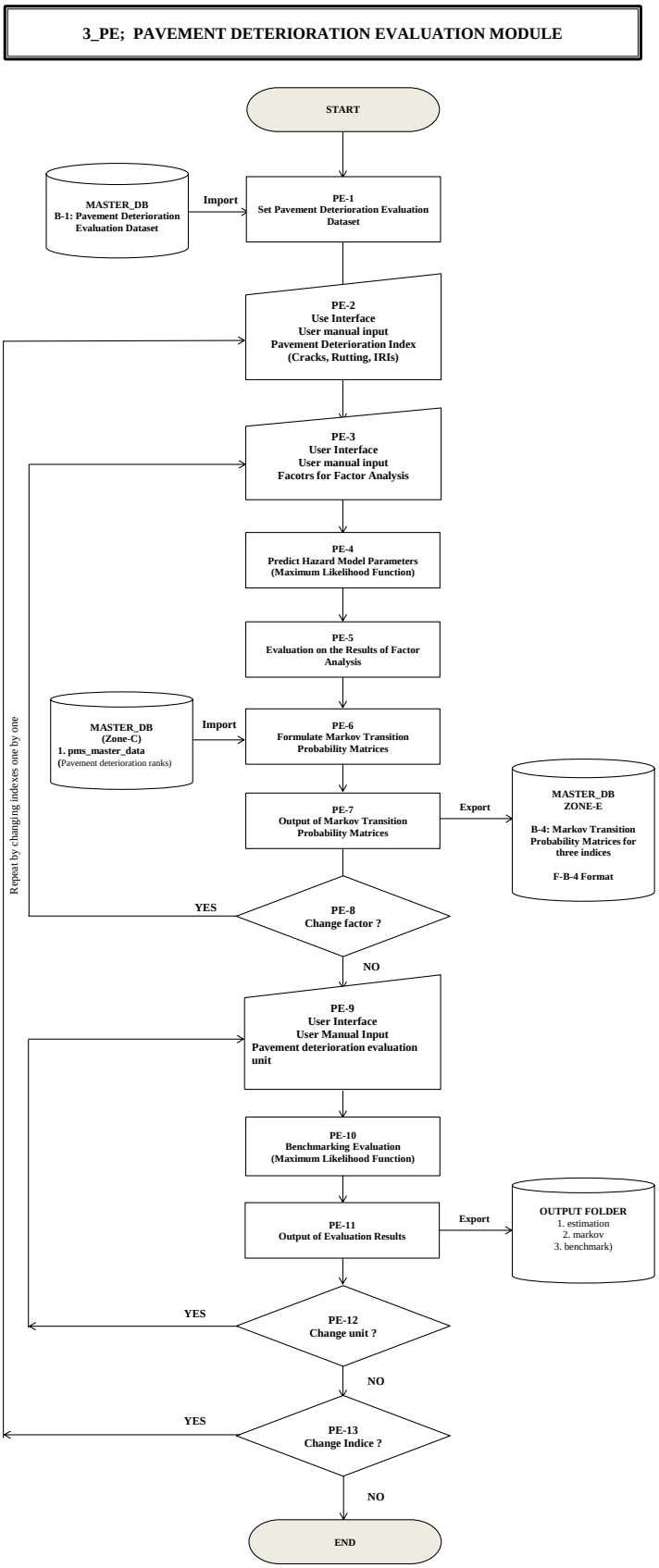


Figure 6.4.4 Flow Chart – Pavement Deterioration Evaluation Module

PE-1: Import pavement deterioration evaluation dataset

The first step of this Pavement Deterioration Evaluation Module is to import the dataset for this module from the Master Database. The dataset for the computation of this module was already prepared in Data Management Module and saved in MASTER_DB.

PE-2: Set pavement deterioration ranks through user interface (User manual input)

Users are requested to select one of the pavement deterioration indexes; (1) crack ratio, (2) rutting depth and (3) IRI through user interface. Hereafter, simulation will be executed for all steps from PE-2 to PE-13 in accordance with the selected pavement deterioration index until user selection is completed.

PE-3; Set factors for factor analysis through user interface (Use manual input)

Factor analysis is aiming to find out the most influential factor to the pavement deterioration based on the latest pavement condition survey data. Users can specify maximum up to four (4) factors at a time from the following seven (7) factors; (1) Heavy traffic volumes (veh/day), (2) Pavement type, (3) Repair work types, (4) Pavement thickness, (5) Annual precipitation, (6) Temperature, and (7) Topographical conditions. Then Factor analysis will be executed for all steps from PE-3 to PE-8 in accordance with the specified factors until selection is completed.

PE-4; Predict hazard model parameters

Then, hazard parameters will be computed based on the selected factors. A total of seven (7) factors are considered for factorial analysis. Up to four (4) factors can be selected at a time of analysis. A Hazard Parameter is defined as a probability of pavement deterioration changing from one rank to the next rank in terms of deterioration progress. An inverse value of this hazard parameter indicates an expected life expectancy of the pavement for the rank under consideration**.**

PE-5; Evaluation on the results of factor analysis

Evaluation of calculated hazard parameters is conducted, applying t-tests to the calculated parameters. Based on t-test results, users can understand how the selected factor influences on the deterioration of pavement**.**

PE-6/PE-7; Formulate Markov transition probability matrices and store in MASTER_DB

Based on the hazard parameters computed in the previous steps, Markov Transition Probabilities will be calculated for three pavement deterioration indexes one-by-one.

Computation results of the probabilities for three pavement deterioration indexes are all saved in the MASTER_DB. **Figure 6.4.5** shows the concept of Markov transition probabilities.

Markov transition probability is defined as time-series probabilities of pavement deterioration changing from one rank to the next rank as shown in the figure below. The module computes the probabilities by taking two (2) latest time series data of pavement condition including maintenance or year of road construction. The latest pavement condition survey data will be considered as the first time series data (hereinafter referred to as "Time Series Data - 1"). The second time series data (hereinafter referred to as "Time Series Data - 2) will be considered either the second latest pavement condition survey data or the latest maintenance history data or the year of road construction, which is closest to the latest pavement condition survey data (i.e. Time Series Data-1). Considering the data availability at the moment in DRVN, currently the probabilities are computed for the time spans from the time when previous overlays (including new road construction) were conducted to the year 2012 when the latest pavement condition survey was conducted by the Project. However, in the future, module (i.e. Data Management Module) will automatically select two time series data based on data availability. As shown in the figure below, transition probabilities are calculated by time elapse and by pavement deterioration rank based on 2012 pavement condition survey data.

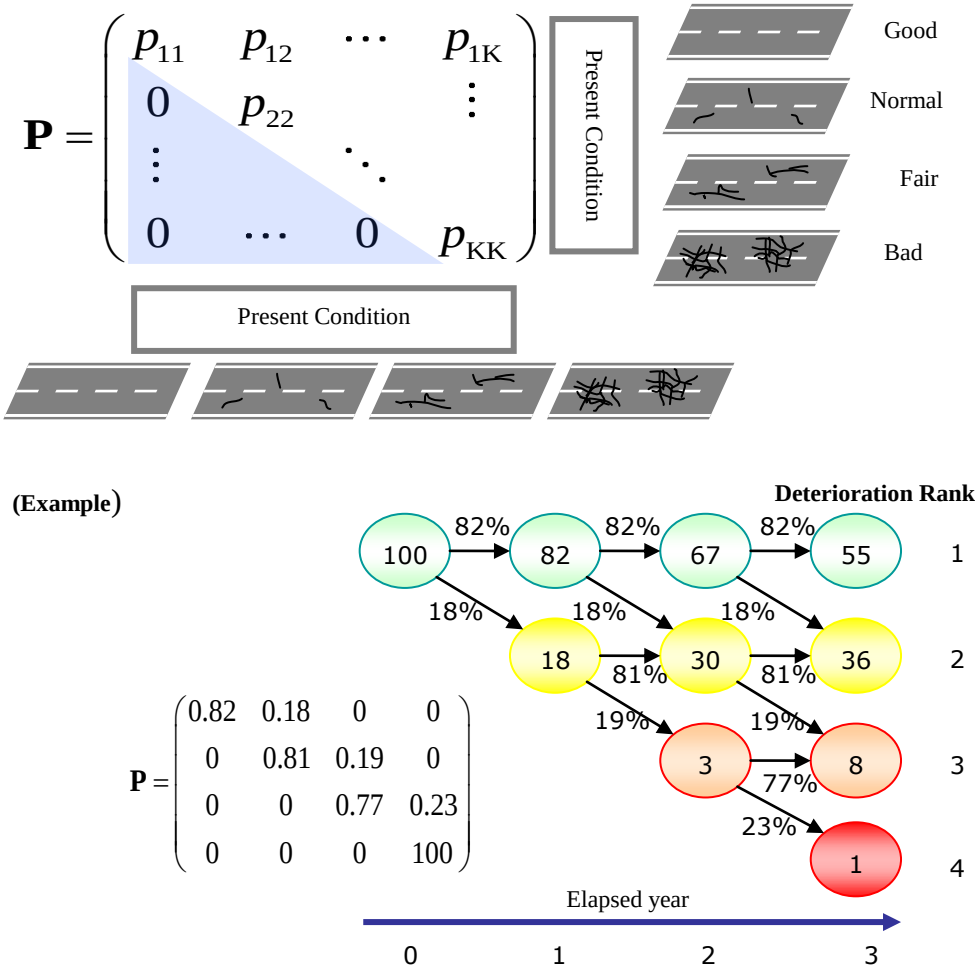


Figure 6.4.5 Concept of Markov Transition Probabilities

PE-3 – PE-8; Repeat simulation for all factors

PE-9; Set pavement deterioration evaluation unit through user interface (use manual input)

Users will be requested to input the unit of pavement deterioration evaluation which is an identification parameter for the evaluation. In general, the road number, the number of road management unit, and so forth are in general applied.

PE-10; Benchmarking evaluation of pavement deterioration speeds

Markov Deterioration Hazard Model:

Base Hazard Rate is expressed as;

$$\lambda_i^k = \beta_{i,1} + \beta_{i,2} x_2^k + \ldots$$

Where,

λ_i^k = Base hazard rate

$\beta_{i,1}$ = Predicted parameter; Constant (???)

$\beta_{i,2}$ = Predicted parameter for specific parameter x_2^k

x_2^k = Specific Parameter (such as traffic volume)

Mixture Markov Deterioration Hazard Model:

Mixture Hazard Rate is expressed as;

$$\lambda_i^{lk} = \tilde{\lambda}_i^{ls} \varepsilon^k$$

Where,

λ_i^{lk} = Mixture hazard rate

$\boldsymbol{\varepsilon^k}$**=** Heterogeneity Parameter

Based on the imported dataset (B-1), software will compute the parameters showing relative speeds (ε) of pavement deterioration for every specified road section. The parameter is defined as that showing the relative speed of pavement deterioration against an average deterioration speed for the section that is a benchmark speed. If ε >1.0, pavement deterioration

for the section progresses faster than the benchmarking speed. On the contrary, if ε <1.0, pavement deterioration progresses slower that the benchmarking speed.

Computation results of the pavement deterioration speeds for three pavement deterioration indexes are all saved in the MASTER_DB one by one.

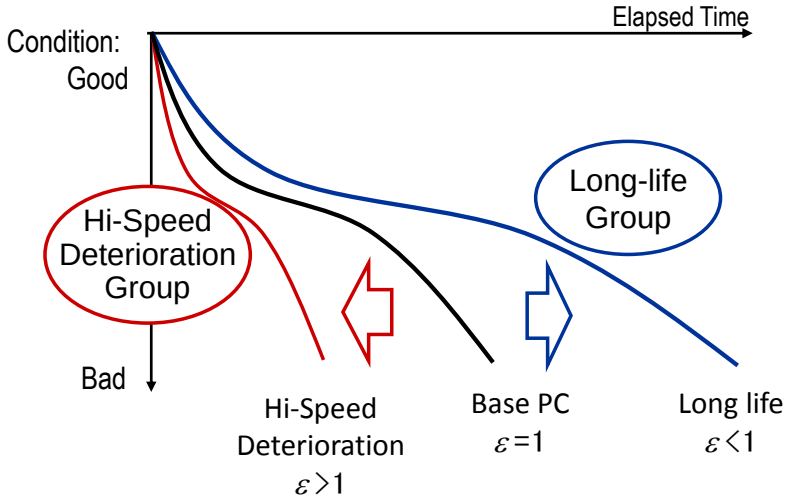


Figure 6.4.6 Benchmarking of Pavement Deterioration Speed

PE-8 – PE-11; Repeat simulation for all pavement deterioration evaluation units

In this step, user can repeat the simulation of other pavement deterioration unit and can evaluate the pavement deterioration. The same process described between PE-8 and PE-10 will repeat.

PE-2 – PE-13; Repeat simulation for all pavement deterioration indexes

Simulation for other remaining pavement deterioration indices other than initially or already simulated indices can be repeated in the same procedure as described between PE-2 and PE-13.

4) Repair Work Planning Module

The flow chart of the Repair Work Planning Module is illustrated in **Figure 6.4.7.** Step-by-step explanation is also shown, following the figure below.

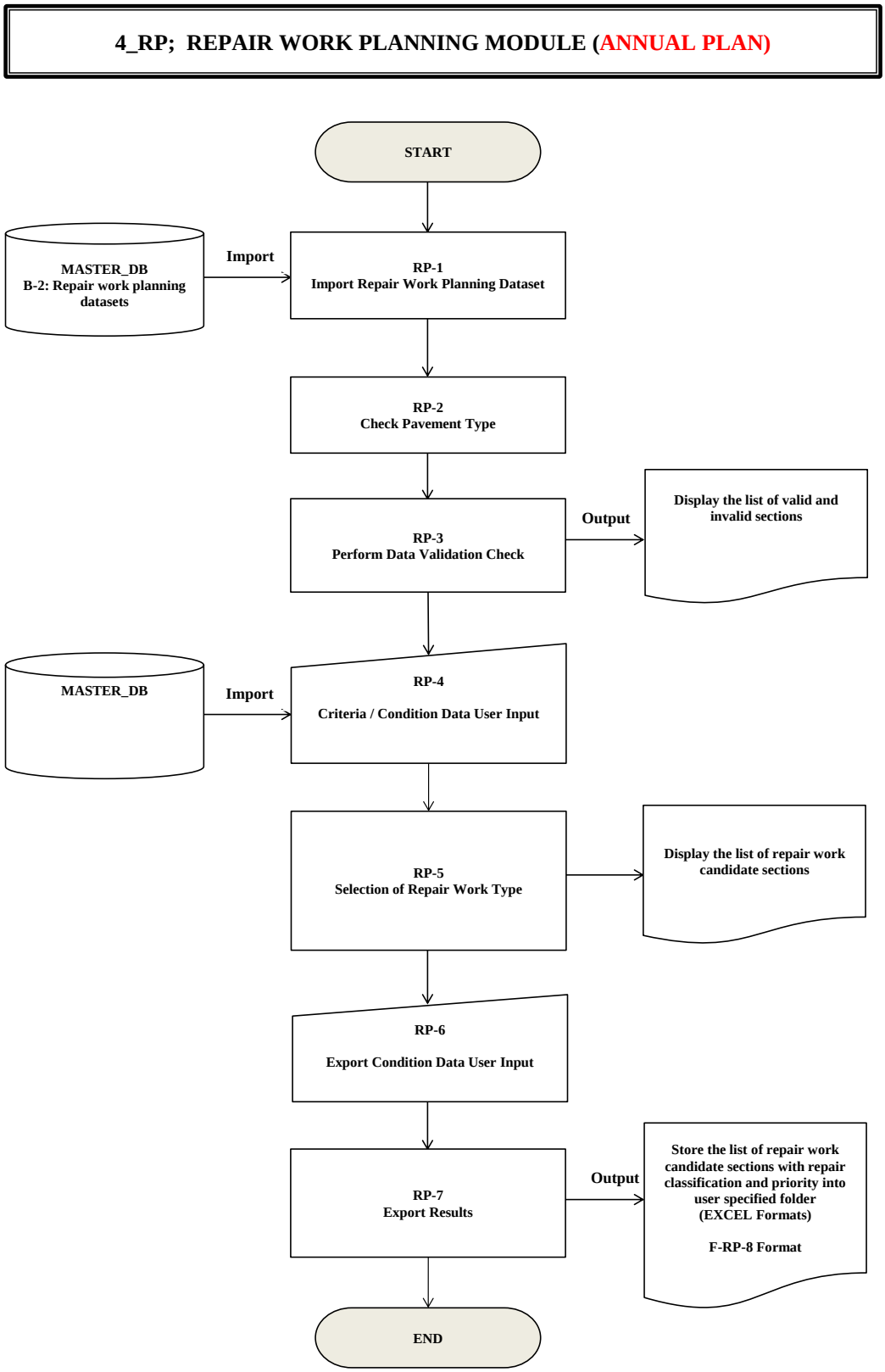


Figure 6.4.7 Flow Chart – Repair Work Planning Module

RP-1: Import the repair work planning dataset (B-3)

The first step of this Repair Work Planning Module is to import the repair planning dataset from the MASTER_DB.

RP-2: Check pavement type

Since repair work types are remarkably different by pavement type (asphalt concrete, bitumen pavement, and cement concrete) this module check the pavement type at this stage and proceed further for the remaining steps. At this moment, repair work selection flowchart is prepared only for asphalt pavement considering fact that approximately 95% of national roads under RRMB I jurisdiction is asphalt concrete and remaining 5% is cement concrete. Expansion of the module to incorporate repair work selection flowchart for other remaining pavement types is possible.

RP-3: Perform data validation check

The validation check for imported repair work planning module dataset is performed to check whether the road sections and values are proper in accordance with definition of each data items. If any of the road section or data of particular sections are improper, those sections or values are displayed by different color. Improper sections and values are excluded from the analysis from hereafter.

RP-4: Criteria / Condition data (user manual input)

Before running the module for identifying appropriate repair work type, conditions or criteria shall be defined at this stage. The default value will be imported automatically (from MASTER_DB). If user want to modify conditions, it is possible. The following default values are included in the module. Repair unit cost can also be updated in this step if necessary.

Table 6.4.18 Standard Repair Works (AC) for Road Class - I, II and III

Repair Work Planning Module

Rutting Depth			Light defects				Medium defects				Heavy defects			
			Rutting Depth < 25 mm				25 mm <= Rutting Depth < 40 mm				40 mm <= Rutting Depth			
Traffic Volume (Heavy Vehicle: AADT)			TV < 100	100 <= TV < 250	250 <= TV < 1,000	1,000 <= TV	TV < 100	100 <= TV < 250	250 <= TV < 1,000	1,000 <= TV	TV < 100	100 <= TV < 250	250 <= TV < 1,000	1,000 <= TV
Crack rate (CR)	Light defects	CR < 5 %	No repair				No repair			Cut and OL 50 mm	OL 30 mm	OL 30 mm	OL 50 mm	Cut and OL 50 mm
		5 % <= CR < 15 %	No repair		Surface treatment		OL 30 mm	OL 30 mm	OL 50 mm	Cut and OL 70 mm	OL 50 mm	OL 50 mm	OL 50 mm	Cut and OL 70 mm
	Medium defects	15 % <= CR < 35 %	OL 30 mm	OL 50 mm	OL 50 mm	Cut & OL 70 mm	OL 50 mm	OL 50 mm	OL 70 mm	Cut & OL 70 mm	OL 50 mm	OL 50 mm	OL 70 mm	Cut and OL 70 mm
	Heavy defects	35 % <= CR < 50 %	Cut & OL 50 mm	Cut & OL 50 mm	Cut & OL 70 mm		Cut and OL 50 mm	Cut and OL 50 mm	Cut & OL 70 mm		Cut and OL 50 mm	Cut and OL 50 mm	Cut and OL 70 mm	
		50 % <= CR	(1) Surface & Binder replacement (2) Pavement whole layer replacement (3) Subgrade replacement (4) Strengthening Overlay				(1) Surface & Binder replacement (2) Pavement whole layer replacement (3) Subgrade replacement (4) Strengthening Overlay				(1) Surface & Binder replacement (2) Pavement whole layer replacement (3) Subgrade replacement (4) Strengthening Overlay			

Table 6.4.19 Standard Repair Works (AC) for Other Road Classes

Repair Work Planning Module						
Traffic Volume (Heavy Vehicle: AADT)			**TV < 100**	**100 <= TV < 250**	**250 <= TV < 1,000**	**1,000 <= TV**
Crack rate (CR)	**Light defects**	**CR < 5 %**	No repair or Daily maintenance (Crack seal, spot replacement etc.)			
		5 % <= CR < 15 %				
	Medium defects	**15 % <= CR < 35 %**	OL 30 mm	OL 30 mm	OL 30 mm	
	Heavy defects	**35 % <= CR < 50 %**	(1) Pavement whole layer replacement (Big repair) (2) Strengthening Overlay			
		50 % <= CR				

RP-5: Selection of repair work type

Upon modifying / accepting the repair work selection criteria, the module will analyze data (i.e. road class, crack rate, rutting depth and traffic volume) and select suitable repair work type for annual repair with corresponding internally computed repair cost. Information such as repair classification and repair method are also supplemented. The result of repair work planning module is categorized by repair method and repair classification. Those sections which are categorized as big repair are candidate sections for further field investigation such FWD test.

RP-6: Export condition data (user manual input)

The result of the module can be exported in various formats such as by road name, direction, and specific sections (From / To) for the following categories;

1. All sections
2. Out of analysis sections
3. Target repair sections
4. No or minor repair sections
5. Medium repair sections
6. Big repair sections

Priority of repair is also set in this stage by taking account of MCI value. Sections having the lowest MCI value shall get the highest priority for repair work under each repair work classification. All the candidate repair work sections are listed in increasing order of MCI value. In principle, section listed up at the top shall get the first priority for repair work. However, it is highly recommended to cross-verify the result with actual field condition. If actual field conditions differ from the analysis result, adjustment in the priority list shall be made.

RP-7: Export results

The output of the module can be saved in a user specified location in MS-Excel format.

RP-8: Final selection of repair work sections taking account of budget and field verification (manual decision making)

Final selection of repair work sections is to be made for all repair work sections selected in RP-5 considering the budget and result of field verification.

(Special Note)

It should be noted here that repair work sections selected here are based on the latest pavement condition surveys with deterioration data recorded every 100 meters, so that uses are recommended to conduct detailed field surveys on the repair candidate sections selected by this planning software in order to confirm repair sections or areas by visual inspection.

5) Budget Planning Module

The flow chart of the medium-term budget planning (Budget Planning Module) is illustrated in **Figure** 6.4.8**.** Step-by-step explanation is also shown, following the figure below.

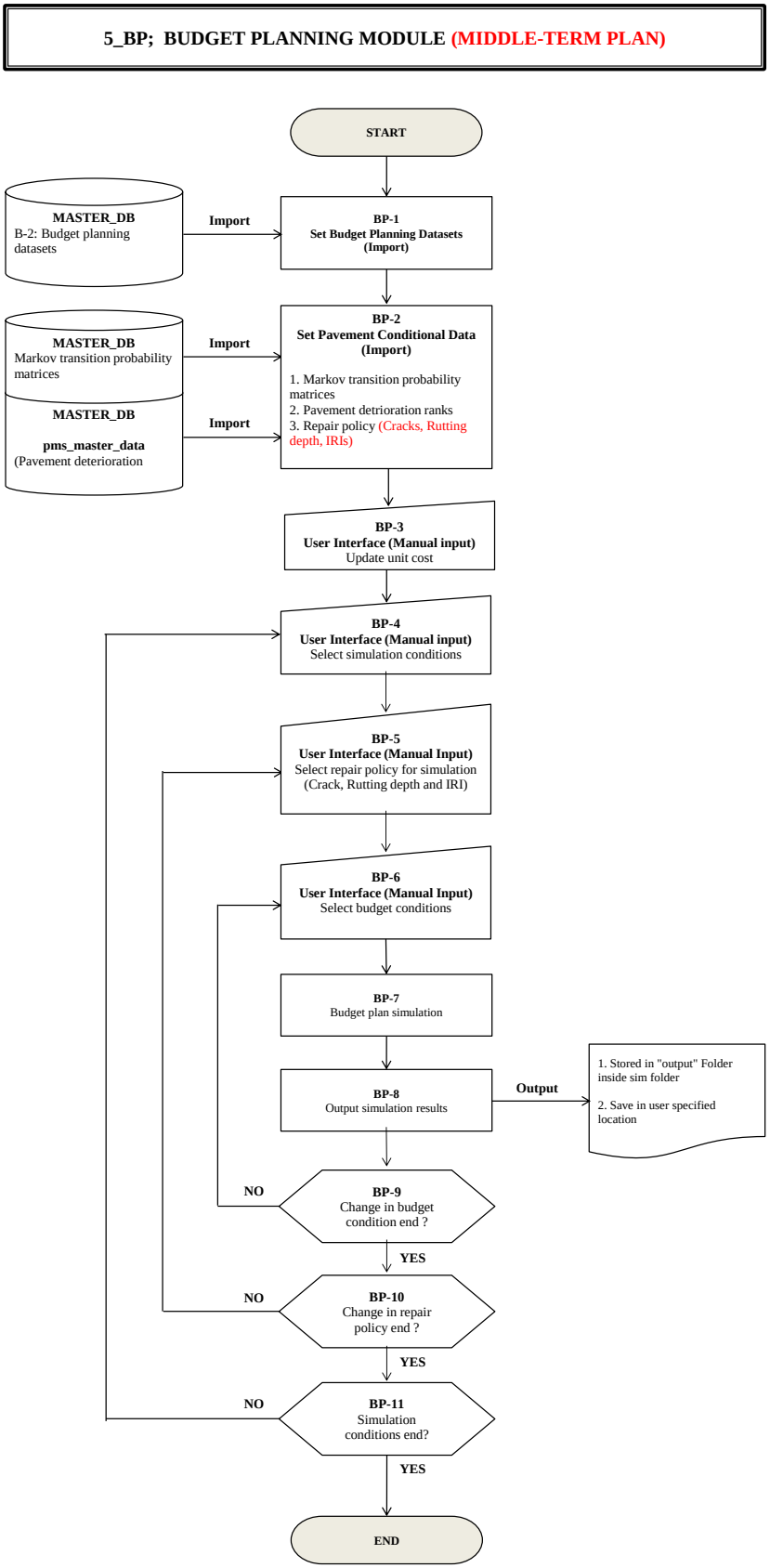


Figure 6.4.8 Flow Chart – Budget Planning Module

BP-1: Import budget planning dataset

The first step of this Budget Planning Module is to import the budget planning module dataset for the computation of this module from the MASTER_DB.

BP-2: Import pavement condition data

Pavement condition data, which include Markov transition probability matrices, pavement deterioration ranks and repair policy, are imported from Master_DB.

BP-3: Update repair work unit cost

In general, repair unit cost is subject to change with market price of labor and material. Therefore, it is necessary to update the repair work unit cost manually by the user at this stage.

BP-4: Set simulation conditions

Users are requested to input simulation conditions shown below by manual. Default values will be preliminarily set for the number Monte Carlo simulation.

- The number of simulation years
- The number of Monte Carlo simulation (Default value is initially set, but changeable)

BP-5/BP-6: Select repair policy for simulation and select budget conditions

Following the data input of simulation conditions in BP-4, users are requested to input the simulation trial conditions. Users are allowed to set trial cases, changing the following conditions;

- Change in repair policy conditions
- Existence of budget constraint
- Change in budget conditions

Simulation conditions can be set for the following three scenarios one-by-one. Please note that user shall change the simulation conditions manually one-by-one. Simulation can be done for one set of simulation condition at a time.

a. Scenario-1: Current budget level scenario (Worst case scenario)

To know the progress of pavement deterioration when current budget level is maintained

b. Scenario-2: Current level of pavement deterioration scenario

To know the magnitude of repair budgets when trying to stop the progress of pavement deterioration at current pavement deterioration levels

c. Scenario-3: Pavement service level scenario (Best case scenario)

To know the magnitude of repair budgets when maintaining all pavement conditions at target levels (pavement service levels)

BP-7: Budget plan simulation

Upon completing all settings required for budget planning, the module will simulate the budget by taking account of all setting condition by using Montecarlo simulation.

BP-8: Output and save data of simulation results

The output of the simulation will be distributed into various sheets such as "Cost", "Budget", "Condition (crack, rut, and IRI)", and risk. The output of the simulation result will be saved inside the system. Also, user can export the simulation result in user specified folder in MS-Excel format. If users want to compare repair costs for all three scenarios mentioned in BP-6, user shall simulate the budget for all three scenarios and present the output in a common graph.

BP-6 – BP-9; Repeat simulation for all budget conditions required

BP-5 – BP-10; Repeat simulation for all repair policies required

BP-4 – BP-11; Repeat simulation for all simulation conditions

(7) Outputs

Figure 6.4.9 to **Figure 6.4.23** show the schematic view of the sample outputs of three main modules (i.e. pavement deterioration evaluation, budget planning and repair work planning). In particular, **Figure 6.4.20** shows the outputs of three scenarios. Also, **Figure 6.4.21** to **Figure 6.4.23** shows the budget status of constraint which is equivalent to Case-1 scenario.

This part shows the output sample of the system. The data that we prepared and used is for indicating output samples only. Please note that it is not real data in Vietnamese road / pavement.

1) Budget Planning Module (Medium-term plan)

Budget Planning Module is provided to simulate prospective repair work demands, pavement condition and risk (rate of non-repair archived) to formulate budget planning for medium-term (3-5 years). This make it possible to prepare material for strategic investment planning of pavement. Budget Planning Module aims to estimate the following three major items;

a. Prospective Transition of Repair Work Demands (Operating Cost and Volume of Repair Work)

This module estimates prospective demand of required budget and volume of repair work. It cannot only simulate repair work budget with and without budget constraint, but also install a function which is available to set budget in each year in response to comply future demands and to comply Vietnamese situations such as support to formulate for tax policy for road operation and management to ensure funds for road work.

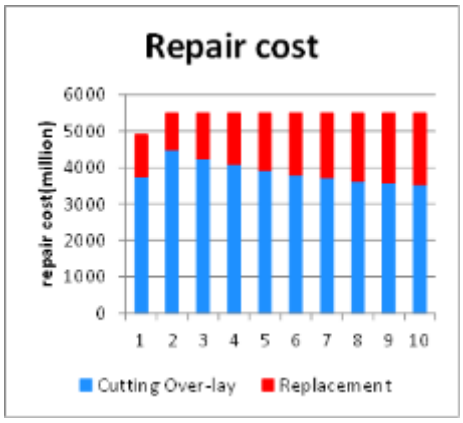


Figure 6.4.9 Estimation of Operating Cost

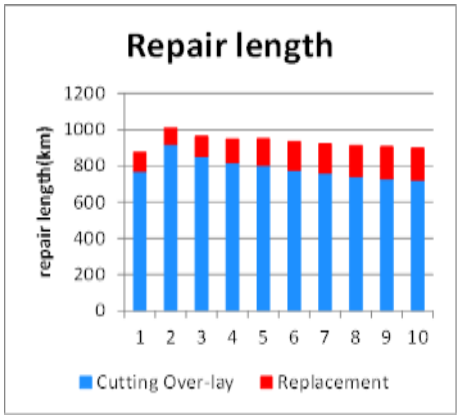


Figure 6.4.10 Estimation of Repair Work Volume

b. Perspective Transition by Pavement Distress

The changes and transition of pavement distress as cracking rate, rutting depth and IRI in the future are estimated by the simulation.

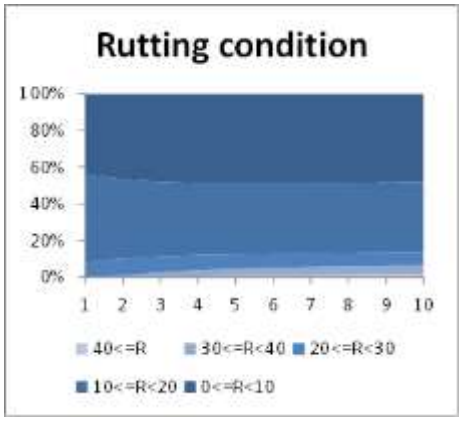


Figure 6.4.11 Estimation of Rutting Depth Transition

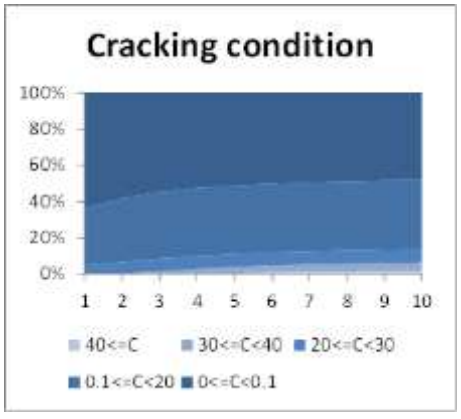


Figure 6.4.12 Estimation of Cracking Rate Transition

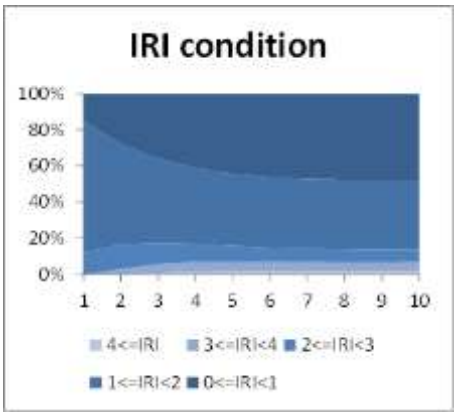


Figure 6.4.13 Estimation of IRI Transition

c. Perspective Transition of Risk

The changes of risk in full road network under budget constrain situation are simulated. Risk is defined by this PMS in following equation.

Risk (%) = Length of non-repair work due to budget constraint (km) / Length of full network managed (km)

In addition, Risk is calculated as Zero (0) if the simulation are conducted under without budget constraint situation.

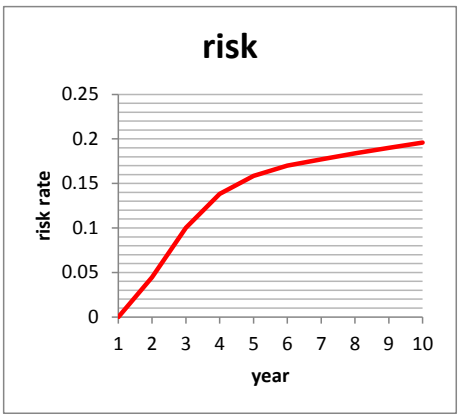


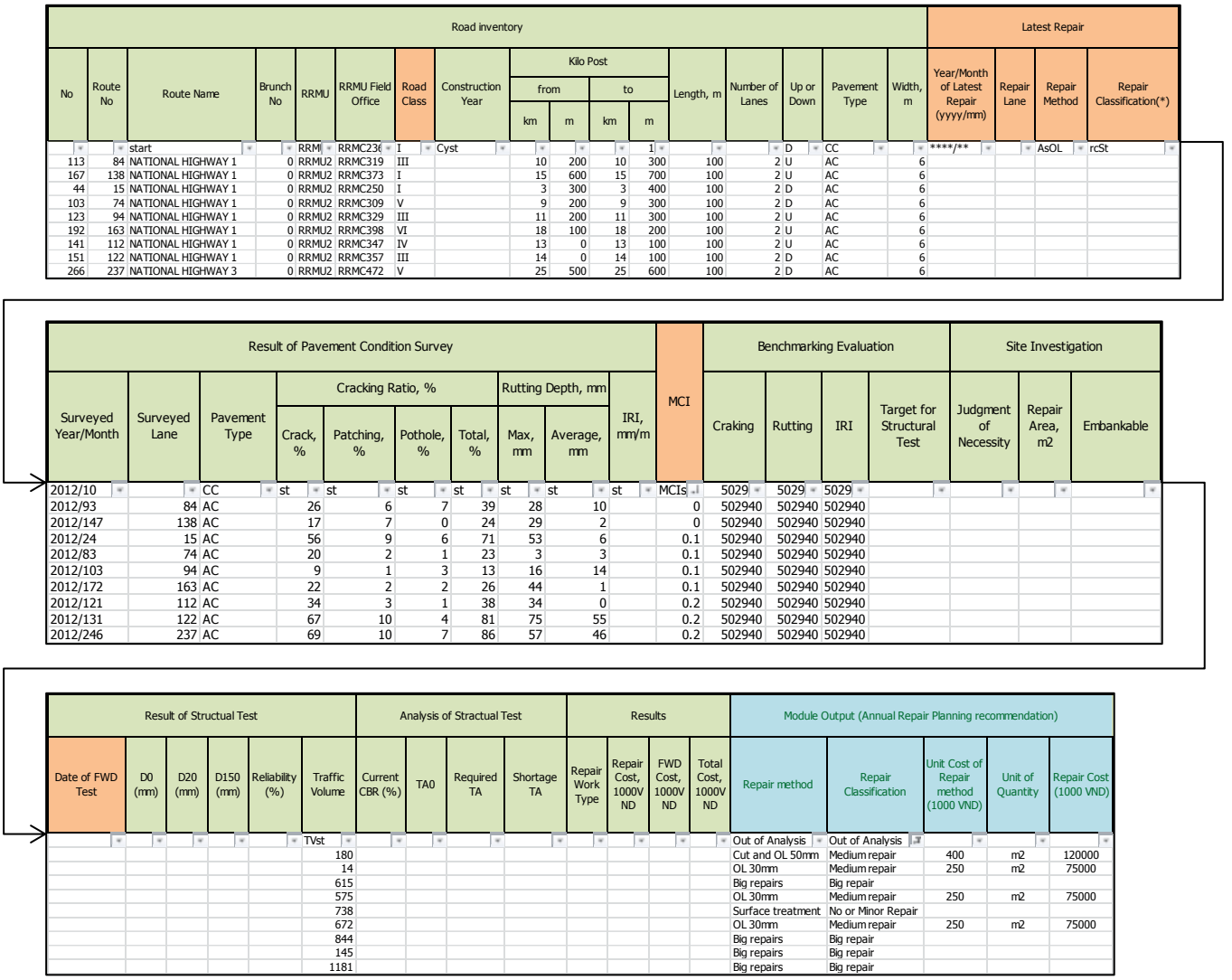
Figure 6.4.14 Estimation of Risk Transition

2) Repair Work Planning Module (Annual plan)

Repair Planning Module is provided to prepare a list of repair candidate sections with standard repair method and their priority.

a. List of Repair Candidate Sections

List of repair candidate sections provides the information of sections for repair work required to refer pavement distress data in the whole network collected by pavement condition survey. This table will be used as reference material for site investigation and detailed survey (as FWD test etc.) In addition, field investigation engineers will judge necessity of repair work and area of repair work in the site of candidate sections.



Road inventory																Latest Repair			
No	Route No	Route Name	Brunch No	RRMU	RRMU Field Office	Road Class	Construction Year	Kilo Post from km	Kilo Post from m	Kilo Post to km	Kilo Post to m	Length, m	Number of Lanes	Up or Down	Pavement Type	Width, m	Year/Month of Latest Repair (yyyy/mm)	Repair Lane	Repair Method	Repair Classification(*)
		start		RRMU	RRMC23(	I	Cyst					1		D	CC		****/**		AsOL	rcSt
113	84	NATIONAL HIGHWAY 1	0	RRMU2	RRMC319	III		10	200	10	300	100	2	U	AC	6				
167	138	NATIONAL HIGHWAY 1	0	RRMU2	RRMC373	I		15	600	15	700	100	2	U	AC	6				
44	15	NATIONAL HIGHWAY 1	0	RRMU2	RRMC250	I		3	300	3	400	100	2	D	AC	6				
103	74	NATIONAL HIGHWAY 1	0	RRMU2	RRMC309	V		9	200	9	300	100	2	D	AC	6				
123	94	NATIONAL HIGHWAY 1	0	RRMU2	RRMC329	III		11	200	11	300	100	2	U	AC	6				
192	163	NATIONAL HIGHWAY 1	0	RRMU2	RRMC398	VI		18	100	18	200	100	2	U	AC	6				
141	112	NATIONAL HIGHWAY 1	0	RRMU2	RRMC347	IV		13	0	13	100	100	2	U	AC	6				
151	122	NATIONAL HIGHWAY 1	0	RRMU2	RRMC357	III		14	0	14	100	100	2	D	AC	6				
266	237	NATIONAL HIGHWAY 3	0	RRMU2	RRMC472	V		25	500	25	600	100	2	D	AC	6				

Result of Pavement Condition Survey										MCI	Benchmarking Evaluation				Site Investigation		
Surveyed Year/Month	Surveyed Lane	Pavement Type	Cracking Ratio, % Crack, %	Cracking Ratio, % Patching, %	Cracking Ratio, % Pothole, %	Cracking Ratio, % Total, %	Rutting Depth, mm Max, mm	Rutting Depth, mm Average, mm	IRI, mm/m		Craking	Rutting	IRI	Target for Structural Test	Judgment of Necessity	Repair Area, m2	Embankable
2012/10		CC	st	st	st	st	st	st	st	MCIs	5029	5029	5029				
2012/93	84	AC	26	6	7	39	28	10		0	502940	502940	502940				
2012/147	138	AC	17	7	0	24	29	2		0	502940	502940	502940				
2012/24	15	AC	56	9	6	71	53	6		0.1	502940	502940	502940				
2012/83	74	AC	20	2	1	23	3	3		0.1	502940	502940	502940				
2012/103	94	AC	9	1	3	13	16	14		0.1	502940	502940	502940				
2012/172	163	AC	22	2	2	26	44	1		0.1	502940	502940	502940				
2012/121	112	AC	34	3	1	38	34	0		0.2	502940	502940	502940				
2012/131	122	AC	67	10	4	81	75	55		0.2	502940	502940	502940				
2012/246	237	AC	69	10	7	86	57	46		0.2	502940	502940	502940				

Result of Structual Test						Analysis of Stractual Test				Results				Module Output (Annual Repair Planning recommendation)				
Date of FWD Test	D0 (mm)	D20 (mm)	D150 (mm)	Reliability (%)	Traffic Volume	Current CBR (%)	TA0	Required TA	Shortage TA	Repair Work Type	Repair Cost, 1000V ND	FWD Cost, 1000V ND	Total Cost, 1000V ND	Repair method	Repair Classification	Unit Cost of Repair method (1000 VND)	Unit of Quantity	Repair Cost (1000 VND)
					TVst									Out of Analysis	Out of Analysis			
					180									Cut and OL 50mm	Medium repair	400	m2	120000
					14									OL 30mm	Medium repair	250	m2	75000
					615									Big repairs	Big repair			
					575									OL 30mm	Medium repair	250	m2	75000
					738									Surface treatment	No or Minor Repair			
					672									OL 30mm	Medium repair	250	m2	75000
					844									Big repairs	Big repair			
					145									Big repairs	Big repair			
					1181									Big repairs	Big repair			

Figure 6.4.15 Table of Repair Candidate Sections

3) Evaluation Module - Deterioration Speed Evaluation

Evaluation Module - Deterioration Speed Evaluation is provided to analyze deterioration speed of road pavement and to implement pavement deterioration factorial analysis.

a. Deterioration Speed Evaluation and Deterioration Factorial Analysis

Deterioration Speed Evaluation is provided to predict pavement deterioration speed based on 2 time series of pavement condition data. The result of evaluation is outputted by the type of

pavement distress. The table and figure below show results of pavement cracking speed analysis without taking road characteristics into consideration (average).

Table 6.4.20 Result of Deterioration Speed Evaluation

(Average: Hazard Rate and Life Time)

Rank	Average		
	Hazard rate	Life time (year)	LifeTime (Year : Accumlated)
1	0.3160	3.16	0.00
2	0.2004	4.99	3.16
3	0.7206	1.39	8.15
4	0.4829	2.07	9.54
5	---	---	11.61

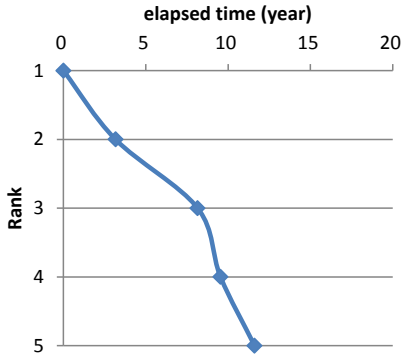


Figure 6.4.16 Result of Deterioration Speed Evaluation (Average: Graph)

Also, the result of cracking speed analysis by pavement types is shown in Table 6.4.21 and Figure 6.4.17 below.

Table 6.4.21 Result of Deterioration Factorial Analysis

((Pavement Type: Hazard Rate and Life Time)

Rank	Pavement Type					
	Asphalt			Cement		
	Hazard rate	Life time (year)	LifeTime (Year : Accumlated)	Hazard rate	Life time (year)	LifeTime (Year : Accumlated)
1	0.3511	2.85	0.00	0.1394	7.17	0.00
2	0.2227	4.49	2.85	0.1343	7.45	7.17
3	0.8007	1.25	7.34	0.6696	1.49	14.62
4	0.5365	1.86	8.59	0.4110	2.43	16.11
5	---	---	10.45	---	---	18.55

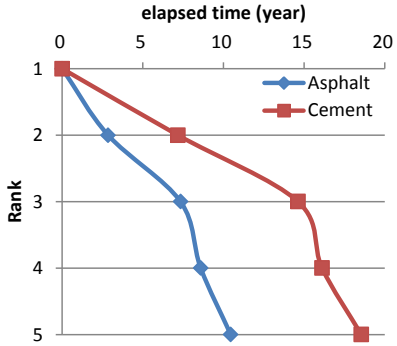


Figure 6.4.17 Result of Deterioration Factorial Analysis (Pavement Type: Graph)

Thus, users can understand the difference of deterioration speed between each pavement types. In addition, other factors believed to affect pavement deterioration can be incorporated in the analysis, if data become available.

b. Markov Transition Probability Matrix

Markov Transition Probability Matrix is provided to show the probability of pavement deterioration, changing from one deterioration rank to the others. This matrix is calculated by using parameters based on deterioration speed analysis and deterioration factorial analysis. The matrix will be applied for deterioration model of budget planning simulation.

Table 6.4.22 Markov Transition Probability Matrix

	Rank1	Rank2	Rank3	Rank4	Rank5
Rank1	0.56	0.39	0.04	0.01	0.00
Rank2	0.00	0.80	0.14	0.05	0.01
Rank3	0.00	0.00	0.45	0.41	0.14
Rank4	0.00	0.00	0.00	0.58	0.42
Rank5	0.00	0.00	0.00	0.00	1.00

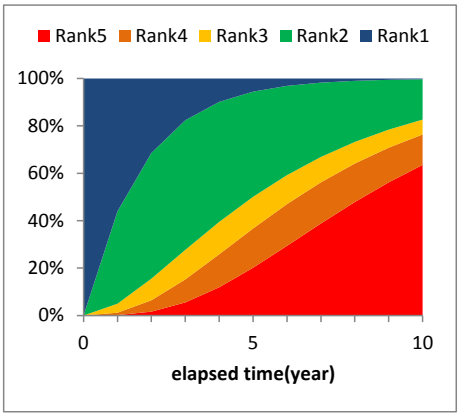


Figure 6.4.18 Transition of Pavement Distress Based on Markov Deterioration Probability Matrix

c. Relative Evaluation (Benchmarking Analysis)

Benchmark Analysis is provided to evaluate pavement deterioration speed in groups recognized as homogenous sections, the relative deterioration speed is expressed as parameters which are indicating the gaps of each homogenous group from average group. The sample output of benchmark analysis is shown in **Table 6.4.23** and **Figure 6.4.19** below.

Table 6.4.23 Result of Benchmark Analysis (Relative Evaluation Value and Life Time)

Route No.	Relative Value	Life Time (Year : Accumulated)				
		1	2	3	4	5
Benchmark	1	0.00	3.16	8.15	9.54	11.61
QL 1	0.4	0.00	7.91	20.38	23.85	29.03
QL 2	2.5	0.00	1.27	3.26	3.82	4.65
QL 3	1.1	0.00	2.88	7.41	8.67	10.56
QL 4E	0.5	0.00	6.33	16.31	19.08	23.23
QL 5	2.2	0.00	1.44	3.71	4.34	5.28
QL 6	2	0.00	1.58	4.08	4.77	5.81
QL 10	1.1	0.00	2.88	7.41	8.67	10.56
QL 15	0.7	0.00	4.52	11.65	13.63	16.59
QL 18	0.5	0.00	6.33	16.31	19.08	23.23
QL 37	0.3	0.00	10.55	27.18	31.81	38.71
QL 38	0.2	0.00	15.82	40.77	47.71	58.06
QL 38B	2.5	0.00	1.27	3.26	3.82	4.65
QL 43	0.5	0.00	6.33	16.31	19.08	23.23
QL 70	0.4	0.00	7.91	20.38	23.85	29.03
QL 279	0.6	0.00	5.27	13.59	15.90	19.35
Southern Ring	0.8	0.00	3.96	10.19	11.93	14.52
No.1 to Ninh Phuc port	0.95	0.00	3.33	8.58	10.04	12.22
NB-BN	0.5	0.00	6.33	16.31	19.08	23.23
HCMH	1.3	0.00	2.43	6.27	7.34	8.93

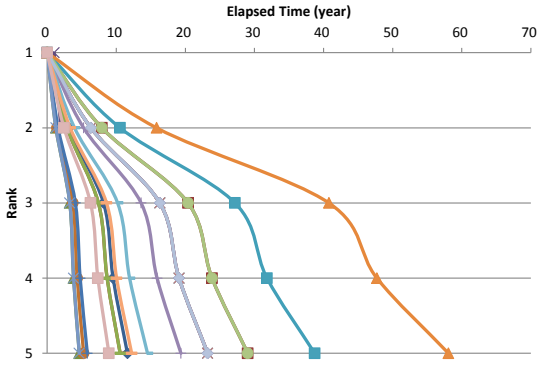


Figure 6.4.19 Result of Benchmarking Analysis (Graph)

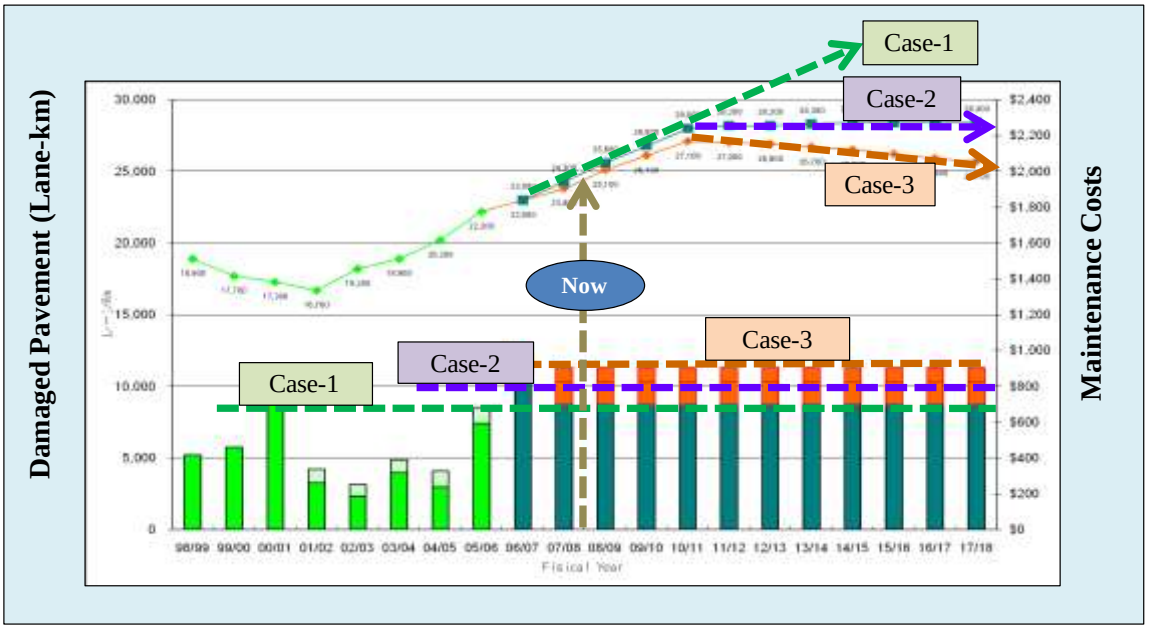


Figure 6.4.20 Sample (1) Output with Three Scenarios

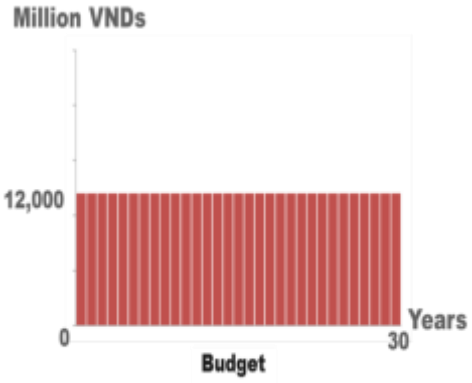


Figure 6.4.21 Sample (2) Budget Constraint

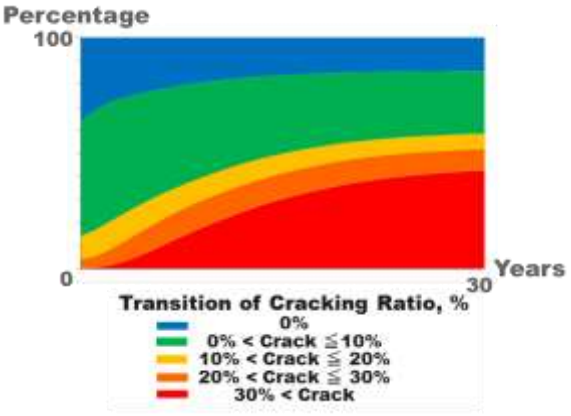


Figure 6.4.22 Sample (3) Growth of Cracks

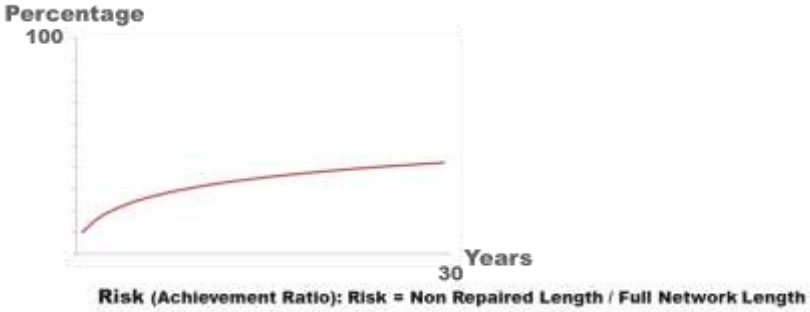


Figure 6.4.23 Sample (4) Growth of Risks under Budget Constraint

6.4.9 PMS Dataset

(1) Data Requirements

The number of data requirement is estimated approximately 6 types and around 65 in number.

1) By Data Type

a.	Road inventory data	27 data
b.	Latest pavement condition data (2012)	10 data
c.	2nd latest pavement condition data (2007)	10 data
d.	Traffic count data (for Factor Analysis)	6 data
e.	Maintenance history data	6 data
f.	Others (Maintenance History)	2 data

- Maintenance budget data

2) By Module type

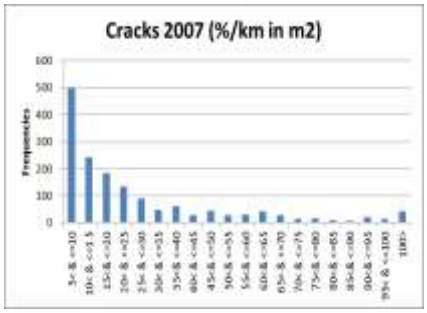
g.	Budget Planning:	11 data
h.	Repair Work Planning	31 data
i.	Deterioration Prediction	19 data

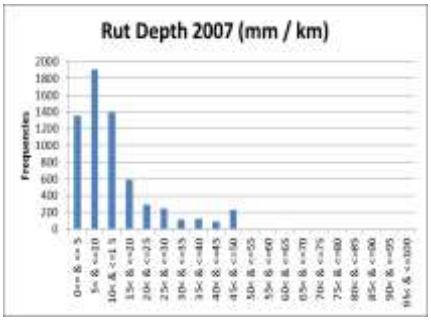
3) Indexes to measure pavement deterioration

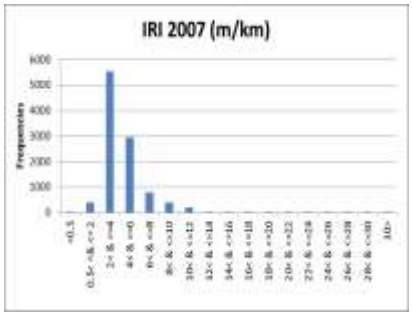
The following indexes to measure pavement deterioration will be taken into account in VPMS. These indexes are considered representatives capable enough showing pavement deterioration properly and also measurable in principle by road condition survey vehicle.

- Cracks
- Rut Depths
- IRIs

The following figures shows sample frequency distributions of pavement deteriorations taken up from RoSyBASE 2007.







4) Evaluation of Potential Use of RoSyBASE 2007 data

SAPI-II study, which was conducted in 2009, clarified that it was so hard to ensure quality of RoSyBASE data that it is not good enough to apply to VPMS. As an alternative way, the Project recommends that the use of the years of "construction completion" or "latest surfacing" is more preferable rather than relying on RoSyBASE data 2007. RRMB I has inputted data related to year of construction completion and the latest repair works and those data are used for budget planning.

6.4.10 Institutional Arrangement for Developing VPMS Computer software

VPMS computer software was developed on the basis of the framework agreed between DRVN and JICA Project Team. A professional group specialized for developing the VPMS computer software were organized, which consists of JICA experts, DRVN staffs, RRMB I staffs, RTCs staffs (Central / RTC 2) and UTC staffs. Technology transfer specialized for computer software development was made to these group members. It is highly recommended to the same group member for attending any kind of trainings in the future either by the project team or Kyoto University.

6.4.11 Institutional Arrangement for System Upgrade and System Expansion

VPMS is not a kind of computer software anyone can handle, but professional software specialized for handling PMS, so that it is necessary that professional engineers who are specially trained for its operation and management should take care of VPMS. It is therefore recommended that a professional engineering organization like RTC Central should play take responsibility for managing and operating the VPMS dataset and the software. The professional organization should play a key role of taking care of VPMS in cooperation with external academies including UTC and Kyoto University to receive professional expertise.

6.4.12 Technical Trainings

(1) Introduction

Technical trainings on overall design framework and operation of PMS have been implemented during the project for technology transfer on PMS development and operation. The training on overall PMS design framework was implemented by organizing the workshop

and participants form concerned organizations were invited. The trainings on operation of PMS have been implemented by providing the lecture as well as a very careful operation of PMS. The practice on operation of PMS has been done from beginning to the end in close supervision of JICA experts. The operation procedure, data input requirements and outputs of the system (both intermittent as well as final outputs) were explained the trainees.

Two (2) engineers; potential operators of PMS, were trained through the OJT. One engineer from Department of Planning and Investment (DPI) and one engineer from Economic and Planning Department of RRMB I were participated in the OJT.

(2) Training Plan

The training plan on PMS development and operation was prepared in cooperation with DRVN. The details of training plan are shown in **Table 6.4.24**.

Table 6.4.24 Training Plan (PMS Development and Operation)

Training	Training Style	Date / Duration / Frequency	Objectives	Curriculum	Trainee	Training Material
1st Training	Lecture	Aug. 2013 • Half day • 1 time	To make familiar with; ▪ Summary of Pavement Condition Survey ▪ Roles and Functions of PMS	▪ Analysis on the Pavement Condition Data of RRMB I Road Network ▪ Software Functions for Pavement Maintenance Planning ▪ Software Modules ▪ Preset Conditions ▪ PMS Dataset	WG- 2 members	
2nd Training	OJT	Feb. 24, 2014 ▪ 1 day ▪ 1 time	To make familiar with; ▪ Data generation and management ▪ Master data management	1. Computer Practice ▪ System log-in ▪ User Authorization ▪ Data update PMS dataset generated by conversion software ▪ Master data settings and updating 2. Discussion	DPI, DRVN, Economic and Planning Dept., RRMU2	Manual PMS
	OJT	Feb. 25, 2014 ▪ 1 day ▪ 1 time	To make familiar with; ▪ Pavement Deterioration Speed Evaluation (Modeling for Deterioration Prediction) ▪ Benchmarking Evaluation	1. Computer Practice ▪ Data Generation 1 (From PMS dataset to Dataset for modules) ▪ Pavement Deterioration Speed Evaluation (Modeling for Deterioration Prediction) ▪ Deterioration Factorial Analysis ▪ Benchmarking Evaluation 2. Discussion	DPI, DRVN, Economic and Planning Dept., RRMU2	Manual PMS
	OJT	Feb. 26, 2014 ▪ 1 day ▪ 1 time	To make familiar with; ▪ Budget Planning simulation	1. Computer Practice ▪ Data Collection (Repair work type and cost) ▪ Repair Work Name to apply to PMS ▪ Unit Costs for Repair Work ▪ Budgeting Trends ▪ Repair Criteria etc. ▪ Data Generation 2 (From PMS dataset to Dataset for modules) ▪ Budgeting Simulation 2. Discussion	DPI, DRVN, Economic and Planning Dept., RRMU2	Manual PMS
	OJT	Feb. 27, 2014 ▪ 1 day ▪ 1 time	To make familiar with; ▪ Repair work planning	1. Computer Practice ▪ Data Generation (from PMS dataset to Dataset for modules) ▪ Selection of Repair candidate sections ▪ Selection of Targeted Sections for Detail Survey – Using Benchmarking Evaluation ▪ Determination of Repair Sections 2. Discussion	DPI, DRVN, Economic and Planning Dept., RRMU2	Manual PMS
Intensive Training	Lecture / OJT	March 5, 2014	To make familiar with PMS	Operation Procedure	DRVN, RRMB I, Sub-bureaus& RTC	

(3) Implementation of Trainings

The trainings were implemented in accordance with the training plan discussed above. Training program, trainer, trainees and key contents of the training are shown in **Table 6.4.25**.

Table 6.4.25 Implementation of Trainings

Date	Time	Trainer	Trainee	Venue	Training Materials	Key Contents
Aug 27, 2013	9:15 - 10:10	Mr. Kato	WG-2 members	Seminar Room, DRVN	Power Point Hand out	▪ Results of Analysis on Pavement Condition Data of RRMUB I Road Network ▪ PMS Functions for Pavement Maintenance Planning ▪ PMS Database Structure
Feb. 24, 2014	10:30 - 11:30	Mr. Mori	Mr. Sinh, DRVN Mr. Nghia, RRMB-I	PMUTA Office, DRVN	Operation Manual, PMS System	▪ System Installation ▪ System Login ▪ PMS Dataset Update ▪ Data Management Module and Module dataset preparation ▪ Pavement Deterioration Evaluation ▪ Benchmarking ▪ Budget Planning (Mid-term) ▪ Repair Work Planning (Annual Plan)
Feb. 25, 2014	9:20 - 11:00	Mr. Mori	Mr. Sinh Mr. Nghia			
	15:00 - 17:00	Mr. Mori	Mr. Sinh Mr. Nghia			
Feb. 26, 2014	9:00 - 9:30	Mr. Mori	Mr. Sinh			
	9:40 - 11:30	Mr. Mori	Mr. Sinh			
	13:30 - 16:30	Mr. Mori	Mr. Sinh			
Feb. 27, 2014	9:00 - 11:30	Mr. Mori	Mr. Sinh Mr. Nghia			
	13:30 - 15:30	Mr. Mori Mr. Do	Mr. Sinh Mr. Nghia			

6.4.13 Mid-term and Annual Budget Plans for RRMB I Jurisdiction

(1) General

Mid-term and annual plans were formulated based on the pavement condition data collected in 2012. Mid-term plan was formulated taking into consideration of deterioration prediction into consideration whereas annual plan was prepared without taking into consideration of deterioration progresses. Some road sections have repaired after pavement condition data collection in 2012. However, mid-term and annual plan were formulated without taking consideration of repaired sections between 2012 and 2014 because these information are not available at the moment. Therefore, direct application of this computation outputs is not appropriate. DRVN and RRMB I are requested to pay careful attention on this issue.

(2) PMS Dataset Preparation

The conversion software was used to prepare PMS dataset by importing data from road database. The conversion software developed the PMS dataset in a specified format which is the input file of the PMS. Upon successful preparation of PMS dataset from the conversion software, PMS dataset was imported and updated in PMS software. PMS has further generated module datasets

for pavement deterioration evaluation, budget planning and repair work planning modules by employing Data Management Module which is incorporated in PMS.

(3) Preset Condition Data

a. Pavement Defects Ranking

The classification of pavement condition indexes (Cracking Rate, Rutting Depth and IRI) are divided in numbers of rank for evaluating the pavement deterioration and budget simulation as shown in **Table 6.4.26**. This rank class can be changed if necessary.

Table 6.4.26 Pavement Defects Rank Classification

Cracking Ratio (%)

Rank	Range (%)
1	C = 0
2	0 < C ≤ 10
3	10 < C ≤ 20
4	20 < C ≤ 30
5	30 < C ≤ 40
6	40 < C ≤ 50
7	50 < C

IRI (mm/m)

Rank	Range (mm/m)
1	0 < IRI ≤ 2
2	2 < IRI D ≤ 4
3	4< IRI ≤ 6
4	6 < IRI ≤ 8
5	8 < IRI ≤ 10
6	10 < IRI ≤ 12
7	12 < IRI

Rutting Depth (mm)

Rank	Range (mm)
1	0 < RD ≤ 10
2	10 < RD ≤ 20
3	20 < RD ≤ 30
4	30 < RD ≤ 40
5	40 < R

b. Repair Policy, Repair work type, Unit Cost and Budget Condition

User's manual input condition for policy, repair work type, unit cost, budget condition and simulation year are set as shown in **Table 6.4.27**. However, it can be changed based on the actual situation for each year.

Table 6.4.27 Preset Condition

Simulation Conditions	Case - 1	Case - 2	Case - 3
Scenario Name	Current Budget Level Scenario	Current Pavement Condition Level Scenario	Target Management Level Scenario
Budget Constraint	390,000 Mil VND	No	No
Risk	No	Average 13.2 %	No

Management Level	Cracking: Greater than 40% = Cut & Overlay, Greater than 50% = Whole Layer Replacement Rutting: Greater than 40mm = Cut & Overlay IRI: Not Applied
Repair Cost (Unit Cost)	Cut & Overlay: 350,000 VND/m2 Whole Layer Replacement: 980,000 VND/m2
Simulation Duration	30 Years

(4) Pavement Deterioration Prediction

Pavement deterioration predictions are made for each pavement defects indices. The results of pavement performance predicted by Pavement Deterioration Evaluation Module are illustrated in **Figure 6.4.24**. Cracking propagation on pavement surface in the early stage of the pavement is very minimal; it takes approximately 12 years to start cracking. However, once cracking is appeared, its deterioration speed is very in comparison to other two indices. Similarly, rutting and IRI are appeared on pavement surface immediately after the construction / maintenance. Once rapid propagation of rutting is stopped, rutting deterioration progresses is moderate in comparison to other indices. As for IRI, initial stage of IRI deterioration is relatively rapid.

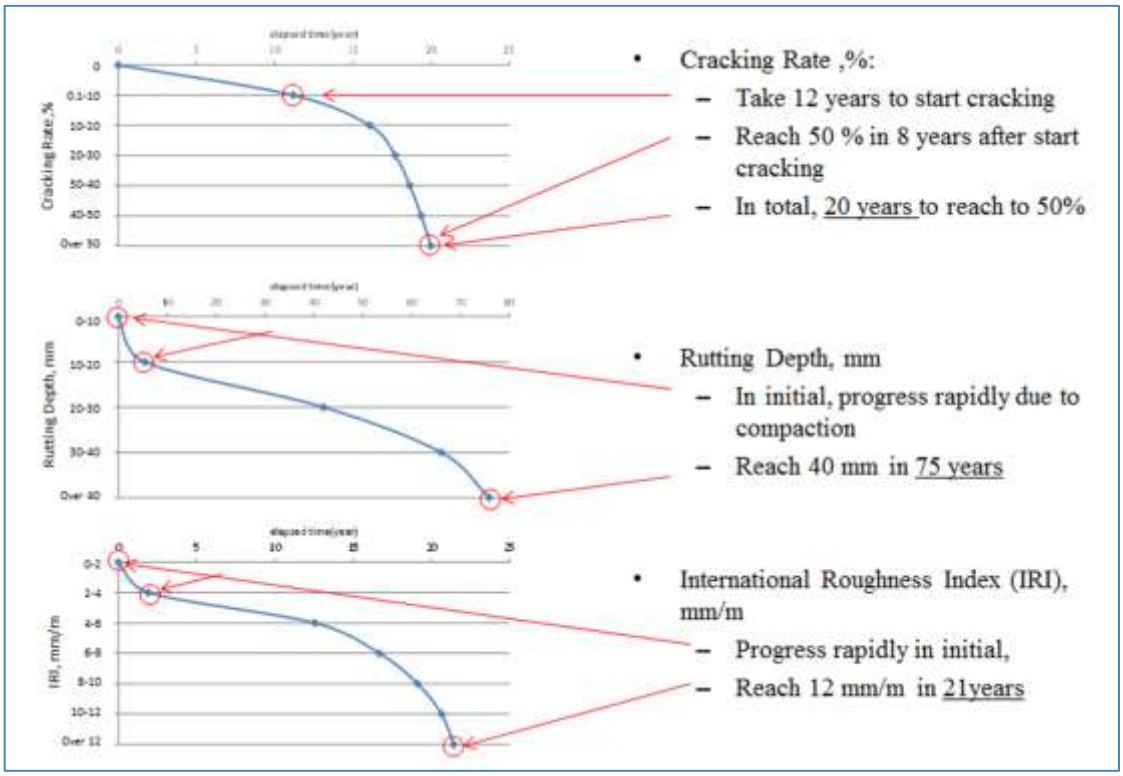


Figure 6.4.24 Pavement Deterioration Prediction

(5) Simulation Scenario

Three budget scenarios are set for budget simulation as follow;

Case -1: Current Budget Level Scenario (Budget Constraint / Worst Scenario)

Case - 2: Current Pavement Level Scenario

Case - 3: Target Management Level Scenario (No Budget Constraint / Best Scenario)

1) Case - 1: Current Budget Level Scenario

Current budget level scenario simulates the budget and informs the road operator coverage of total repair length, percentage risk of non-repaired road section and transition of pavement defects. In this simulation, budget amount is kept inputted and coverage of road total repair length, risk and transition of pavement defects are examined. Road operator can understand whether the current budget level is sufficient or not and its consequences if same budget level is applied. **Table 6.4.28** shows the amount of total proposed budget, total approved budget and approved budget which is included pavement repair and periodic repair only (excluded budget for daily maintenance) for RRMB I. The table illustrates that the approved budget for periodic pavement repair in 2014 for RRMB I is 387,760 (approx. 390,000) million VND.

Table 6.4.28 Proposed and Approved Budget in 2014 for RRMB I (Mil. VND)

Repair Type	Total Proposed Budget for RRMB I in 2014	Total Approved Budget for RRMB I in 2014	Total Approved Budget for RRMB I in 2014 (Pavement, Periodic Repair only)
Total	**693,690**	**666,612**	**387,760**
Routine Maintenance	89,274	88,761	
Periodic repair	**593,559**	**567,005**	**387,760**
Medium Repair	480,577	500,498	396,952
Transferred works from previous year	264,311	273,884	206,237
New medium repair works	216,266	226,615	163,715
Big Repair	17,809	15,173	17,809
Transferred works from previous year	17,809	15,173	17,809
New big repair works			

(Source) Prepared by RRMB I

In Case - 1 simulation, the amount of budget constraint is inputted 390,000 million VND while simulating the budget scenario.

2) Case - 2: Current Pavement Condition Level Scenario

Current pavement condition level scenario simulates the budget and determine how much amount of budget is required if road operator willing to keep the road condition in the current pavement condition level for the budget planning period. Budget amount is determined by inputting different value of budget and calculating risk until the current level of pavement

condition (average) is reached. Equation below indicates the method of calculation for "Risk" which is defined as the "length of non-repaired work due to budget constraint by Length of full network managed by RRMB I.

$$RISK\ (\%) = \frac{Length\ of\ non-repaired\ work\ due\ to\ budget\ constraint\ (km)}{Length\ of\ full\ network\ managed\ by\ RRMB\ I\ (km)}$$

$$RISK\ (\%) = \frac{598.981\ (km)}{4525.20\ (km)}$$

$$RISK\ (\%) = 13.2$$

In case - 2, the conditions of simulation are configured as average risk during simulation term (30 years) as 13.2 % approximately.

3) Case - 3: Management Level Scenario

This scenario simulates the budget and pavement deterioration by taking consideration of DRVN's target management level of pavement condition stipulated in strategic vision or some technical standards. This scenario is assumed that DRVN repair the pavement immediately when the pavement conditions are reached the target management level. The following conditions were considered during budget simulation.

Table 6.4.29 Simulation Conditions

Scenario Name	Target Management Level Scenario
Budget Constraint	No
Management Level	Cracking: Greater than 40% = Cut & Overlay, Greater than 50% = Whole Layer Replacement Rutting: Greater than 40mm = Cut & Overlay IRI: Not Applied
Repair Cost	Cut & Overlay: 350,000 VND/m2 Whole Layer Replacement: 980,000 VND/m2
Simulation Duration	30 Years

(6) Results of Budgeting Simulation

1) Summary

The results of simulation based on the three budget scenarios are shown in **Table 6.4.28** and **Figure 6.4.25**, **Figure 6.4.26**, and **Figure 6.4.27**. The first year budget and repair length for case - 3 are very high as shown in **Figure 6.4.25**, and **Figure 6.4.26** respectively, however budget and repair length from the second year substantially low in comparison to the first year. Similarly, the transition of pavement deterioration indices over the budget analysis year varies from case - 1 to case - 3. Pavement deterioration in case - 1 is extremely severe because length or deteriorated road section is increasing every year.

Table 6.4.28 Summary of Budget Simulation Results

Items		Case - 1	Case – 2	Case - 3
Annual Average Budget (Million VND)		389,998	779,998	778,850
Risk	Average (%)	38.1	9.6	0
	Maximum (%)	58.8	13.0	0

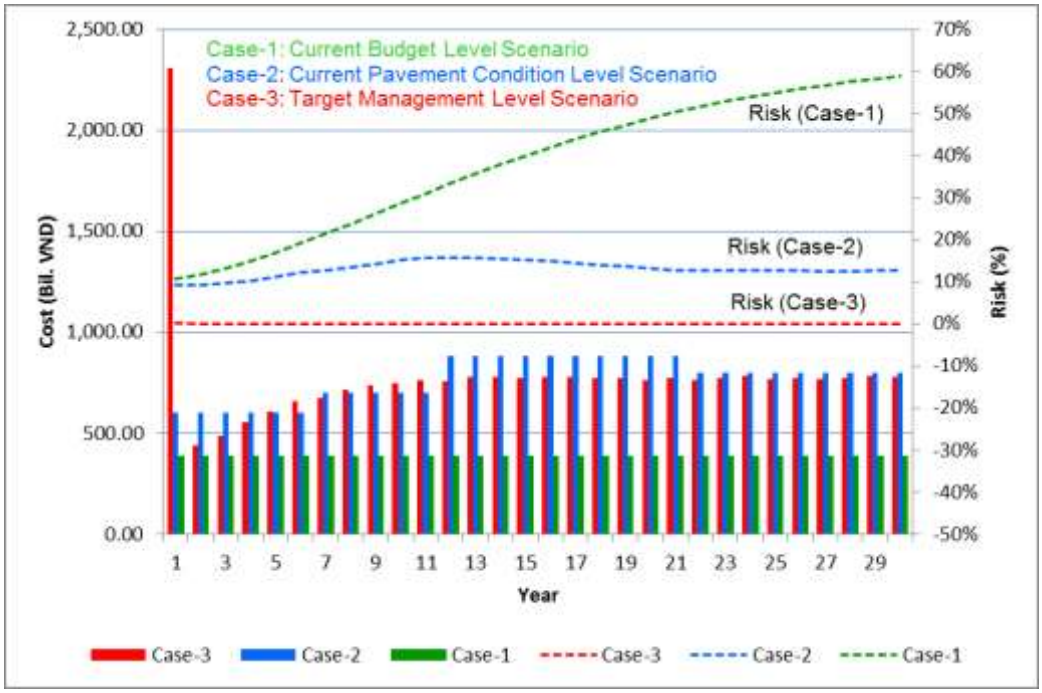


Figure 6.4.25 Summary of Budget Simulation Results (Cost and Risk)

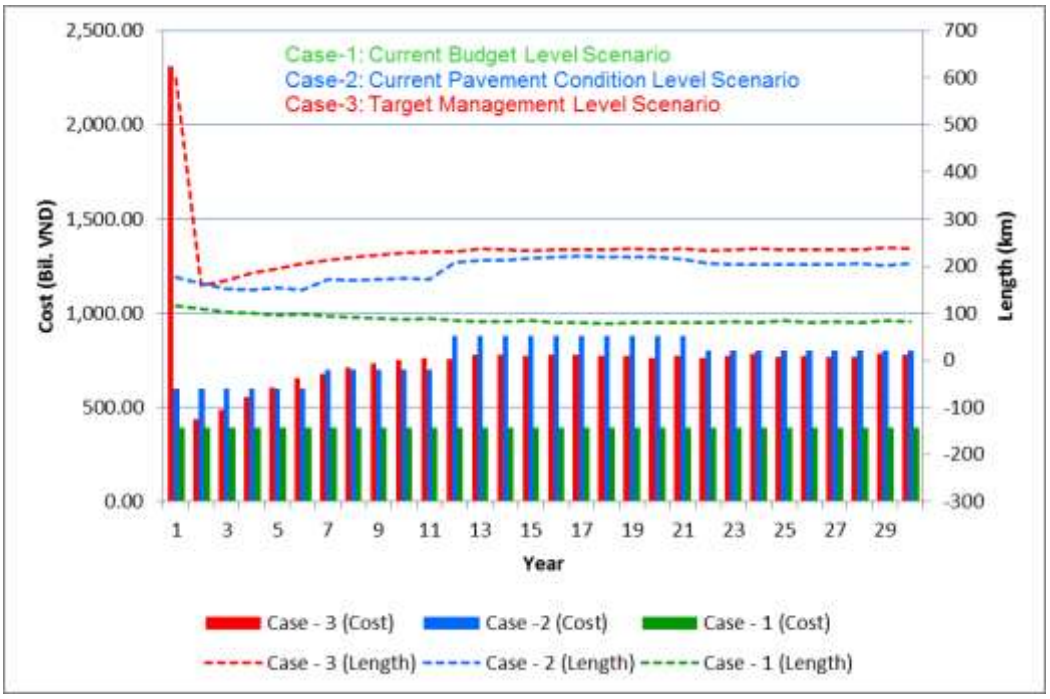


Figure 6.4.26 Summary of Budget Simulation Results (Cost and Length)

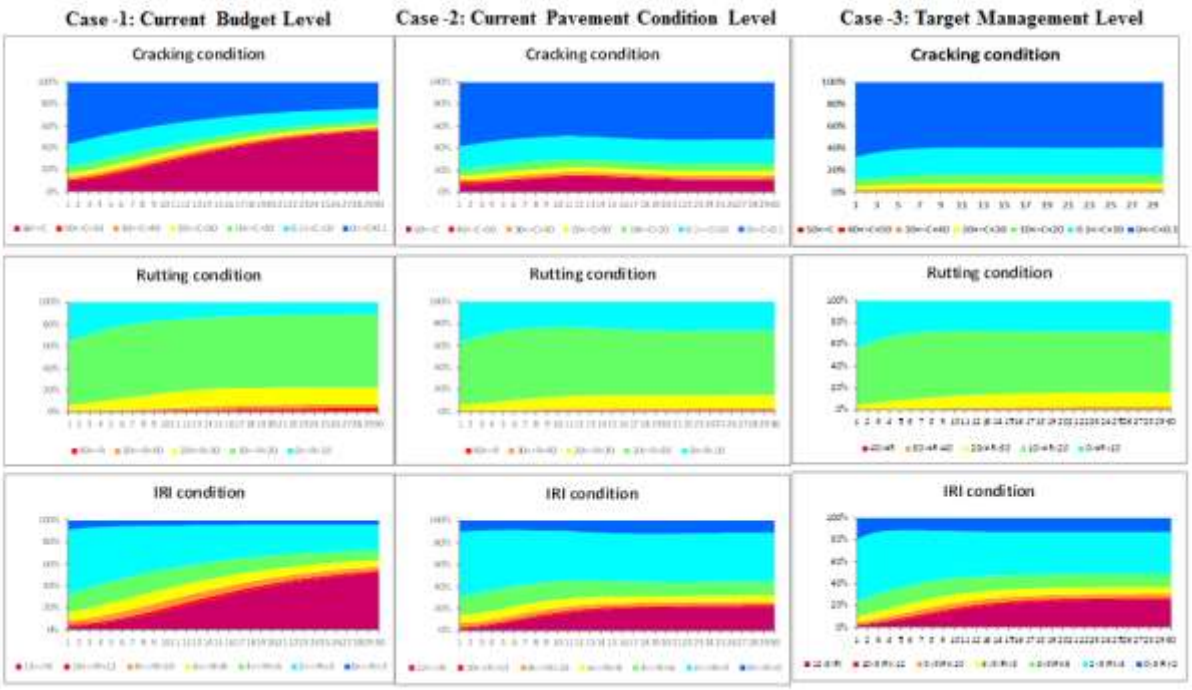


Figure 6.4.27 Summary of Budget Simulation (Pavement Deterioration Transition)

6.4.14 Annual Repair Work Plan (Annual Plan)

(1) General

Annual repair work plan is prepared based on pavement condition data in 2012 to determine priority of sections for repair work and select repair work type for nominated sections. Road sections are prioritized by MCI values. Repair work unit costs are prepared by DRVN for the year 2014. The following repair work types are used in annual repair work planning module.

- Overlay (30 mm, 50 mm, and 70 mm) *[Medium Repair]*
- Cut and Overlay (30 mm, 50, mm and 70 mm) *[Medium Repair]*
- Big Repair (which may falls under surface and binder replacement, Whole layer replacement, subgrade replacement, strengthening overlay)

Figure 6.4.28 shows a repair work selection matrix incorporated in the Annual Repair Work Planning Module.

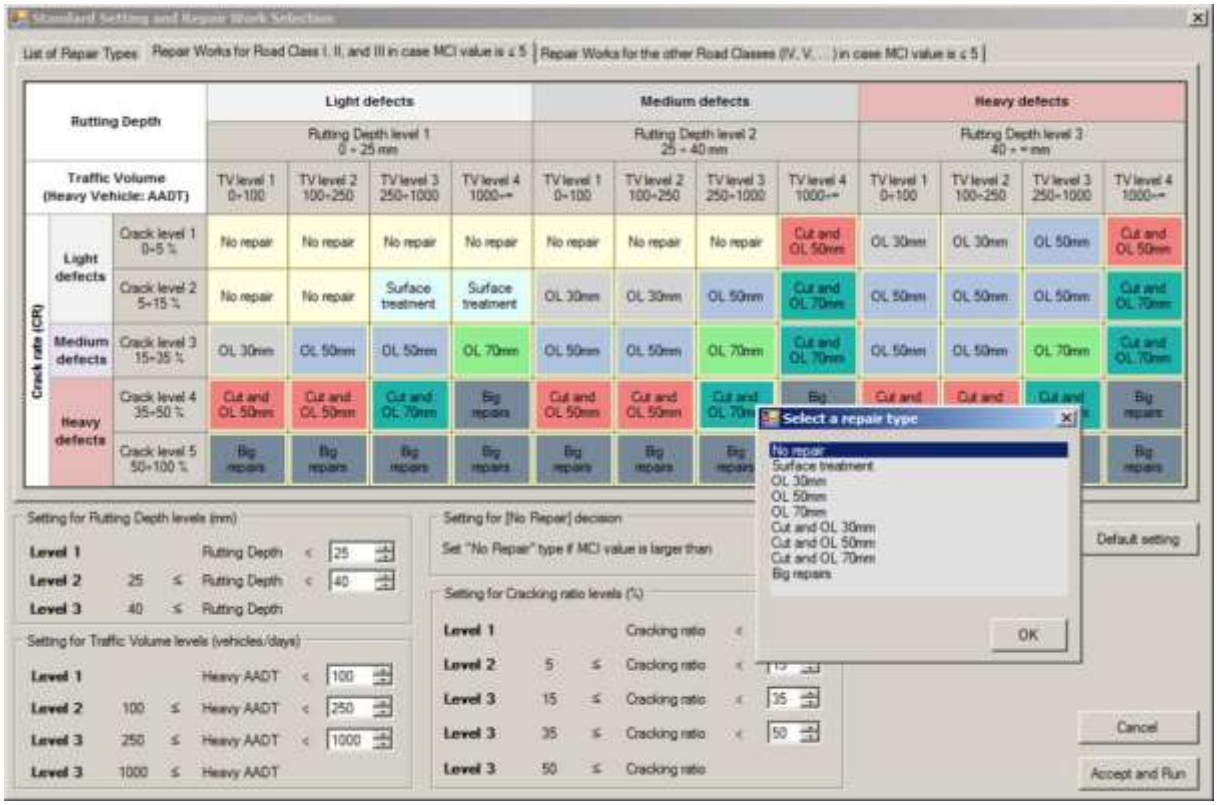


Figure 6.4.28 Standard Setting and Repair Work Selection Matrix

(2) Repair Cost

As described in the previous chapter, the target maintenance works are periodic repair work only. In Vietnam, periodic maintenance work further falls into a medium repair work and a big repair work. The unit cost of big repair work in general varies by the thickness of pavement structure, so that in this Project repair costs of medium repair work are computed in the simulation.

(3) Result of Annual Repair Work Planning Module (Annual Plan)

Summary of module's output is shown in **Table 6.4.29**.

Table 6.4.29 Summary of Repair Work Planning Module's Output

SN	Items	Big Repair (Periodic Repair)	Medium Repair (Periodic Repair)	No or Minor Repair (Routine Maintenance)
1	No. of Sections	3,668	3,294	35,817
2	Road Length (km)	311	307	3,259
3	Cost (mil VND)	NA	394,540	NA
4	MCI Range	0 – 4.97	0.81 – 5.0	0 – 9.26
6	Total Sections	52,924		
7	Total Length (km)	4,745		
8	Total Out of Analysis Sections	10,145		

(4) Repair Sections

Roads section categorized under "Nor or Minor Repair, "Medium Repair" and "Big Repair" are listed by 100m road section data. Road sections are sorted (prioritized) by MCI value. As described above also, only medium repair work sections have repair work cost. The output of the module can be exported in MS-Excel format. RRMB I is encouraged to select the road section from the priority list of the road sections for annual repair work taking into consideration of budget condition for maintenance work in RRMB I. Since there are thousands of sections identified for repair work. Only a sample output is illustrated in **Table 6.4.**.

Table 6.4.32 Output of Repair Work Planning Module (Annual Plan)

Road inventory												Result of Pavement Condition Survey			MCI	Traffic Volume	Module Output (Annual Repair Planning recommendation)				
No	Route Name	Brunch No	Road Class	Kilo Post				Length, m	Number of Lanes	Up or Down	Pavement Type	Width, m	Cracking Ratio, %	Rutting Depth, mm	IRI, mm/m			Repair method	Repair Classification	Unit Cost of Repair method	Unit of Quantity	Repair Cost
				from		to							Total, %	Average, mm								
				km	m	km	m															
37488	NATIONAL HIGHWAY 5	0	III	89	1000	90	0	5	3	U	AC	10.14	34.8	44	21.33	0.81	5715	Cut and OL 70mm	Medium repair	550	m2	9,295
43044	NATIONAL HIGHWAY 10	0	II	135	1700	135	1800	100	2	U	AC	6.78	0.2	55	3.01	1.07	982	OL 50mm	Medium repair	400	m2	135,600
12713	NATIONAL HIGHWAY 6	0	III	192	1000	193	0	10	2	D	AC	6.88	38.9	36	9.94	1.32	438.5	Cut and OL 70mm	Medium repair	550	m2	18,920
24991	NATIONAL HIGHWAY 70	0	III	192	1000	193	0	5	2	D	AC	6.24	20.9	49	4.05	1.34	275.5	OL 70mm	Medium repair	500	m2	7,800
5346	NATIONAL HIGHWAY 2	0	III	230	200	230	300	100	1	D	AC	3.78	33.5	38	8.74	1.4	231.5	OL 50mm	Medium repair	400	m2	151,200
49049	NATIONAL HIGHWAY 43	0	V	50	240	50	300	60	1	U	AC	3.67	31.8	39	7.75	1.41	28.5	OL 30mm	Medium repair	250	m2	55,050
13047	NATIONAL HIGHWAY 6	0	III	224	500	224	600	100	1	D	AC	3.43	29.7	40	6.03	1.46	304.5	OL 70mm	Medium repair	500	m2	171,500
39343	NATIONAL HIGHWAY 6	0	III	205	300	205	400	100	1	U	AC	3.28	41.9	34	4.66	1.47	341	Cut and OL 70mm	Medium repair	550	m2	180,400
13758	NATIONAL HIGHWAY 6	0	III	290	0	290	100	100	1	D	AC	2.95	36.2	35	10.35	1.48	428.5	Cut and OL 70mm	Medium repair	550	m2	162,250
23111	NATIONAL HIGHWAY 70	0	IV	21	600	21	700	100	1	D	AC	3.16	25	41	6.44	1.59	737.5	OL 30mm	Medium repair	250	m2	79,000
37551	NATIONAL HIGHWAY 6	0	III	41	100	41	200	100	1	U	AC	3.39	43.4	30	12.87	1.59	943	Cut and OL 70mm	Medium repair	550	m2	186,450
39046	NATIONAL HIGHWAY 6	0	III	177	800	177	900	100	1	U	AC	3.18	38	34	4.3	1.62	461	Cut and OL 70mm	Medium repair	550	m2	174,900
9943	NATIONAL HIGHWAY 4E	0	V	31	500	31	510	10	1	D	AC	3.13	33.4	32	29.09	1.63	223.5	OL 30mm	Medium repair	250	m2	7,825
12560	NATIONAL HIGHWAY 6	0	III	178	400	178	500	100	1	D	AC	3.17	43.1	30	7.85	1.65	504	Cut and OL 70mm	Medium repair	550	m2	174,350
12189	NATIONAL HIGHWAY 6	0	III	142	900	143	0	90	1	D	AC	3.46	25.8	38	11.65	1.67	507.5	OL 70mm	Medium repair	500	m2	155,700
33574	NATIONAL HIGHWAY 3	0	II	116	200	116	300	100	2	U	AC	7.44	47.8	28	5.07	1.71	458.5	Cut and OL 70mm	Medium repair	550	m2	204,600
5758	NATIONAL HIGHWAY 2	0	III	267	700	267	800	100	1	D	AC	3.71	36.3	33	4.8	1.72	142	Cut and OL 50mm	Medium repair	400	m2	148,400
12976	NATIONAL HIGHWAY 6	0	III	217	1000	218	0	5	1	D	AC	3.28	45.6	31	1.44	1.73	333.5	Cut and OL 70mm	Medium repair	550	m2	9,020
13757	NATIONAL HIGHWAY 6	0	III	289	900	290	0	90	1	D	AC	3.32	48.2	27	8.57	1.73	429	Cut and OL 70mm	Medium repair	550	m2	164,340
43045	NATIONAL HIGHWAY 10	0	II	135	1800	137	0	75	2	U	AC	6.84	0	49	3.85	1.77	981	OL 50mm	Medium repair	400	m2	102,600
13733	NATIONAL HIGHWAY 6	0	III	287	700	287	800	100	1	D	AC	3.16	46.9	27	7.53	1.78	438	Cut and OL 70mm	Medium repair	550	m2	173,800
13094	NATIONAL HIGHWAY 6	0	III	228	500	228	600	100	1	D	AC	3.33	45.3	27	7.73	1.8	315.5	Cut and OL 70mm	Medium repair	550	m2	183,150
39014	NATIONAL HIGHWAY 6	0	III	174	600	174	700	100	1	U	AC	3.15	49.7	25	7.5	1.83	475	Cut and OL 70mm	Medium repair	550	m2	173,250
11810	NATIONAL HIGHWAY 6	0	III	107	1000	108	0	5	1	D	AC	3	21.7	41	3.55	1.84	482	OL 70mm	Medium repair	500	m2	7,500
13124	NATIONAL HIGHWAY 6	0	III	231	200	231	270	70	1	D	AC	3.21	39.8	29	6.74	1.85	323	Cut and OL 70mm	Medium repair	550	m2	123,585
13101	NATIONAL HIGHWAY 6	0	III	228	1000	229	0	5	1	D	AC	3.46	43.4	30	1.53	1.86	317.5	Cut and OL 70mm	Medium repair	550	m2	9,515
13318	NATIONAL HIGHWAY 6	0	III	249	0	249	100	100	1	D	AC	3.35	47.1	24	13.42	1.89	367.5	Cut and OL 70mm	Medium repair	550	m2	184,250
30249	NATIONAL HIGHWAY 2	0	III	89	700	89	800	100	1	U	AC	3.32	0	48	3.98	1.89	1661	Cut and OL 50mm	Medium repair	400	m2	132,800
35006	NATIONAL HIGHWAY 3	0	IV	250	155	250	200	45	1	U	AC	2.74	29.3	32	16	1.89	279.5	OL 30mm	Medium repair	250	m2	30,825
11883	NATIONAL HIGHWAY 6	0	III	114	300	114	400	100	1	D	AC	3.15	47.4	24	15.56	1.9	487	Cut and OL 70mm	Medium repair	550	m2	173,250
12563	NATIONAL HIGHWAY 6	0	III	178	700	178	800	100	1	D	AC	3.61	49.4	23	14.44	1.9	502.5	Cut and OL 70mm	Medium repair	550	m2	198,550
51491	NATIONAL HIGHWAY 70	0	III	193	800	193	900	100	2	U	AC	7.02	15.7	44	6.5	1.9	275.5	OL 70mm	Medium repair	500	m2	175,500
13761	NATIONAL HIGHWAY 6	0	III	290	300	290	400	100	1	D	AC	3.29	44	26	7.84	1.91	427.5	Cut and OL 70mm	Medium repair	550	m2	180,950
38695	NATIONAL HIGHWAY 6	0	III	144	0	144	100	100	1	U	AC	3.17	47	26	3.97	1.92	515.5	Cut and OL 70mm	Medium repair	550	m2	174,350
12215	NATIONAL HIGHWAY 6	0	III	145	200	145	300	100	1	D	AC	3.38	36.2	28	14.82	1.93	509	Cut and OL 70mm	Medium repair	550	m2	185,900
13425	NATIONAL HIGHWAY 6	0	III	259	0	259	100	100	1	D	AC	3.18	40.3	28	7.41	1.94	393	Cut and OL 70mm	Medium repair	550	m2	174,900
12532	NATIONAL HIGHWAY 6	0	III	175	600	175	700	100	1	D	AC	3.19	45.1	24	16.8	1.95	515	Cut and OL 70mm	Medium repair	550	m2	175,450
50215	NATIONAL HIGHWAY 70	0	V	75	300	75	400	100	1	U	AC	2.93	27.5	34	7.27	1.95	297	OL 30mm	Medium repair	250	m2	73,250
38693	NATIONAL HIGHWAY 6	0	III	143	800	143	900	100	1	U	AC	3.15	39.7	29	2.92	1.96	515	Cut and OL 70mm	Medium repair	550	m2	173,250
5360	NATIONAL HIGHWAY 2	0	III	231	500	231	600	100	1	D	AC	3.7	43.9	26	5.49	1.97	228.5	Cut and OL 50mm	Medium repair	400	m2	148,000
45466	HO CHI MINH ROUTE	0	III	479	0	479	100	100	1	U	AC	3.33	49.8	24	3.92	1.99	387	Cut and OL 70mm	Medium repair	550	m2	183,150
25930	NATIONAL HIGHWAY 279	0	IV	86	1000	87	0	10	1	D	AC	3.4	28.4	36	20.08	2	249	OL 30mm	Medium repair	250	m2	8,500
11912	NATIONAL HIGHWAY 6	0	III	117	0	117	100	100	1	D	AC	3.24	45.5	24	7.54	2.03	489	Cut and OL 70mm	Medium repair	550	m2	178,200
12610	NATIONAL HIGHWAY 6	0	III	183	300	183	400	100	1	D	AC	3.06	46.5	24	5.4	2.04	482.5	Cut and OL 70mm	Medium repair	550	m2	168,300
12522	NATIONAL HIGHWAY 6	0	III	174	600	174	700	100	1	D	AC	3.12	43.1	25	6.2	2.06	519	Cut and OL 70mm	Medium repair	550	m2	171,600
38105	NATIONAL HIGHWAY 6	0	III	90	400	90	500	100	1	U	AC	3.32	48.8	23	5.28	2.06	495	Cut and OL 70mm	Medium repair	550	m2	182,600
22388	NATIONAL HIGHWAY 43	0	V	34	700	34	800	100	1	D	AC	3.46	29.1	31	7.89	2.08	575.5	OL 30mm	Medium repair	250	m2	86,500
26204	NATIONAL HIGHWAY 279	0	IV	104	200	104	300	100	1	D	AC	2.93	27.9	30	16.86	2.09	249	OL 30mm	Medium repair	250	m2	73,250
11661	NATIONAL HIGHWAY 6	0	III	94	400	94	500	100	1	D	AC	3.19	49	23	8.76	2.1	581	Cut and OL 70mm	Medium repair	550	m2	175,450
38506	NATIONAL HIGHWAY 6	0	III	126	500	126	600	100	1	U	AC	3.36	47.3	24	2.68	2.11	502.5	Cut and OL 70mm	Medium repair	550	m2	184,800
12219	NATIONAL HIGHWAY 6	0	III	145	600	145	700	100	1	D	AC	3.22	41.4	25	5.71	2.12	509.5	Cut and OL 70mm	Medium repair	550	m2	177,100
30085	NATIONAL HIGHWAY 2	0	III	74	200	74	300	100	1	U	AC	3.26	0	46	6.05	2.12	1937	Cut and OL 50mm	Medium repair	400	m2	130,400
12472	NATIONAL HIGHWAY 6	0	III	169	700	169	800	100	1	D	AC	3.23	49.3	22	8.89	2.13	526.5	Cut and OL 70mm	Medium repair	550	m2	177,650
13126	NATIONAL HIGHWAY 6	0	III	231	275	231	300	25	1	D	AC	3.16	41.8	24	7.84	2.14	323.5	Cut and OL 70mm	Medium repair	550	m2	43,450
49106	NATIONAL HIGHWAY 43	0	V	55	700	55	800	100	1	U	AC	3.23	32.1	28	9.78	2.15	28.5	OL 30mm	Medium repair	250	m2	80,750
30030	NATIONAL HIGHWAY 2	0	II	68	900	69	0	95	2	U	AC	7.24	30.2	30	5.63	2.16	2031	Cut and OL 70mm	Medium repair	550	m2	189,145
9968	NATIONAL HIGHWAY 4E	0	V	32	600	32	660	60	1	D	AC	3.53	33.2	24	42.33	2.18	223.5	OL 30mm	Medium repair	250	m2	52,950
18982	HO CHI MINH ROUTE	0	III	479	500	479	600	100	1	D	AC	3.29	42.9	24	5.23	2.18	508	Cut and OL 70mm	Medium repair	550	m2	180,950
30610	NATIONAL HIGHWAY 2	0	III	121	500	121	600	100	1	U	AC	3.8	33.1	27	9.81	2.18	1033.5	Cut and OL 70mm	Medium repair	550	m2	209,000
11857	NATIONAL HIGHWAY 6	0	III	111	1000	112	0	5	1	D	AC	3.22	49.8	21	5.21	2.19	485	Cut and OL 70mm	Medium repair	550	m2	8,855
11868	NATIONAL HIGHWAY 6	0	III	112	1000	113	0	10	1	D	AC	3.13	47.9	21	7.89	2.19	486	Cut and OL 70mm	Medium repair	550	m2	17,215

CHAPTER 7 IMPROVEMENT OF ROAD MAINTENANCE TECHNOLOGY

7.1 DEVELOPMENT OF ROAD FACILITY INSPECTION GUIDELINE

7.1.1 Background

Road maintenance and operation are to perpetuate road function by carrying out road inspection, cleaning, vegetation care, repair works, and accident and disaster restoration, thereby ensuring safe and healthy road conditions for the facility users. In addition, large-scale rehabilitation and reconstruction are also needed in order to upgrade road facilities and traffic functions in compliance with the changes in traffic conditions and road environments.

In order to ensure efficient and safe implementation of road maintenance operation, it is important to carefully identify the problems lying behind the current status of roads. Inspection works, therefore, play an important role not only in clarifying problems, but also in sending information and data to the planning systems needed for the planning of road maintenance and operation.

With this concept, the Project decided to develop road facility inspection technical standards in cooperation with WG-3.1. However, standardization of road facility inspection technology is quite new to the existing Specification of Road Routine Maintenance Standard, so that more in-depth discussion was expected before incorporating it into technical standards rather than the development of road routine maintenance manual. It was therefore agreed between both partied to develop a road facility inspection guideline for national highway maintenance.

Following this agreement, discussion was first carried out with the working group members on the framework of the road facility inspection guideline. Based on the framework, the draft guideline was then developed through 2 and a half years of discussion.

This main report explains the framework of this road facility inspection guideline. The Road Facility Inspection Guideline developed in this study is attached in the “Manual and Guideline” edition.

7.1.2 Objectives of Road Inspection

The objectives of road inspection are to survey the current status of road conditions, to identify road and traffic problems and to obtain information and data for planning maintenance and operation plans following the principles of road maintenance and operation.

Major roles and functions of road inspection are shown below;

(1) To inspect current status of road facilities and identify defects and deteriorations;

(2) To diagnose the progress of defects and deteriorations;

(3) To plan road maintenance and repair work plans;

(4) To register inspection data into data bases

7.1.3 Current Inspection Practices in DRVN

(1) Road Inspection

Outline of current road inspection is shown in **Table 7.1.1**.

Table 7.1.1 Outline of Road Inspection

Road Structures	Names of Inspection	Frequencies	Implementation bodies	Inspection Points
A. Roads & Structures	Routine Inspection	Once a day	Road Patrol, RRMCs	
	Periodic Check	Monthly	RRMCs, Repair Team	Pavement Surface, Drainage system, Road Signals, Dikes, etc.
		Quarterly	RRMU/PDOTS, RRMCs	
	Special Check		RRMUs/PDOTs	Pavement & Sub-grade Strength, Evenness
B. Bridges	Routine Check		Repair team, Technicians	Bridge deck, Beams, Bearings, Abutments, Piers
	Periodic Check	Twice a year: Before and after rainy season	RRMUs/PDOTs	Erosion, scour of piers etc.
	Unscheduled Check	Unscheduled As required	VRA, RRMUs/PDOTs, RRMCs	Bridge defects and damages
	Special Check		RRMUs/PDOTs	Subgrade in soft soil or sliding curb, Strength of Pavement, Bridge
	Bridge Inspection	Initial inspection; to record initial status of structures before traffic operation.	RRMUs/PDOTs	Whole bridge
		Follow up inspections; 10 years later, then 5-7 year intervals	RRMUs/PDOTs	Whole bridge

Source: "Technical Standards on Road Routine Maintenance", May 28, 2003, MOT.

Table 7.1.2 Traffic Counting

Traffic Categories	Counting stations	Frequencies	Counting time
Primary station (High traffic sections)	30 – 50 km intervals, Ferry, Floating Bridge, Toll places	Once per month 5^{th}, 6^{th}, 7^{th} of each month	1^{st} day: 5:00-21:00 2^{nd} day; 5:00-21:00 3^{rd} day; 24 hours
Secondary station (Low traffic sections)	50 – 100 km intervals		

Source: "Technical Norm on Road Routine Maintenance", May 28, 2003, MOT

7.1.4 Problem Identification

The following are the problems identified.

a) Road and bridge inspections have been carried out in accordance with the Technical Standards 2003. It prescribes the inspection procedures including inspection classification, inspection organizations and frequencies of inspections, but little about the details of inspection points and measurements, i.e. how to inspect and where to inspect. A guideline showing information on the inspection points and measurements using simple figures and tables will be needed.

b) Routine and periodic inspections have been carried out by the staffs belonging to maintenance companies and RRMUs/PDOTs. Of these inspections, the periodic inspection often requires high engineering knowledge and expertise in performing the inspection and in making diagnosis of the structural deterioration. It is very important to incorporate professionalism and objective views into the periodic and the special inspections.

c) Upon completion of road inspections, diagnosis of road structure deterioration is carried out to make a judgment on the extent of damages, followed by the selection of repair works. However, the diagnosis has been commonly done based on the engineer's experience and judgment due to the lack of appropriate guideline. There is no guideline available for diagnosis except for the one on pavement structures.

d) Some regional agencies are said to have set out their own criteria for diagnosis, although further details were not confirmed. In general, criteria preferably to be incorporated in the diagnosis guideline should include; (1) conformity with design standards, (2) extent of deterioration, and (3) impact on socio-economy or nearby areas.

e) Selection and prioritization of repair places and work types has been done mainly based on the engineer's experience and judgment because of lack of appropriate guidelines. Also, under the current budget constraints, the selected works are basically the reactive maintenance works.

7.1.5 Overseas Practices – Road Maintenance Practices in Japan

(1) Current Status of Road Network in Japan

Total length of the road network in Japan was 1,210,251 kilometers in April 2010.

Of which, national roads, consisting of 22,787 kilometers sections are directly managed by MLIT and 31,949 kilometer sections are committed to prefecture governments, as shown in **Table 7.1.3** Expressway networks consisting of 7,802 kilometers nationwide are operated by expressway companies which were privatized in 2005. There are three expressway companies founded by the Government which are charged with inter-city expressway management. In addition, the Government founded three other expressway companies charged with metropolitan expressway management centering around Tokyo and Osaka, and Honshu-Shikoku expressways. However,

Legal status of the later three expressways are the national or prefectural roads, but are operated as toll roads shows high standard road networks in Japan.

Table 7.1.3 Road Network in Japan

Class	Length (km)	Maintenance and Operation
Expressways	7,802	Expressway companies
National Roads	54,981	
1. Designated sections	22,787 (42%)	MLIT
2. Non-designated sections	31,949 (58%)	Prefecture Governments
Prefecture Roads	129,366	Prefecture Governments
Municipal Roads	1,018,100	Cities, Towns and villages
Total	1,210.251	

(Note) Road length; as of April 1st, 2010, MLIT data
Breakdown of National roads: from Road Statistics 2008.

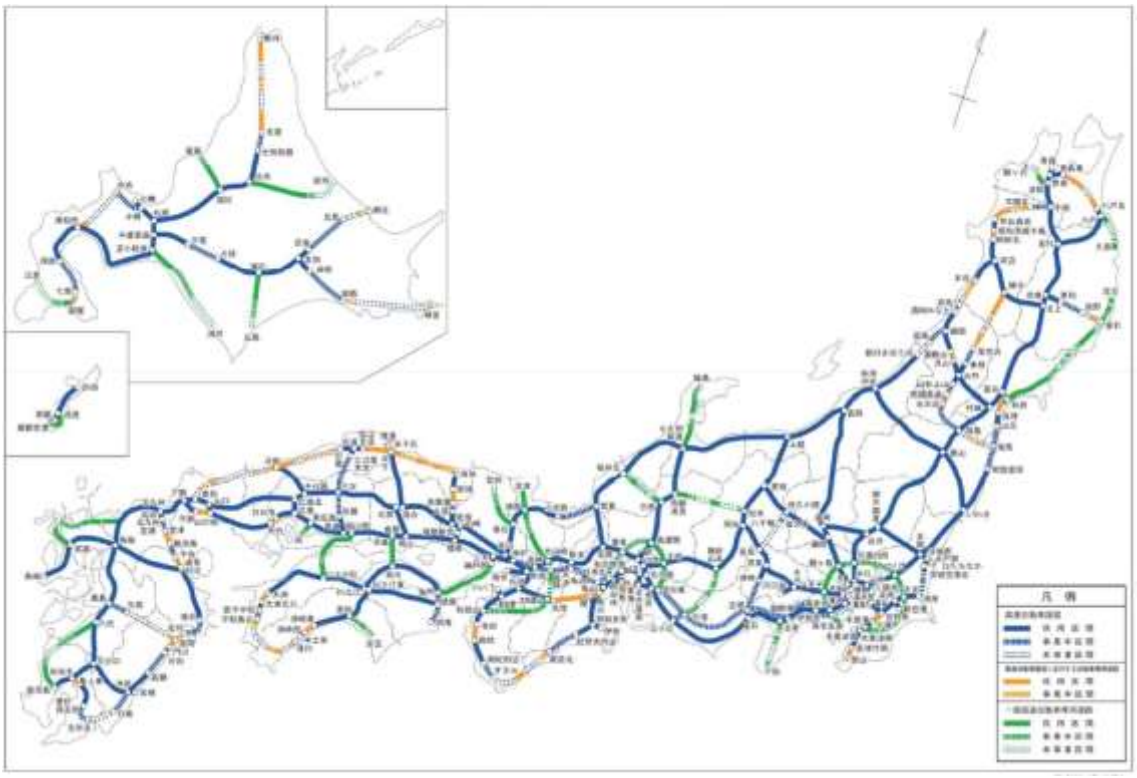


Figure 7.1.1 High Standard Road Network in Japan

(2) Road Infrastructures in Japan

1) Bridges

Table 7.1.4 shows the number of road bridges on the road network in Japan. There are 676,742 bridges on the road network, consisting of 148,223 bridges over 15 metres long and 17,643 bridges over 100 metres. Of these, 19,995 bridges have been directly managed by MLIT.

Table 7.1.4 Bridge Infrastructure

Class	All Bridges		Bridges over 15 m		Bridges over 100 m	
	Number	%	Number	%	Number	%
Expressways	7,427	1	6,402	4	2,928	17
National Roads (Designated)	19,995	3	10,794	7	3,191	18
National Roads (Non-designated)	29,946	4	12,778	9	2,220	13
Prefecture Roads	100,273	15	32,516	22	4,941	28
Municipal Roads	519,101	77	85,733	58	4,363	25
Total	676,742	100	148,223	100	17,643	100

(Source) MLIT 2005 data.

2) Tunnels

Table 7.1.5 shows the number of road tunnel infrastructure on the road network. There are 8,784 tunnels on the road network, consisting of 1,777 tunnels over 500 metres long and 706 tunnels over 1,000 metres. Of these, 1,129 tunnels have been directly managed by MLIT.

Table 7.1.5 Road Tunnel Infrastructure

Class	All Tunnels		Tunnels over 500 m		Tunnels over 1,000 m	
	Number	%	Number	%	Number	%
Expressways	739	8	428	24	235	33
National Roads (Designated)	1,129	13	357	20	146	21
National Roads (Non-designated)	2,213	25	526	30	192	27
Prefecture Roads	2,346	27	360	20	111	16
Municipal Roads	2,357	27	106	6	22	3
Total	8,784	100	1.777	100	706	100

(Source) MLIT 2005 data.

(3) National Road Maintenance and Operation by MLIT

Forty two percent of the national highways, 22,787 kilometres are directly managed by MLIT as designated sections**. Figure 7.1.2** shows the organization structure of MLIT. Under the headquarters in Tokyo, there are eight regional bureaus stationed in major cities in the regions. Regional bureaus play the role of project owner and undertake road maintenance and repair work contracts with private companies including approval of design change, inspection and payment to contractors.

Under the regional bureaus, there are construction offices and maintenance offices. However, maintenance and repair field works have been outsourced to private companies, so that the main

responsibility of these maintenance offices is to supervise maintenance and repair works carried out by private companies.

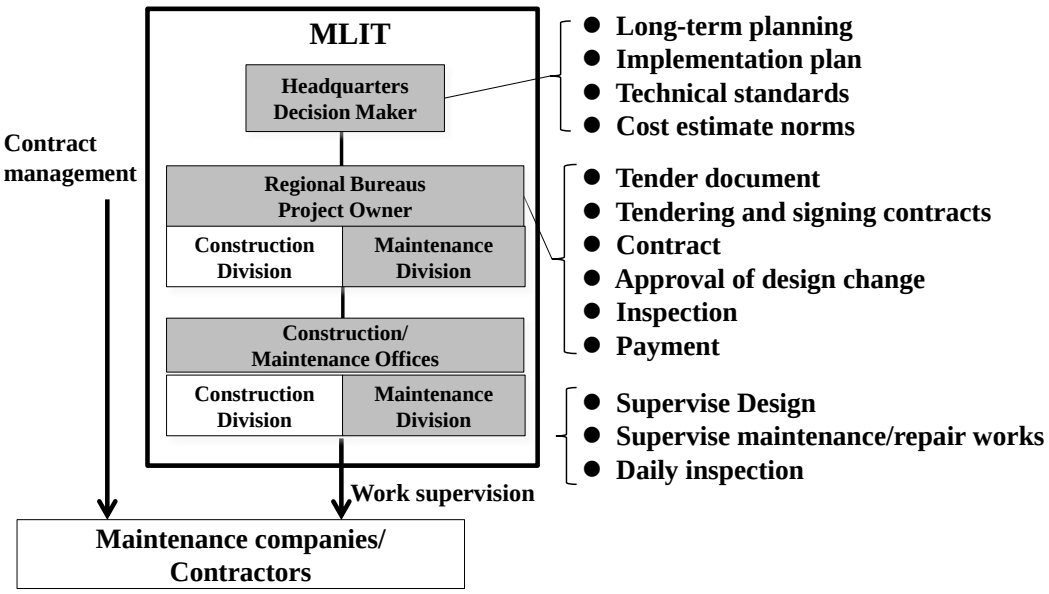


Figure 7.1.2 MLIT Organization Structure

(4) Maintenance and Repair Budgets for the National Road Network under MLIT Management

Figure 7.1.3 illustrates maintenance and repair budgets for the national roads under MLIT management. There used to be an over 2,000 billion Yen budget for maintenance and repair works for the national roads, but the budget allocation has recently declined to 70 percent of that level, 1,400 billion Yen, being influenced by the recent staggering economy.

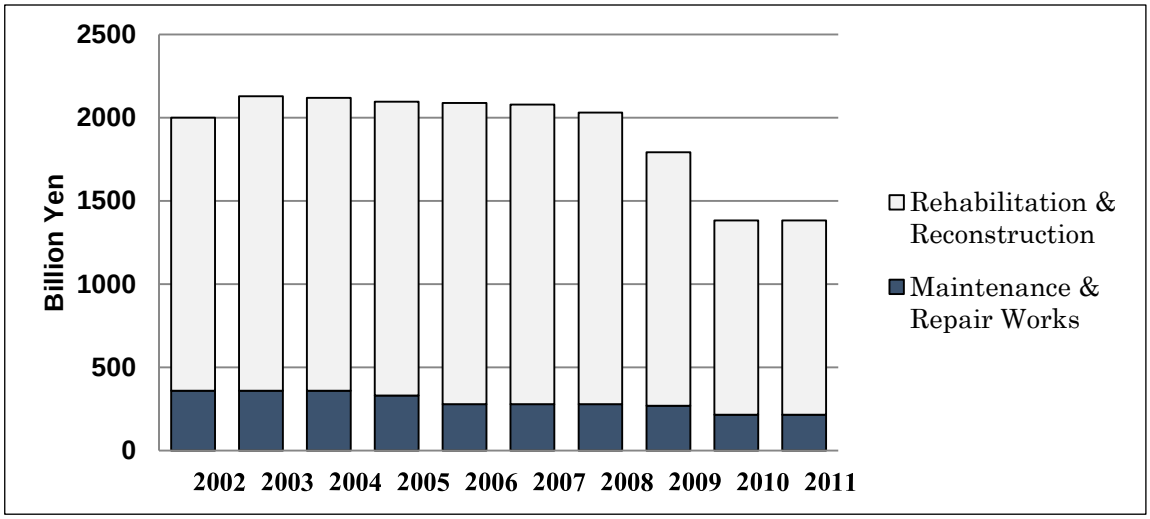


Figure 7.1.3 Road Maintenance and Repair Budget for MLIT National Roads

In addition, **Figure 7.1.4** shows the shares of budget expenditures. Of the 2011 year budgets, 55 percent were spent on repair works and 45 percent were on maintenance budget. Of the maintenance expenditures, 28 percent of the budgets were spent on urgent repairs for natural disasters and vehicle accidents, followed by facility maintenance, 22 percent. On the other hand, breakdown of repair works indicates that 70 percent of repair work budget were spent on medium and large repair works.

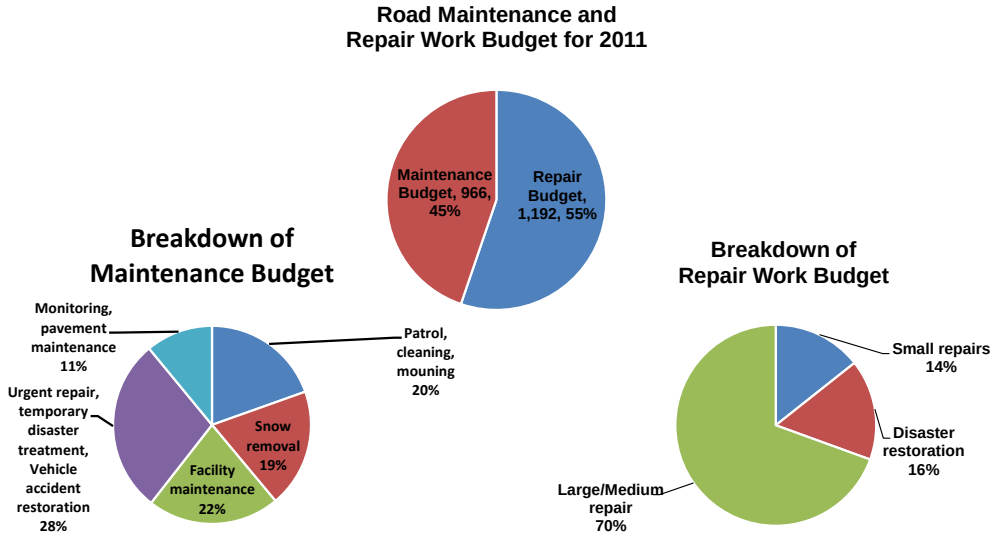


Figure 7.1.4 Maintenance and Repair Budgets for MLIT National Roads

(5) Inspection Manual for National Road Maintenance

MLIT standardized road inspection manuals by structure types as shown below:

+ Bridge Periodic Inspection Manual
+ Road Tunnel Periodic Inspection Manual
+ Road Electric Facility Inspection Manual
+ Road Management Facility Inspection Manual

MLIT plays a leading role in standardizing maintenance and inspection manuals and distributing them to the relevant road administrators in the regions. Standardization has been applied to not only maintenance and inspection manuals, but also construction work specifications which are parts of contract dossiers. Maintenance and inspection manuals are, in general, compulsory for MLIT including relevant ministerial level organizations, but not for road administrators in the regions. They are allowed to develop their own manuals, but in reality they tend to follow MLIT standards.

Currently, MLIT focuses more on the enhancement of bridge maintenance and repair technology as the aging of bridges progresses. The concept of asset management is applied to the national road assets, trying to find the best timing for investments for maintenance and repair works and to minimize life-cycle costs of road facilities, in particular bridges and road pavements. R & D on new technologies which aim to prolong facility life-cycles have been intensively carried out by its research institute in cooperation with private sectors.

The major components in the bridge inspection manual are as follows;

a) Bridge members to be inspected

b) Typical defects and deterioration to be focused on in the inspection

c) Standard inspection measures

d) Selection of inspectors

e) Criteria for the diagnosis of the results of inspection

f) Criteria on whether to implement repair works.

g) Criteria on the need for additional surveys

h) Registration of inspection data into databases.

(6) Typical Defects and Deterioration by Materials

MLIT inspection manuals in general show typical defects and deterioration by the types of materials to be particularly focused on during the inspections as shown in **Table 7.1.6**.

Table 7.1.6 Typical Defects and Deterioration by Materials (Bridge Inspection)

Material	No.	Defects & Deterioration	Material	No.	Defects & Deterioration
Steel	A1	Corrosion		C2	Pavement roughness
	A2	Cracks		C3	Pavement abnormality
	A3	Looseness, Falling		C4	Unusual pavement
	A4	Rupture		C5	Shoe functional defects
	A5	Deterioration of anti-corrosion	Common	D1	Abnormality at Anchorage zone
Concrete	B1	Cracks		D2	Change in colour, deterioration
	B2	Steel bar exposure		D3	Water leakage
	B3	Water leakage		D4	Unusual sound/vibration
	B4	Break off		D5	Unusual deflection
	B5	Damages to reinforcement		D6	Deformation, loss of members
	B6	Floor Deck Cracks		D7	Clogging
	B7	Creep, Voids		D8	Settlement, movement
Others	C1	Unusual expansion gaps		D9	Scouring

(7) Typical Defects and Deterioration by Facility Members

They also show facility members to be focused on and their typical defects and deterioration as shown in **Table 7.1.7**.

Table 7.1.7 Typical Defects and Deterioration by Facility Members (Bridge Inspection)

Facilities	Members	Points to be inspected		
		Steel	Concrete	Others
Pavement	Road surface			Roughness, Cracking, Rutting, Structural capacity
Bridges	Superstructure	A1-A5, C1, D1, D4-D6	B1-B7, C1, D1-D6	
	Substructure	A1-A5, D4-D6	B1-B3, B5, B7, D1-D6	
	Bearing	A1-A5, C4, D3, D4-D8		
	Road surface	A1-A5, D6, C1, C2, D6,D7	B1-B3, B7, D2, D6	
	Drainage system	A1, A4, A5, D2, D3, D6, D7		
Road facilities	Lighting, Traffic signs	A1-A5, D2, D6		

(8) Inspection Manual for Expressway Facilities

Inspection manuals have been developed by expressway companies. Fundamental ideas of inspection are basically the same as those for national roads. However, the expressway facility inspection manual covers the points of inspection for the following eight facilities as shown in **Table 7.1.8**.

Table 7.1.8 Expressway Facility Inspection Manual

No.	Facilities	Focus Points
1	Road pavements	Pavement, slopes, road surface drain facilities
2	Slopes	Slopes, masonry works, retaining walls, ground anchors, debris and avalanche prevention measures, slope drain facilities
3	Bridges	Steel bridges, concrete bridges, substructures, concrete floor slabs, bearings, expansion joints, railing, inspection gallery, drain facilities, bridge falling prevention systems
4	Tunnels	Lining works, portals, interior plates, ceiling plates, drain facilities, pavement
5	Culverts	Concrete culverts, corrugated pipe culverts
6	Traffic safety facilities	Guard fences, headlight blinding prevention plates, passenger fall protection nets provided around median strips, passenger fall protection fences
7	Traffic management/ control systems	Traffic signs, CMS, pavement surface markings, road edge marker posts, distance markers
8	Other facilities	Noise barriers, snow protection, drain facilities adjacent to service roads and other roads

7.1.6 Recommended Framework for National Road Inspection in Vietnam

The following form the framework of the national road inspection manual recommended by the JICA Project Team. Each of the following subjects is elaborated hereafter in this working paper. The framework will be reviewed and modified in accordance with the discussion with the WG-3 counterparts, before further developing the DRVN road inspection manual.

a) Definition of road inspection

b) Road inspection methods

c) Frequencies of road inspection

d) Diagnosis of inspection results

e) Selection of maintenance and repair works

f) Maintenance and repair work data registration

g) Inspection party and eligibility of inspectors

h) Targeted facilities to be standardized in the inspection manual

7.1.7 Definition of Road Inspection

Basically, the current DRVN technical standards are already equipped with the fundamentals of road inspection, so that improvement based on current inspection system fundamentals is recommended. The following are the categories of road inspections recommended by the Project Team;

(1) Initial Inspection

- Initial inspection is intended to thoroughly survey the initial status of road facilities upon completion of construction.
- Initial inspection needs to be done within two years after the opening of road facilities to the public, since it is known that initial defects come to surface within two years after the opening.
- The inspection should be carried out with short distance visual inspection.

(2) Routine Inspection

- Routine inspection is a daily inspection to quickly find any unusual incidents and defects on the roadway.
- It generally consists of on-board visual inspections and hammering tests.

(3) Periodic Inspection

- Periodic inspection is to survey damages to road facilities, including deterioration and defects, to evaluate them in comparison with predetermined judgment criteria, to select the most suitable repair methods for the damages and to preserve data in relevant databases. For these reasons, it is carried out at a fixed interval.
- The survey and diagnosis are in principle done for the main parts of structures.
- The periodic inspection provides base information for the planning of road maintenance and repair works.

(4) Unscheduled Inspection (Special Inspection)

- Unscheduled inspection is generally carried out in order to supplement the above inspections and to cope with emergencies, such as unusual weather, traffic accidents and natural disasters.

(5) Survey and Design (or Detailed Inspection)

- Survey and design is to further specify causes of structural defects or to evaluate the performance of expected repair works, when making a judgment on whether repair works are indeed effective, so that survey and design is, in general, carried out anytime required by the above-mentioned periodic inspection.
- Another objective of survey and design is to provide information for rehabilitation and reconstruction works. In particular, F/S, basic designs and technical designs need to be prepared for reconstruction works which include upgrading of facility functions. Also, technical designs are to be prepared for rehabilitation works intended to replace facilities without functional upgrade.

7.1.8 Inspection Methods

Outline of inspection methods are as follows.

Table 7.1.9 shows the types of inspection and the types of inspection method.

(1) On-board Visual inspection

On-board visual inspection is carried out by the maintenance staff in the patrol vehicles, so that it has a wide coverage in a short time period, but viewpoints are fairly limited. When detecting unusual incidents, maintenance staffs are requested to get out of their cars and to clarify the incidents.

(2) Distance View Inspection

This is a method of visual inspection from a distance and by getting out of the vehicle.

(3) Short-distance Visual Inspection

Using a pathway or scaffolding to check the status of the structure by visual observation or with binoculars close to the structure is a method of detection. In addition, it may employ a simple machine, equipment, etc. as required.

(4) Hammering

This is also a short distance inspection by listening to the sound of hitting the target structure with a hammer to determine the deterioration level of the structure (peel, creeping, loosening of bolts, etc.)

(5) Measurement with Non-destructive Equipment

Table 7.1.9 Inspection Methods by Type

Inspections & Surveys	Inspection methods
1. Initial Inspection	● Short-distance visual inspection ● Hammering inspection ● Pavement condition survey vehicle (for road pavement inspection)
2. Routine Inspection	● Vehicle on-board visual inspection, in principle. ● If anything unusual is detected, inspectors are requested to get out of the car and implement short-distance visual inspections to find the causes of incidents and the extent of damages.
3. Periodic Inspection	● Pavement condition survey vehicle (for road pavement inspection) ● Short-distance visual inspection ● Hammering inspection, Crack gage, measuring tape ● Non-destructive test equipment ● Photos
4. Unscheduled Inspection	● Short-distance visual inspection
5. Survey and design or Detailed Inspection	● Same as above

(Source) Project for capacity enhancement in Road Maintenance in Vietnam

7.1.9 Inspection Frequencies

(1) Recommended Inspection Frequencies

The JICA study team recommended the inspection types and frequency as shown in **Table 7.1.10**.

Table 7.1.10 Inspection Frequencies

Inspections & Surveys	Frequencies
1. Initial Inspection	● Within 2 years or within the warranty periods specified in the construction contract dossiers after the opening of facilities to the public
2. Routine Inspection	Inspection frequencies are based on traffic volumes; ● More than 10,000 vehicles per day; every day ● Less than 10,000 vehicles per day; every other day
3. Periodic Inspection	Inspection frequencies are, in principle, as follows; ● Pavement condition survey; Once every 3 years ● Bridges/Tunnels; Once every 5 years ● Road safety facilities and road management facilities: Once every 10 years (Note) 1. However, if the facilities are once rated as "C" in the diagnosis of the periodic inspection, the next inspection should be carried out no later than two years after the previous inspection. 2. Also, if the facilities are once rated as "D" or "E" in the diagnosis of the periodic inspection, the inspection should be carried out no later than one year after the previous inspection. 3. However, upon completion of repair works, original frequencies stated above are applied for the above two cases.
4. Unscheduled Inspection	● Immediately after disasters
5. Survey and design or Detailed Inspection	● As requested by periodic inspection, rehabilitation and reconstruction

7.1.10 Diagnosis of Inspection Results

(1) Diagnosis Criteria

Table 7.1.11 Diagnosis Criteria

Rating	Diagnosis Criteria	Degree of Damages	Impact on functions	Impact on environment	Need of repair works (Urgency)	Measures
A	・ No damage or minor damages are identified.	Small	Small	-----	Low	・ No repair works
B	・ Medium damages are identified. ・ Serious progress of damages is not anticipated within coming 5 years. ・ Repair works are needed, but not urgent.	Medium	Medium	-----	Medium	・ Further survey ・ Planned maintenance/repair works (*1)
C	・ Medium to large damages are identified ・ Progress of damages is anticipated within coming 5 years. ・ Repair works are needed within 5 years.	Medium-large	Medium-large	-----	Medium	・ Further survey ・ Planned maintenance/repair works
D	・ Large damages are identified. ・ Structure functional deterioration is large. ・ Urgent repair works are needed.	Large	Large	-----	High	・ Urgent repair works
E	・ Large impacts on environment or road users are anticipated.	-----	-----	Large	High	・ Urgent repair works

*(Note) (*1): Planned maintenance and repair works means strategic and preventive works based on life-cycle cost analysis.*

7.1.11 Selection of Maintenance and Repair Works

The Project conducted a current status survey on pavement repair works employed in the past for the national road maintenance in Vietnam. Based on this survey, the Project developed the framework of the selection of pavement repair works and then the repair work selection algorithm for road pavement based on the framework as shown in **Table 7.1.12**.

(1) Algorithm of pavement repair work selection

a) Standard repair works shown in the table are simply explaining standard repair works in designing annual repair plans. However, due to data limitation to develop algorithm, it is recommended to conduct a field study, to re-examine the standard repair works shown in the table and to conduct a detail design before implementing repair works if needed.

b) Pavement repair works will be applied to the sections with MCI <= 5.0.

c) When CR < 5%, no repair work will be applied in principle. However, as rutting depth progresses and heavy vehicle traffic increases, surface treatment and overlay works need to be implemented.

d) When 5 % <= CR < 35 %, overlay works will be applied, however, cut & overlays will be applied to the heavy traffic volume sections.

e) When CR progresses up to 35 % <= CR < 50 %, cut and overlays will be applied in order eliminate the damaged depth of pavements,.

f) When 50 % <= CR, big repair works including Surface and Binder replacement, whole pavement layer replacement and Subgrade replacement will be applied. Big repair should be based on engineering calculation based on technical standards.

g) Interval time since last repair to the new repair works, which is stipulated in Circular 10, will be examined manually on the basis of the outputs of this module.

h) In the sections in the urban area with heavy traffic and heavily deteriorated pavement, cut and overlay will be applied in principle. Simple overlay will be applied to other sections.

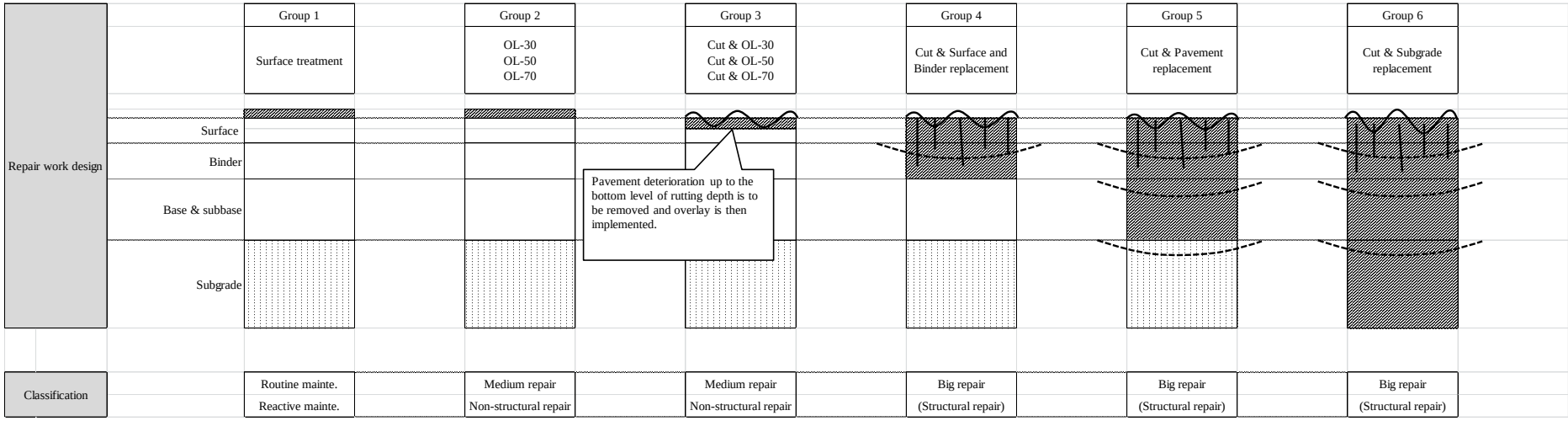
i) Prioritization in implementing repair works will be set based on MCI values.

(2) Definition of terminology shown in the table

・ No repair	Repair works are not needed, but pavement monitoring needs to be continued
・ Surface treatment	Routine maintenance, reactive maintenance siming to recover road pavement serviceability
・ OL	New pavement layer will be placed on the existing pavement.
・ Cut and overlay	New pavement layer will be places after cutting pavement deterioration to the specified depth.
・ Surface and binder replacement	Pavement surface including binder are to be replaced. Design of this repair work should be made on structural design on the basis of technical standards.
・ Whole layer replacement	Pavement whole layers are to be replaced. Design of this repair work should be made on structural design on the basis of technical standards.
・ Subgrade replacement	Pavement and subgrade are to be replaced. Design of this repair work should be made on structural design on the basis of technical standards.

Table 7.1.12 Standard Repair Works for Asphalt Pavement Concrete (AC) to be applied to Road Class-I, II and III

Rutting Depth			Light defects				Medium defects				Heavy defects			
			Rutting Depth < 25 mm				25 mm <= Rutting Depth < 40 mm				40 mm <= Rutting Depth			
Traffic Volume (Heavy Vehicle: AADT)			TV < 100	100 <= TV < 250	250 <= TV < 1,000	1,000 <= TV	TV < 100	100 <= TV < 250	250 <= TV < 1,000	1,000 <= TV	TV < 100	100 <= TV < 250	250 <= TV < 1,000	1,000 <= TV
Crack rate (CR)	Light defects	CR < 5 %	No repair				No repair			Cut and OL 50 mm	OL 30 mm	OL 30 mm	OL 50 mm	Cut and OL 50 mm
		5 % <= CR < 15 %	No repair		Surface treatment		OL 30 mm	OL 30 mm	OL 50 mm	Cut and OL 70 mm	OL 50 mm	OL 50 mm	OL 50 mm	Cut and OL 70 mm
	Medium defects	15 % <= CR < 35 %	OL 30 mm	OL 50 mm	OL 50 mm	Cut & OL 70 mm	OL 50 mm	OL 50 mm	OL 70 mm	Cut & OL 70 mm	OL 50 mm	OL 50 mm	OL 70 mm	Cut and OL 70 mm
	Heavy defects	35 % <= CR < 50 %	Cut & OL 50 mm	Cut & OL 50 mm	Cut & OL 70 mm		Cut and OL 50 mm	Cut and OL 50 mm	Cut & OL 70 mm		Cut and OL 50 mm	Cut and OL 50 mm	Cut and OL 70 mm	
		50 % <= CR	(1) Surface & Binder replacement (2) Pavement whole layer replacement (3) Subgrade replacement				(1) Surface & Binder replacement (2) Pavement whole layer replacement (3) Subgrade replacement				(1) Surface & Binder replacement (2) Pavement whole layer replacement (3) Subgrade replacement			
(Source)		Developed from Road Facility Design Manual, Gifu Prefecture, Japan												



7.1.12 Inspection Staff Arrangement and Their Eligibility

(1) Pavement Inspection

The following staff arrangement needs to be applied for the periodic road pavement condition survey to be carried out by a pavement condition survey vehicle.

1) Inspection staff arrangement

A basic staff arrangement per one party for the pavement condition survey by vehicle is shown in **Table 7.1.13**. The table shows a basic arrangement, so that the staff arrangement should be reviewed and adjusted to a reasonable level which can meet the scale of survey, the number of bridges and difficulty in survey implementation.

Table 7.1.13 Survey Staff Arrangement for Road Pavement Inspection

Survey stage	Inspectors per one party	The number of staff per Party
(1) Preliminary survey	● Chief inspector	1
	● Assistant inspector	3
	● Car driver and traffic controller	2
(2) Road condition survey	● Chief inspector	1
	● Assistant inspector	3
	● Car driver and traffic controller	2
(3) Data analysis and registration	● Chief engineer	1
	● Assistant engineer	16

2) Responsibility assignment

Responsibility assignment for chief inspectors and assistant inspectors is as follows;

a. Chief inspector

A chief inspector is responsible for supervising overall pavement condition surveys including preliminary survey, road condition survey, data analysis and data registration.

b. Assistant inspector

Assistance inspectors assist a chief inspector including preliminary survey, road condition survey, data analysis and data registration.

3) Eligibility

a. Chief inspector

A chief inspector should be qualified for supervising pavement condition surveys and have at least 20 years of experience in pavement design, pavement construction or pavement maintenance. He should hold a training certificate on pavement condition surveying provided by DRVN and have experience in pavement condition surveys.

b. Assistant inspector

An assistance inspector should be qualified for conducting pavement condition surveys and have at least 10 years of experience in pavement design, pavement construction or pavement maintenance. He should hold a training certificate on pavement condition surveying provided by DRVN.

(2) Bridge Inspection

The following plan needs to be applied for the periodic bridge inspection.

1) Inspection staff arrangement

A basic staff arrangement of a survey team for bridge inspection is shown in **Table 7.1.14**. The table shows a basic arrangement, so that staff assignment should be reviewed and adjusted to a reasonable level which can meet the scale of survey, the number of bridges and difficulty in survey implementation.

Table 7.1.14 Staff Assignment for Bridge Inspection

Inspectors per one party	The number of staff
(1) Chief inspector	1
(2) Assistant inspector	3
(3) Vehicle operator Traffic control staff	As required

2) Responsibility assignment

Responsibility assignment for chief inspectors and assistant inspectors is as follows;

a. Chief inspector

A chief inspector is responsible for supervising overall inspection works including inspection of bridge main bodies and accessories and the diagnosis of the results of the inspections.

b. Assistant inspector

Assistance inspectors assist a chief inspector including data registration into related databases, upon receiving instructions.

3) Eligibility

a. Chief inspector

A chief inspector should be qualified for supervising bridge inspections and have at least 20 years of experience in bridge design, bridge construction or bridge maintenance. He should hold a training certificate on pavement condition surveying provided by DRVN.

b. Assistant inspector

An assistant inspector should be qualified for conducting bridge inspections and have at least 10 years of experience in bridge design, bridge construction or bridge maintenance.

7.1.13 Targeted Facilities to be Standardized

Targeted facilities for inspection to be prescribed in the DRVN Inspection Guideline include the following facilities;

- Pavement
- Bridges
- Cut slopes and embankments
- Tunnels
- Box culverts and pipe culverts
- Traffic safety facilities
- Traffic management facilities
- Other facilities

Details of inspection for each of the above facilities including, focus points of inspection, defects and deteriorations to be focused on and diagnosis criteria and repair works are prescribed in subsequent chapters.

7.2 DEVELOPMENT OF ROAD ROUTINE MAINTENANCE MANUAL

7.2.1 Background

The Project initially started improving the current road routine maintenance technical standard coded 22 TCN 306-03 as an WG-3 activity. However, during the implementation of this project, urgent need of revising the standard arose from field engineers, so that DRVN decided to take an immediate action of revising the road routine maintenance technical standard coded 22 TCN 306-03 by domestic efforts. However, coming revision was expected to be limited to minor revision, so that DRVN and JICA Project Team agreed to develop a manual which can supplement information to the revised road routine maintenance standards, Specification of Road Routine Maintenance, TCCS 07:2013/TCDBVN. It was also agreed to develop a road facility inspection technical standard as a guideline, since road facility inspection also plays an important in detecting defects and deterioration of road facilities, giving key information to maintenance repair activities coming after inspection. However, standardization of road facility inspection technology is fairly new to the existing Specification of Road Routine Maintenance Standard, so that it may need more in-depth discussion rather than the road routine maintenance manual before incorporating it into technical standards.

Following this agreement, discussion has been carried out with WG-3 members on the frameworks of the road routine maintenance standard and the road facility inspection guideline. Based on these frameworks, the draft manual and the guideline were then developed through 2 and a half years of discussion.

7.2.2 Objectives

Objectives of this study are as follows;

(1) To develop a road routine maintenance manual

Definition of road routine maintenance by DRVN includes "routine maintenance work" and "small scale repair work". Small scale repair work includes crack repair work and pothole repair work and so forth. For middle to large scale work of extension and renovation, Construction Standards developed by MOT is applied. Therefore this project is implemented focusing on technical improvement on routine maintenance work and small scale repair work.

(2) To develop a pavement maintenance goal and criteria for acceptance (confirmation of construction completion)

Although existing standard has criteria for acceptance, they are still unclear and do not have any concrete values for acceptance regarding construction completion of pavement repair works.

(3) To conduct technology transfer on the developed routine maintenance manual including foreign practices to DRVN staff through OJT trainings

Technology transfer is to be made on the maintenance manual developed in this Project to the targeted organizations in a pilot area.

7.2.3 Current Status of Technical Standards on Road Maintenance in Vietnam

(1) Technical Standard on Road Routine Maintenance 22 TCN 306-03

On the other hand, Technical Standards 2003 stipulates technical regulations on road inspection and routine maintenance works.

Furthermore, for technical guidance, the Manual of Rural Road Maintenance for Provincial and District Transport Officers has been issued in 2009 to support road engineers at province and district level in road maintenance.

The Technical Standards 2003 is also applied to the routine maintenance of the national roads. **Table 7.2.1** shows the table of contents of Technical Standards 2003.

Table 7.2.1 Contents of Technical Standard 2003

Chapter	Section	Contents
1. General Regulations	1.1	Scope of application
	1.2	Legal documents
	1.3	Glossary of terms and abbreviations
2. Management Tasks	2.1	Document and record control
	2.2	Management of road reservation
	2.3	Inspection, monitoring of structures technical conditions
	2.4	Classification, assessment of technical conditions of bridge structure
	2.5	Traffic counting
	2.6	Duty to assure traffic operation
	2.7	Bridge duty
	2.8	Road, bridge, registration
	2.9	Monitoring, analysis of traffic accidents
3. Routine Maintenance	3.1	Subgrade
	3.2	Shoulder
	3.3	Drainage system
	3.4	Pavement
	3.5	Dike, earth retaining wall
	3.6	Drift and causeway
	3.7	Tunnel
	3.8	Road to ferry
	3.9	Emergency ramp
	3.10	Drainage culvert
	3.11	Bridge
	3.12	Construction for management
	3.13	Roadway signal system
	3.14	Routine maintenance of trees
4. Approval and Result Assessment	4.1	Approval of maintenance works
	4.2	Performance evaluation of road routine maintenance
5. Traffic Safety in Road Routine Maintenance		
6. Labor Safety		
7. Environmental protection		

As major components, Chapter 1 prescribes Scope of application and legal documents to be applied for the routine maintenance and Chapter 2 treats various management tasks including responsibility assignment to RRMUs/RRMCs/RTCs and inspection, monitoring of structure conditions, traffic count, registration procedures and so forth. Chapter3 is the main chapter that stipulates all routine maintenance works including subgrade, shoulder, drainage, pavement, tunnel, bridge and various road facilities. Chapter 4 prescribes approval of routine maintenance works stating about implementation bodies, benchmarks of approval, work types and so forth. The approval and acceptance is carried out based on the signed contracts between RRMUs and RRMCs, evaluating work performance in conformity with the contract documents. Chapter 5 and 6 describe about traffic and labor safety respectively and Chapter 7 prescribes environmental protection which is the subject to be focused on in recent years.

Road inspection, evaluation of defects and deterioration, and repair work selection form essential and important parts of the road maintenance project. Although Chapter 2 regulates inspection and evaluation tasks, it devotes only a few pages for those matters. In addition to that, in spite of the

importance of maintenance works, the description of each maintenance work in Chapter 3 is rather brief and rough not to be clearly understood. In the revision task of the existing standard, those Chapters are required to be significantly overhauled.

With regard to Chapter 4, 5, 6 and 7, they seem to be also not enough in explanation about contents of the concerned theme respectively. Therefore, it is necessary to supplement shortfall of description and to revise them in more detail in new standard to be remade.

(2) Specification on Road Routine Maintenance TCCS 07: 2013/TCDBVN

Specification on Road Routine Maintenance, TCCS07: 2013/TCDBVN, is disseminated as the second version of "Specifications of Road Routine Maintenance, 22TCN306-2003" with supplementations and updates. The purpose of Specification on Road Routine Maintenance is to serve current need of road routine maintenance and management work for national roads. The Specification will be enhanced continuously during the use process hereafter, taking account of constructive opinions to be issued specialists, scientists, consulting firms, road construction and management units.

This standard regulates technical requirements and provides some guidelines on management and implementation of routine maintenance of roads managed by Central and Local agencies, including works on the roads. This standard does not apply to periodical and unexpected maintenance work of roads in general. This standard does not apply to highways and local roads from communal level and below. For bridges on roads, this standard applies to small bridges. There is particular regulation on routine maintenance work for medium and big bridges.

The Specification regulates the following activities as main routine road maintenance activities; pavement crack sealing, pothole patching, repair slope protection, repair road geometry, vegetation control, drainage damage repair, masonry damage repair, mesh gabion repair, traffic management and safety and facility repair, painting and so forth,

(3) Rural Road Maintenance Handbook

Ministry of Transport disseminated technical guidance and assistance for local authorities in charge of road maintenance in order to help assist the road maintenance activities for district-level and commune-level roads. There are two handbooks so far published, one for commune roads published in 2003 and the other for district roads in 2009.

(4) Issues Identified from Current Status Survey

Review and problem identification were conducted for Technical Standard on Road Routine Maintenance 22 TCN 306-03 and for Specification on Road Routine Maintenance, TCCS07: 2013/TCDBVN, aiming to identify the focus points of development for road routine maintenance standards.

1) Technical Standard on Road Routine Maintenance 22 TCN 306-03

Since no information update in the Standard 2003 has been made since its dissemination, so that information is fairly outdated and becomes inconsistent in contents with that in Road Maintenance Norms 2001.

2) Specification on Road Routine Maintenance TCCS 07: 2013/TCDBVN

DRVN conducted minor change in contents of the previous Technical Standard on Road Routine Maintenance 22 TCN 306-03 and disseminated a new version of road routine maintenance standard in 2013, namely Specification on Road Routine Maintenance TCCS07: 2013/TCDBVN, upon MOT approval. Brief assessment was made on the Specification and the results of assessment are summarized as follows;

a. Document Quotation

Some technical documents such as TCVN, TCN and QCVN are presented in the Specification in order to refer for further understanding. However, only a list of these documents are shown, thereby it is rather difficult for engineers to choose appropriate documents efficiently. If those documents are categorized in a table, it would be better to utilize them immediately.

b. Terms and definition

Apart from abbreviations, the terms given their definition are very small in numbers. However, many technical terminologies are shown in the Specification, so that they should be clearly defined for those inexperienced to get better understanding of the Specification.

c. Road routine maintenance work

- Explanation of routine maintenance work technologies is made mainly in text format. Lack of visual information, including photos, illustrations, tables and figures, may cause field engineers difficulty in understanding the Specification.
- The Specification does not show any information on road facility inspection and diagnosis of defected and deteriorated road facilities, which is the most essential information in road routine maintenance.
- Selection of maintenance works based on road facility inspection is an important activity, but not stipulated so much in the Specification.
- The Specification does not elaborate in detail on maintenance and repair technologies unlike technical specifications prepared for the tendering of construction works.
- The Specification does not demarcate the use of maintenance works between urban and mountainous regions. It seems to be fairly hard to apply the Specification to urban roads, because of significant differences in road and traffic conditions.
- Medium repair and big repair works have been conducted in accordance with construction standards, TCVN, TCV and QCVN, prepared by MOT and other relevant Ministries. However, due to big differences in road environment between construction and maintenance,

it is in general hard to apply construction standards and norms to medium repair works. With this, DRVN is recommended to develop technical standards and norms specially prepared for medium repair works. Contents of DRVN's new specification are shown in **Table 7.2.2**.

Table 7.2.2 Contents of Specification 2013

	Title		Contents
1	Scope of application		What kind works are applied to manual and notes in use
2	Quoted documents		Relevant standards for application
3	Terms and definitions		Abbreviations and Definition of technical terminologies
4	General Regulations	4.1 Maintenance activity	All contents of activities for routine maintenance
		4.2 Management activity	All contents of management activities regarding road routine maintenance works
		4.3 Inspection results application	Evaluation of road quality with inspection
5	Specifications of road routine maintenance	5.1 Embankment	Maintenance work of embankment, slope, drainage
		5.2 Roadside maintenance	Flatness, stability, drainage slope etc. of roadside
		5.3 Drainage	Side, horizontal, step, line ditch's maintenance
		5.4 Pavement	Concrete, asphalt, macadam, aggregate and earth pavement maintenance works
		5.5 Revetment and retaining wall	Maintenance works such as clearing plants, supplementing stones and clearing water
		5.6 Spillway and underground	Plastering cracks, replacing concrete slabs, removing mud from waterway, supplementing riprap and so on
		5.7 Tunnel	Maintenance of tunnel covering, drainage, and lighting
		5.8 Ferry station	Maintenance of station and road to station
		5.9 Emergency road	Repair of signboard, clearing obstacles on road and ditches and ensuring enough friction on road
		5.10 Discharge culvert	Dredging, re-filling cracked culvert, repairing broken masonries and so forth
		5.11 Small bridges	Maintenance works of bridge surface, girder, shoes, piers, abutment, and approach roads
		5.12 Management house	Bridge, toll, vehicle counting, weighing station
		5.13 Equipment	Various equipment for maintenance
		5.14 Road signal system	Road signals, road marking, traffic islands, median strip
		5.15 Green tree system	Clipping branches, watering, replanting cutting etc.
6	Inspection, evaluation and acceptance of routine maintenance		Procedures for acceptance and evaluation criteria
7	Traffic safety		Traffic safety measures for maintenance works
8	Labor safety		Attention points for maintenance workers
9	Environmental protection in the implementation of road routine maintenance		The observance of law on environmental protection and government decree guiding the implementing the law

Appendix 1. Facilities of road patrol

Appendix 2. Inspection form of road damage

Appendix 3. Classification, evaluation of road quality

Appendix 4. Form of vehicle counting

Appendix 5. Statistical form of road traffic accident

Appendix 6. Acceptance instruction of road routine maintenance and management work

Appendix 7. Form of acceptance minutes of road routine maintenance work

Appendix 8. Form of defining shortcomings in road routine maintenance work

7.2.4 Foreign Practices

(1) Practices in Japan

Before going into development of Road Routine Maintenance Manual, a foreign practice on the development of road maintenance standards was introduced, referring to practices in Japan as a sample.

(2) MLIT guidelines and manuals

In Japan, Road Act was promulgated in 1952 which stipulates road maintenance and management. MLIT (Ministry of Land, Infrastructure, Transport and Tourism) has developed the legal framework for road construction and maintenance procedures including institutional issues and disseminated regulations to central and regional bodies responsible for infrastructure development in Japan, following the enactment of Road Act.

(3) Methodology of developing technical guidelines and manuals

Japan Road Association (JRA) which is a third sector public organization founded in 1947 plays roles of collecting information on foreign practices for road construction and maintenance, developing manuals and guidelines given MLIT instructions and disseminating public information to the public on behalf of MLIT. **Table 7.2.3** shows guidelines and manuals developed by JRA. Currently, guidelines and manuals developed by JRA have been widely used in road construction and maintenance in Japan.

Guidelines and manuals shown in the table are in general compulsory in implementation for MLIT and relevant ministerial agencies. But they are not compulsory for regional road construction and maintenance projects implemented by local governments, but they are simply voluntary guidelines. Local governments are allowed to develop their own guidelines and manuals, but in reality they tend to apply MLIT guidelines and manuals to their road construction and maintenance projects.

Information included in these guidelines and manuals has been well organized and has covered diverse, advanced and practical technologies currently applied to the fields of road construction and maintenance. Much of the information included in MLIT guidelines and manuals can be referred in the development of a road routine maintenance manual in Vietnam.

Table 7.2.3 Guidelines and Manuals published by JRA

Title	Issued
Road Maintenance Repair Manual	1978
Road Bridge Maintenance Manual	1979
Steel Road Bridge Painting Manual	1990
Road Tunnel Maintenance Management Manual	1993
Technical Standard/Explanation of Pavement Structure	2001
Pavement Design and Construction Guide	2006
Pavement Design Manual	2006
Pavement Construction Manual	2006
Pavement Performance Evaluation Method	2006
Pavement Recycle Manual	2004
Plant Recycle pavement Technical Guidance	1992
Surface Recycling method Technical Guidance	1988
Road Surface Regenerative Subgrade Method	1987
Road Earthquake Measures Manual (Before earthquake)	2006
Road Earthquake Measures Manual (After earthquake)	2006
Road Environment Protection Technical Standard/Explanation	1988
Road Bridge Expansion Joint Manual	1970
Reference Material regarding Earthquake Resistant Reinforcement of Road Bridge	1997
Materials for Earthquake Resistant Design of Road Bridge	1998
Materials for Reinforcement of Existing Road Bridge Foundation	2000
Fatigue of Steel Bridge	1997
Fatigue Design Manual for Steel Road Bridge	2002
Road Bridge Shoe Manual	2004

7.2.5 Contents requirement for road Routine Maintenance Manual

Based on the problem identification described in the previous section, requirements for the development of road routine maintenance manual are set as follows;

- Quoted documents need to be categorized to ensure easy reference.
- Any technical terminologies referred in the manual should be clearly defined.
- The manual should provide a series of technical information needed for the field work of road routine maintenance, ranging from inspection, types of defects and deterioration, diagnosis, repair work selection to repair work specification. In particular, a guideline for road facility inspection should be developed immediately.
- The manual should provide not only technical information, but also management information for road routine maintenance works, including work acceptance criteria, target level of road maintenance (Pavement management levels) and data management, .
- The manual should be simple, informative and explanatory to field engineers which can ensure easy reference during maintenance activities. Photos, tables, figures and illustrations should be incorporated in a proper manner for easy reference.
- The manual should contain state-of-the-art technologies for road routine maintenance.

7.2.6 Framework of Routine Road Maintenance Manual

Framework of contents for road routine maintenance manual was developed based on the contents requirement discussed in the previous section. **APPENDIX-A** attached at the end of this Chapter

shows the contents structure of new routine road maintenance manual, focusing on a part, Road Routine Maintenance Technology.

7.2.7 Methodology of developing Routine Road Maintenance Manual

(1) Development road routine maintenance manual and inspection guideline

JICA Project developed a new road routine maintenance manual, dividing the manual into two parts; one for road facility inspection and the other for road maintenance manual. New road routine maintenance manual was developed in order to supplement information to Specification on Road Routine Maintenance TCCS 07: 2013/TCDBVN. However, the part of facility inspection is quite new to DRVN, so that the Project decided to develop a guideline on road facility inspection separately and independently from Road Routine Maintenance Manual.

(2) Introduction of new technologies

New road inspection and maintenance technologies are coming out every year in Japan. The Project selected some inspection and repair work technologies and introduced them in Vietnam including two types of advanced technologies; ones for road facility inspection technologies and others for road maintenance and repair technologies. Discussion and brief evaluation on whether these technologies can be applicable to Vietnamese road environment was conducted in cooperation with WG-3.1 and WG-3.2, which led to the conclusion that a further study including a pilot study is needed before incorporating them into the road routine maintenance manual and guidelines.

7.2.8 Draft road routine maintenance manual

The Project developed a draft versions of Road Routine Maintenance Manual and Guideline for Road Facility Inspection in cooperation with working group members including specialists from the University of Transport and Communications. A separate report of this Project, Guidelines and Manuals, contains draft versions of Road Routine Maintenance Manual and Guideline for Road Facility Inspection.

7.2.9 Dissemination and Utilization of Road Routine Maintenance Manual

DRVN is now recommended to distribute the draft reports on the Road Routine Maintenance Manual and on the Guidelines for Road Facility Inspection to relevant stakeholders including experts for commenting. Upon completion of assembling comments, DRVN is requested to review their contents and to take procedures for standardization.

APPENDIX-A; Framework of Road Routine Maintenance Manual

Draft Contents for Road Routine Maintenance Manual

	Contents List	
1	Scope of application	
2	Quoted document	
3	Terms and definitions	
4	General regulation	
5	Road maintenance technology	
5.1	General Provisions	
5.1.1	Objectives of Road Maintenance	
5.1.2	Definition of maintenance and repair	
5.1.3	Road Elements and Structures on the Road	
5.1.3.1		Roadbed and road slope
5.1.3.2		Road Pavement
5.1.3.3		Side-drain system
5.1.3.4		Culverts
5.1.3.5		Bridges
5.1.3.6		Retaining walls
5.1.3.7		Road Safety system
5.1.4	Road Maintenance	
5.2	Roadside Area Routine Maintenance	
5.2.1	Introduction	
5.2.2	Defects and routine maintenance for roadside area	
5.2.3	Routine Maintenance of Roadside Area	
5.2.3.1		Removing and disposing obstructions
5.2.3.2		Reshape or re-grade shoulder surface to the correct level
5.2.3.3		Vegetation control on shoulder and on the slopes
5.2.3.4		Adding Shoulder Material
5.2.3.5		Walkway maintenance
5.2.4	Road slope maintenance	
5.2.4.1		Overview
5.2.4.2		Damages of road slope
5.2.4.3		Emergent measures of slope maintenance
5.2.4.4		Maintenance and repair of natural slope
5.2.4.5.		Maintenance and repair damages of bio-engineering stabilized slope
5.2.4.6.		Slopes are covered with structural materials
5.3	Drainage System Routine Maintenance	
5.3.1	Introduction of Road Drain System	
5.3.2	Drainage System Distresses	
5.3.2.1		Distresses of rainwater side drainage system
5.3.2.2		Distresses of slope drains system
5.3.2.3		Distresses of underground drainage system
5.3.2.4		Distress of manholes and drainage pipes
5.3.3	Road Drain System Maintenance and Repair	
5.4	Routine Maintenance of Transverse Drainage or Culverts System	
5.4.1	Introduction of Transverse Drainage System and Distresses of Culverts	
5.4.2	Maintenance and repair of transverse drainage system	
5.4.3	Cleaning drainage facilities	
5.4.3.1		Cleaning plan
5.4.3.2		Cleaning methods

	Contents List	
5.7.3.1		Grading unpaved pavement
5.7.3.2		Labor based reshaping
5.7.3.3		Patching
5.7.3.4		Re-graveling
5.7.3.5		Anti-dust treatment
5.7.3.6		Surface Treatment
5.7.4	Bitumen Treatment on Unbound Aggregate Existing Pavement	
5.7.4.1		Road conditions for this method application
5.7.4.2		Investigation
5.7.4.3		Determine the layer structure and thickness
5.7.4.4		Example of standard design
5.8	Road Cleaning	
5.8.1	Introduction	
5.8.2	Road Surface Cleaning	
5.8.2.1		Implementation and execution plan
5.8.2.2		Mode of cleaning by machine and mode of combination
5.8.3	Oil Contamination Clearing	
5.9	Maintenance of pavement on bridge	
5.9.1	Introduction	
5.9.2	Bridge pavement surface failure and causes	
5.9.3	Evaluation of Bridge Pavement Surface	
5.9.4	Selection of treatment method	
5.9.5	Maintenance method	
5.9.5.1		First-Aid repair
5.9.5.2		Repair methods
5.1	Maintenance of pavement in tunnel	
5.11	Road Protection Structure Maintenance	
5.11.1	Introduction	
5.11.2	Defects and Causes	
5.11.3	Maintenance and Repair	
5.11.4	Revetment maintenance and repair	
5.11.4.1		Introduction
5.11.4.2		Maintenance and repair
5.12	Drift and Causeway Routine Maintenance	
5.12.1	Introduction	
5.12.2	Routine maintenance activities	
5.12.2.1		Small repairs
5.12.2.2		Grading and clearing
5.12.2.3		Replace guide posts
5.13	Tunnel Routine Maintenance	
5.13.1	Introduction	
5.13.2	Defects and treatments selection	
5.13.2.1		Tunnel damage types
5.13.2.2		Monitoring and causes of damage
5.13.2.3		Treatment selection
5.13.3	Treatment methods	
5.13.3.1		Cement atomization
5.13.3.2		Breaking base, projecting net
5.13.3.3		Concrete blowing
5.13.3.4		Locking bolt
5.13.3.5		Anti-seepage construction
5.13.3.6		Internal rolled concrete
5.13.3.7		Cleaning the road at tunnel
5.14	Maintenance technologies for ferry access road	

	Contents List	
5.14.1	Introduction	
5.14.2	Ferry access road maintenance	
5.15	Emergency Escape Ramp maintenance technologies	
5.15.1	Introduction	
5.15.2	Emergency Escape Ramp Maintenance	
5.16	Bridge Routine Maintenance	
5.16.1	Overview	
5.16.2	Classification of intervention levels	
5.16.2.1		Introduction
5.16.2.2		Criteria of intervention level of steel structures
5.16.2.3		Criteria of intervention level of concrete structures
5.16.3	Policy of repairing	
5.16.4	Repairing methods of steel structures	
5.16.4.1.		Repairing methods selection
5.16.4.2		Crack treatment methods
5.16.4.3		Replacing methods
5.16.4.4		The heat straightening method
5.16.4.5		Painting repair method
5.16.4.6		Waterproofing method
5.16.5	Repair methods for concrete structure	
5.16.5.1		Repair method selection
5.16.5.2.		Cracks treatment methods
5.16.5.3.		Cross section repair methods
5.16.5.4.		The partial filling method
5.16.5.5.		Surface re-covering methods
5.16.5.6.		Anti-rust treatment method
5.16.5.7.		The method of making titanium metal anode to prevent the electric corrosion
5.16.5.8.		The electric anti-corrosion methods by changing the zinc anode
5.16.5.9.		Electrochemical desalination method
5.16.5.10		Electrochemical re-alkali method
5.16.5.11		Water proofing method, water stopping method
5.16.6	Bridge bearing repair	
5.16.6.1		Introduction
5.16.6.2		The partial repair method
5.16.6.3		Bridge bearings replace
5.16.6.4		Methods of filling more materials
5.16.7	Repair expansion joints	
5.16.7.1		Overview
5.16.7.2		The partial repair method
5.16.7.3		Replacing the entire materials
5.16.7.4		The method of filling more materials
5.16.7.5		The non-drainage method
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5.17	Maintenance of Road Associated Facilities	
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6.2	Inspection Method	
6.3	Inspection Procedure	
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6.5	Acceptance Criteria	

7.3 ROAD PAVEMENT MATERIALS

7.3.1 Introduction

Two (2) workshops on Road Pavement materials were held during the Project. Discussion topics include the following 4 points;

a) Pavement maintenance material and method

b) Bridge deck waterproofing material and method

c) Asphalt emulsion for road pavement, and

d) Introduction of samples pavement maintenance material.

7.3.2 Pavement Repair Materials used in Japan

Based on the workshop presentation, pavement repair technologies currently incorporated in the road maintenance in Japan are briefly introduced as follows;

(1) Hot Applied Asphalt-Type Crack Sealant

Rain water penetrates into the pavement and leads various and serious damage, such as potholes. To prevent these serious damage, crack sealing with proper material has been applied to prolong pavement life, preventing water penetration into the pavement.

Desired properties for crack sealant are “adhesion with existing pavement”, “anti-stickiness at high temperature”, ”anti-brittleness at low temperature”, ”weather resistance”, ”and soakness into cracks”. Most existing crack sealant uses straight asphalt and did not show desirable performance, such as brittle right after applied.

The new Crack sealant is currently applied in the field which is specialized for crack sealant using the technology of Polymer Modified Asphalt to satisfy the desired properties.

The standard properties for the new Crack sealant are shown as **Table** 7.3.1 penetration, higher softening point, and higher bending stiffness are remarkable.

Table 7.3.1 Standard Properties for Crack Sealant

ITEM		STANDARD	PROPERTIES	TEST METHOD
Penetration (25℃, Cone needle)	Mm	6 or less	2.2	Manual for pavement research and test method (Japan Road Association)
Softening Point	℃	100 and more	116.0	
Viscosity (200℃)	mPa・s	Report	930	
Density (15℃)	%	Report	1.06	
Bending Work load	kPa	700 and over	910	
Bending Stiffness	mPa	30 or less	21	
Adhesion Mass	Mass%	5 or less	0	NICHIREKI Method

Strict application control for good performance, such as "Maximum heat temperature: 240degree", "Avoid reputational and partial heating" and "Use special primer" is needed. For application, some application goods are required, such as melting device and sealing device for crack sealant. Application procedure is as follows;

- Dry and clean application area
- Apply special primer
- Melt clack sealant
- Infuse clack sealant
- Spray dried sand if necessary

(2) Cold Applied Asphalt-Type Patching Mix

Potholes must be repaired as soon as possible when they come out in order to ensure traffic safety. On the other hands, pot holes often arise in rainy season. So, the patching mix with durable and applicable in rain should be needed.

Desired properties for patching mix are "workability into the flooded pothole", "durability to the primary stage and long term stage after patching", "anti-scattering of aggregates" and "water resistance". Existing patch mixes are using straight asphalt and light oil as cut back binder, and they doesn't have enough strength after patching and required reputational applications.

On the other hands, new patching mix has excellent durability for both primary stage and long term stage after patching due to using the binder with Polymer Modified Asphalt technology and highly evaporated solvent.

The standard properties for the new patching mix are shown as **Table 7.3.2** and Table **7.3.2**. It has excellent durability, easy compaction with open graded with high viscosity binder, and applicable in rainy days.

Table 7.3.2 Standard Properties for PATCHING MIX

ITEM		STANDARD	PROPERTIES	TEST METHOD
Density	g/cm3	Report	1.92	Manual for pavement Research and Test Method (Japan Road Association)
Marshall Stability	kN	1.0 and over	1.2	
Cantablo Loss	%	5.0 or less	0.5	

Table 7.3.3 Passage Mass Percentage (%)

SIEVE SIZE	13.2mm	4.75mm	2.36mm	600µm	300µm	150µm	75µm	TEST METHOD
STANDARD	100	87-100	18-35	10-21	6-14	3-10	1-8	Manual for pavement Research and Test Method (Japan Road Association)
PROPERTIES	100	94.5	26.4	15.9	9.8	7.5	5.3	

Strict application control for good performance should be applied;

- Application depth should be more than 2 cm
- More than 2 layer compaction need to be secured if application depth is more than 5 cm.
- Compaction whose margin is about 40% in its depth, must use plate compactor.
- Oil must not be used during compaction
- Excessed patching mix must be sealed off.
- Store should be less than 10 layers when piled.

For application, only a few goods are required, such as plate compactor. Application procedure is as follows;

- Clean application area
- Put patching mix into pothole
- Compact patch mix with plate compactor

(3) Cold Applied Asphalt –Type Bump Repair

Bumps in general outbreak around manholes and bridge joint. Early repair works are needed for bumps to ensure traffic safety and to avoid damage for construction itself. Application material for these area needs to thin-layer application and excellent adhesion with existing pavement.

Desired properties for bump repair are rut resistance, wear resistance, applicable to thin layer, faster application, excellent adhesion with existing pavement, easy application, and applicable on the wet surface. There are some similar materials with resin binder; however, these resin based bump repair is very dangerous when adhesion with existing pavement is lose, they come off with large solid. Also resin based material cannot apply with wet surface and takes long time to cure, so it is not suite for repair works.

This asphalt emulsion based bump repair uses the technology of micro-surfacing, and satisfies the requirement for repair works with higher level.

The standard properties for this bump repair are as shown in the tables below. Faster setting, application and faster open traffic, and excellent adhesion and solidity are remarkable.

Table 7.3.4 Standard Properties for Bump Repair

ITEM				STANDARD	PROPERTIES	TEST METHOD
Before Setting	Setting Time	(10℃)	min	2 and more	5	ASTM D 217
		(20℃)	min	2 and more	4	
	Hardened Time	(10℃)	min	30 or less	13	
		(20℃)	min	30 or less	10	
After Setting	Dynamic Stability	(60℃)	R/mm	1,000 and more	3,000	Manual for Pavement Research and Test Method (Japan Road Association)
	Wearing Mass	(-10℃)	cm2	1.0 or less	0.43	
	Adhesion Strength	(20℃,Co)	mPa	0.6 and more	0.87	JEAAT-5
		(20℃,As)	mPa	0.6 and more	1.26	

Table 7.3.5 Passage Mass Percentage (%)

Sieve Size	2.36mm	600μm	300μm	150μm	75μm	TEST METHOD
Standard	100	35-55	20-40	15-30	5-15	Manual for Pavement Research and Test Method (Japan Road Association)
Properties	100.0	43.1	31.8	23.8	11.3	

Strict application control for good performance should be applied, such as quick mixing for aggregates and emulsion, faster leveling by trowel, and no required for special machine like plate or tamper.

For application, equipment and materials required for the works include bucket, water, trowel, and curing tape. Application procedure is as follows;

(1) Fix the application area by curing tape

(2) Quick mix for aggregates and emulsion at site

(3) Pure made cold mixture on application site

(4) Levelled by trowel

(5) Spread curing sand on application site if needed

(4) Bridge Deck Waterproofing

Waterproofing on bridge deck is necessary not only for the pavement, but also for keeping durability of bridge deck itself. Water penetrates by pavement damages bridge deck and lose fatigue resistance of deck slab. To apply the hot asphalt waterproofing membrane on the deck, remarkable upgrading not only waterproofing performance, but also adhesion between deck slab and pavement are expected.

Materials for the waterproofing use the technology of Polymer Modified Asphalt, and is already applied for the bridges in Viet Nam.

In addition, supplemental materials, such as joint sealant on the pavement edge, drainage pipe, and special Polymer Modified Asphalt for bridge deck should be used with the waterproofing to ensure effectiveness of prolonging life cycles for pavement and bridge structure.

The standard properties for proposed waterproofing materials are as shown on the **Table 7.3.6** as a primer, and **Table 7.3.7** as a waterproofing membrane. These materials are suitable for adhesion, waterproofing, and workability.

Also, proposed system structure for the bridge deck waterproofing and pavement is as shown on **Figure 7.3.1.**

Table 7.3.6 Standard Properties for Waterproofing Primer on Concrete Deck Slab

ITEM		STANDARD	PROPERTIES	TEST METHOD
Set to Touch	Min	60 or less	19	JIS K 5600-1-1
Non-Volatile	%	20 and more	40.5	JIS K 6833
Workability		Good	Pass	JIS K 5600-1-1
Water Resistant		No Change in 5 days	Pass	JIS K 5600-6-1

Table 7.3.7 Standard Properties for Hot Applied Asphalt-type Waterproofing Membrane

ITEM		STANDARD	PROPERTIES	TEST METHOD
Penetration	mm	1-5	2.4	Manual for pavement research and test method
Softening Point	℃	80 and more	103.0	JIS K 2207
Tensile Strength	N/mm2	0.35 and more	0.55	JIS A 6021
Growth at Broken	%	300 and more	480	
Alkali Resistance	mm	No Particular	Pass	JIS K 5600-6-1
Salt Resistance	mm	No Particular	Pass	
Tack Free		Non Stick	Pass	Manual for bridge deck waterproofing

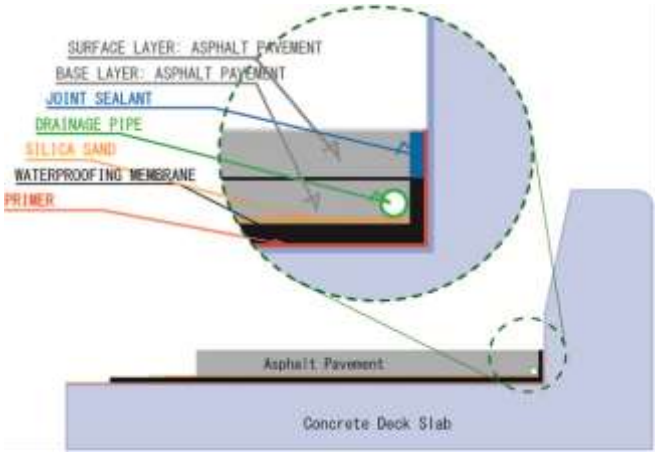


Figure 7.3.1 Proposed Structure for Bridge Deck Waterproofing and Pavement

7.4 PAVEMENT MONITORING SYSTEM (PMoS)

7.4.1 Rational of Pavement Monitoring System

Pavement Monitoring System (hereinafter referred to as "PMoS") is supposed to help the routine road pavement maintenance and the prioritization of repair works, with referring to the policy of maintenance and repair works selection. The workflow of Road Pavement Maintenance using PMoS is shown in **Figure 7.4.1**.

PMoS is actually a visualization system of road conditions utilizing Road Database. It shows road pavement conditions and a maintenance history as bar charts, also management criteria are indicated as bars on each of the bar chart of road pavement condition. All those items are shown in order of chainage of kilopost.

PMoS has been developed under Activity 3: Improvement of Road Maintenance Technology of the JICA Project for Capacity Enhancement in Road Maintenance, working together with JICA experts and Vietnamese experts.

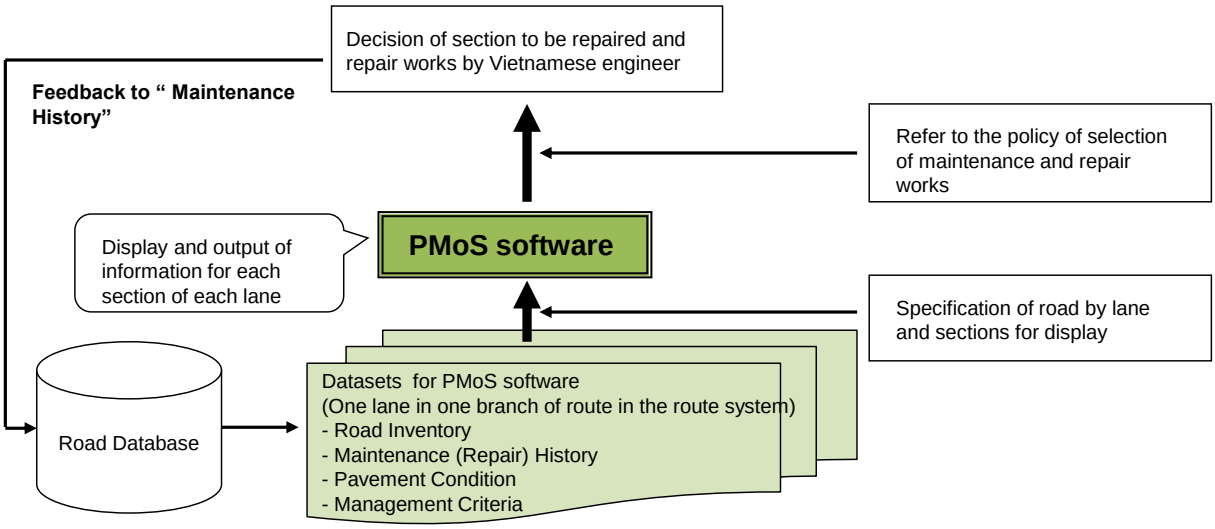


Figure 7.4.1 Image of Workflow of Road Pavement Maintenance Using PMoS

7.4.2 Requirements of Pavement Monitoring System

PMoS is a visualization system supposed to be improved by DRVN in the future. Hence following requirements of the system are considered and fulfilled as follows.

(1) To Visualize Road Conditions

PMoS software visualizes integrated information derived from Road Database.

(2) To Provide Easy Extendibility of the Monitoring Function

PMoS software is developed in MS excel VBA. Copyright belongs to DRVN and JICA. DRVN can modify or add any new functions on PMoS software on their own responsibility.

(3) To Assist Creation of Dataset for Pavement Monitoring

The Conversion Software for PMoS (hereinafter referred to as "the CS") creates dataset for PMoS software from Road Database.

7.4.3 System Development Environment

(1) Operation Software: MS excel 2003 or Later version

The system operation environment of PMoS software was decided from the view of easy operation and easy program management on a standard personal computer. Selected operation system was windows XP (SP3) and later versions of Widows.

(2) Programming Software: MS Visual Basic

The programming software was chosen as MS visual Basic, with considering easy future extensibility and easy management by the DRVN.

7.4.4 Development History

(1) Data Item of PMoS

Data items to be shown by PMoS software are discussed in WG-3. JICA Project took discussions on the job training (OJT) and workshop into consideration and proposed final data items, and WG-3 accepted it.

(2) Activity Relating PMoS

Firstly, current status of pavement monitoring system in Vietnam was survey in 2011. After that, work plan was prepared and discussed in WG-3. Based on the discussions in WG-3, draft version of PMoS was developed and tested in operation. Collected opinions on draft version were considered and PMoS was modified. PMoS was completed after the Workshop conducted in September, 2013.

Activity	Action of WG-3/ DRVN
0. Current Status Survey (Sep, 2011~ Dec, 2011)	
↓	
1. Preparation and Consultation of Work Plan (Dec, 2011~ Mar, 2012)	
↓	
2. Discussion in WG-3 (Mar- Jun, 2012)	
↓	
3. Drafting of Framework for PMoS (Jun, 2012)	
↓	Approval of Work Plan and Framework (Jun, 2012)
4. Development of PMoS (Oct, 2012)	
↓	Acceptance of Draft version of PMoS (Jun, 2013)
5. Operation test of PMoS (Feb – Apr, 2013)	
↓	
6. OJT of PMoS Operation (Aug, 2013)	
↓	Comments on Draft version of PMoS
7. Modification of PMoS System (Aug – Sep, 2013)	
↓	
8. Workshop regarding PMoS (Sep, 2013)	
↓	
9. Intensive Training including PMoS (Mar, 2014)	
	Acceptance of Final version of PMoS

Figure 7.4.2 Development History of PMoS

7.4.5 Structure of PMoS

(1) System Structure of PMoS

In the view of software applications, PMoS consists of the Conversion Software (CS) and PMoS software. PMoS software creates visualized outputs from PMoS datasets and the CS creates PMoS datasets.

PMoS datasets are interpolation datasets between the Road Database and PMoS outputs, which have integrated data records of road database data items with 100m length basically. Since each data records in road database, such as road asset, maintenance history and pavement condition has different unit length of data, integrated dataset of PMoS dataset is required.

Data items and unit length of each record of PMoS dataset were defined from output items through discussions in Activity -3. In this regards, dataset unit was defined as a lane of road branch. Hence, PMoS output file is created from corresponding PMoS dataset of lane of road branch.

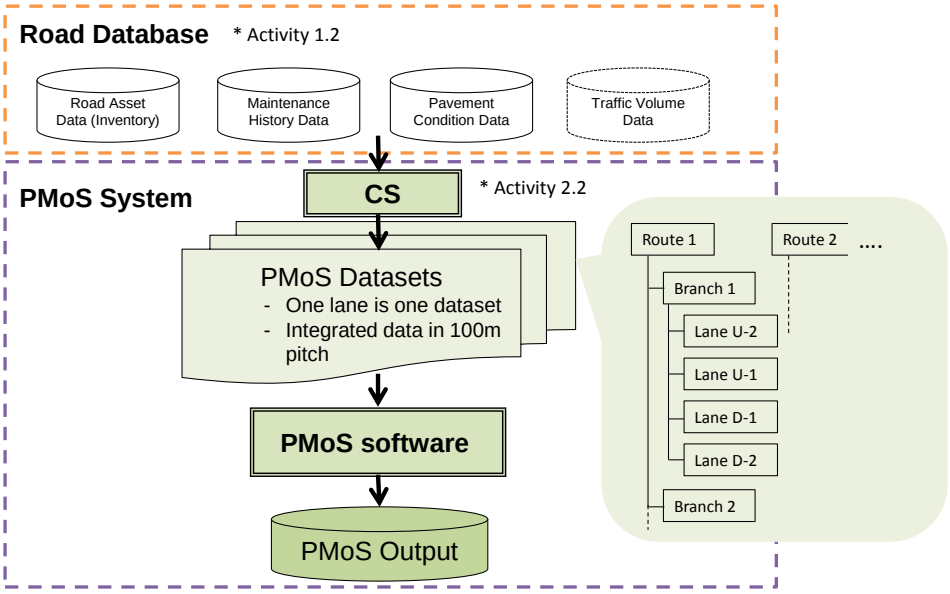


Figure 7.4.3 System Structure of PMoS

(2) Folder Structure of PMoS

PMoS software, PMoS.xla, locates under PMoS folder. In the folder, three (3) folders of "Dataset", "Output" and "Support" are contained. "Dataset" shall contain datasets created by the CS. PMoS software creates output files in "Output". "Support" contains a PMoS user's manual. An operator is required to move dataset files to "Dataset" folder, after he / she creates PMoS datasets by CS.

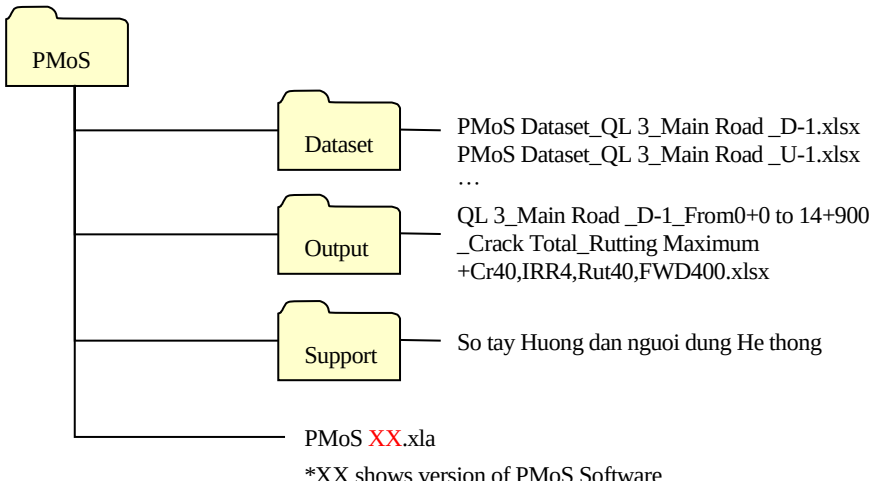


Figure 7.4.4 Folder Structure of PMoS

7.4.6 Function of the PMoS

(1) Function of CS

The function of the CS is to create PMoS dataset, an integrated dataset from Road Database for PMoS software. Further descriptions are elaborated in CS user's manual.

(2) Function of PMoS Software

(1) Load corresponding dataset to visualize

(2) Display following information

+ Road information
+ Maintenance history
+ Pavement condition
+ Evaluation index for each factor such as IRI and Rut depth

(3) Output

The output file is created as new MS Excel file. It is saved in "Output" file, following the naming rule as shown in **Figure** 7.4.5.

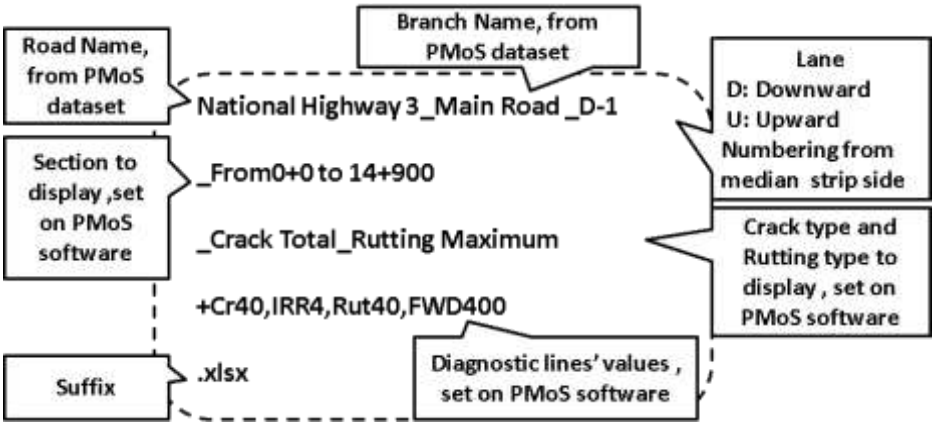


Figure 7.4.5 Naming Rule of PMoS Output File

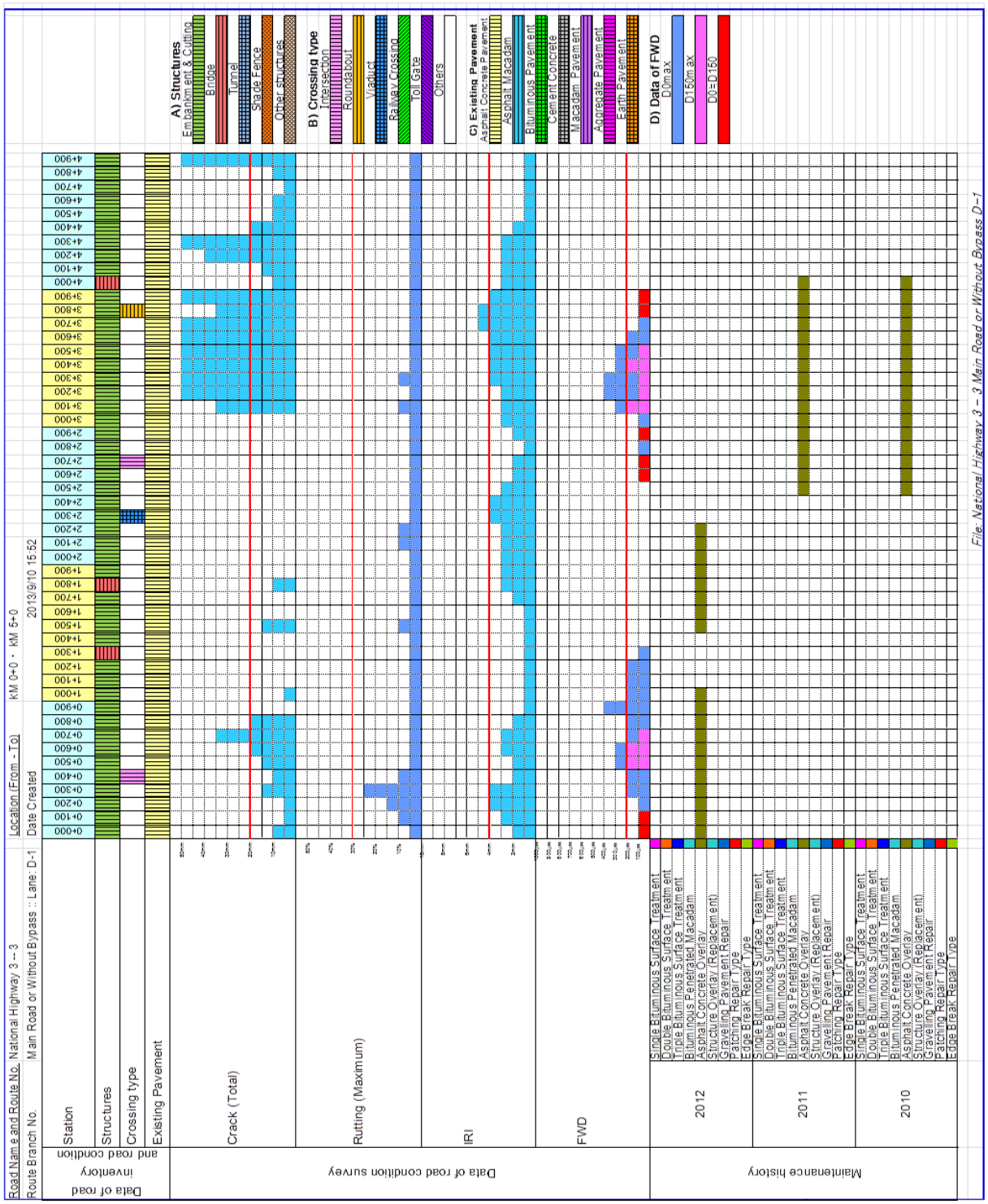


Figure 7.4.6 Output Image of PMoS

7.4.7 Interface of the PMoS Software

The interface of PMoS Software is as shown in **Figure 7.4.7**, which is displayed after activating PMoS software.

You can select corresponding PMoS dataset of specific lane of road and branch which you want to display. Then you should select exact sections to display from pull-down menus, set values for diagnostics as for pavement management and maintenance criteria, select types of values of crack and rutting. After those preparation settings, when you click "Display" button, PMoS system starts creating output.

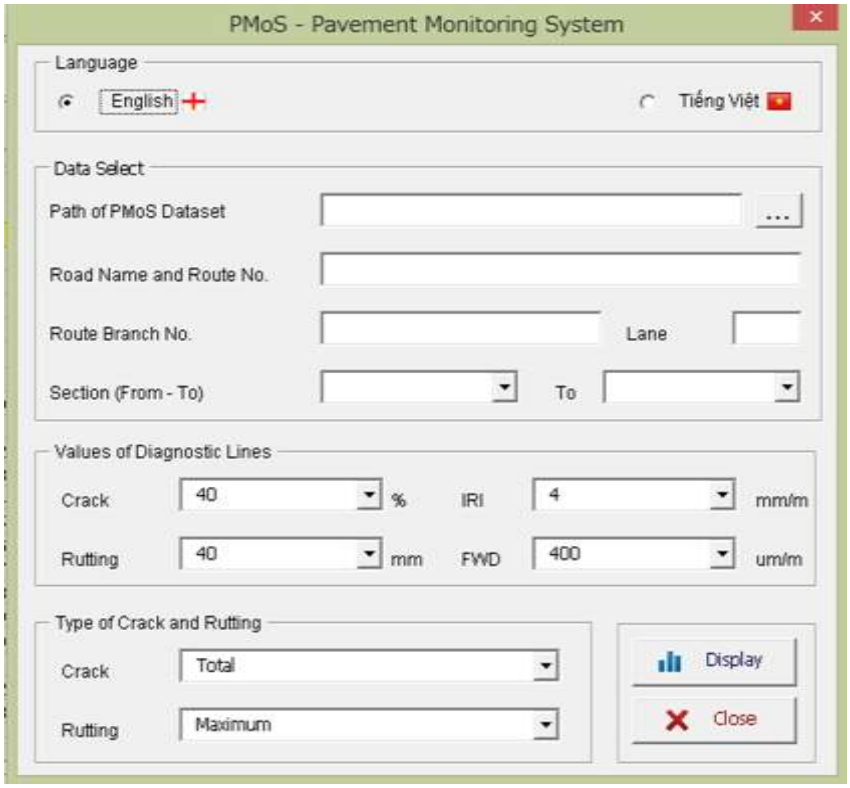


Figure 7.4.7 Interface of PMoS Software

7.4.8 Management and Upgrade of PMoS System

(1) Management

PMoS outputs should be disseminated to RRMB and its sub-bureaus to be utilized for daily maintenance of road pavement at sites. The operator of CS is assumed to be the road database operator, since the CS creates PMoS data sets from the road database. The operator of PMoS software could be same as CS operator and / or end users such as RRMB and its sub-bureaus.

(2) Upgrade

In the case of modification of PMoS, IT center of DRVN is assumed to be a responsible department which has an ability to maintain and upgrade the system developed in MS Visual Basic.

7.4.9 OJT for PMoS

(1) Purpose

A workshop for instruction of PMoS and computer practice on it, called OJT for the PMoS was conducted on the 2nd August. The purpose of the OJT was to introduce the PMoS to the persons in charge of road pavement maintenance and to practice the operation of a draft version of PMoS software with prepared computers.

(2) Attendees of OJT

In total, 13 participants attended the OJT as follows;

- 8 persons form DRVN,
- 3 persons from RTC Central, and
- 2 persons from RRMU II.

(3) Content of OJT

The content and timetable of the OJT is shown in **Table 7.4.1.**

Table 7.4.1 OJT Training Program OJT

Time	Contents	Trainer
Registration Opening		
9:00 – 9:10	Registration	
9:10 – 9:15	Opening Remarks	DRVN
Section-1 Lecture		
9:15 – 10:00	Summary	Mr. Toshinori Kanazawa
	Function and Operation	
	Data format	
	Arrange and Maintenance	
10:00 – 10:10	Discussion	
10:10 – 10:20	Tea Time	
Section-2 Computer Practice		
10:20 – 11:00	Basic Operation Using Sample Data	Mr. Toshinori Kanazawa
	Application of the PMoS Output	
11:00 – 11:20	Discussion	
11:20	End	

(4) Evaluation of OJT

Participants answered questionnaire which evaluate the OJT and own knowledge and skill enhancements. The results are shown in **Figure 7.4.8**. It can be concluded that most of participants understood the contents of the OJT and learned the operation.

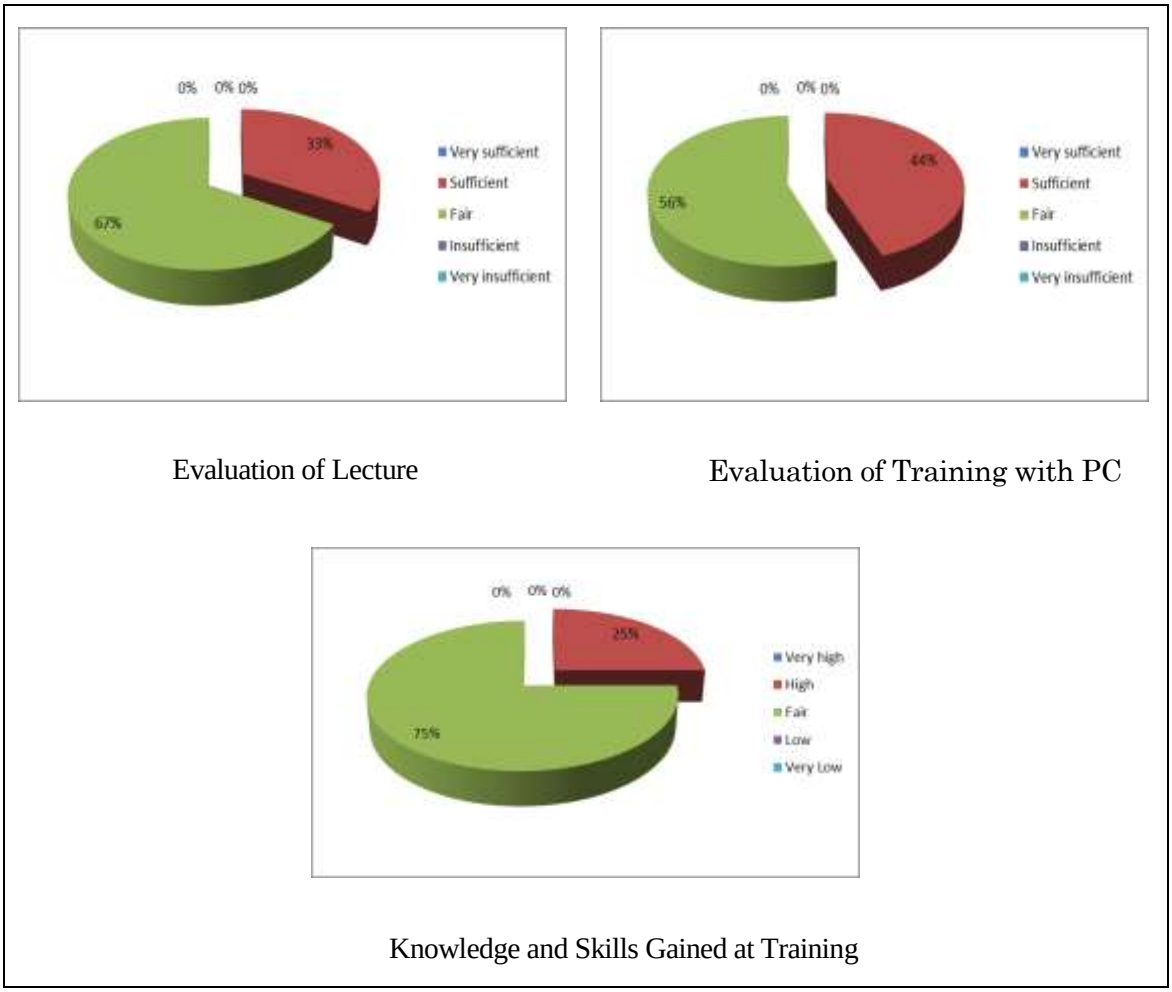


Figure 7.4.8 Results of Questionnaire

Figure 7.4.9 Scenes at OJT

(5) Opinions regarding the Draft Version of PMoS

Opinions and requests of participants of the OJT are summarized as below;

a) FWD should be shown in the display.

Corresponding to this opinion, PMoS software was updated and added item of FWD to display.

b) Request for additional function of drawing up reports for pavement planning

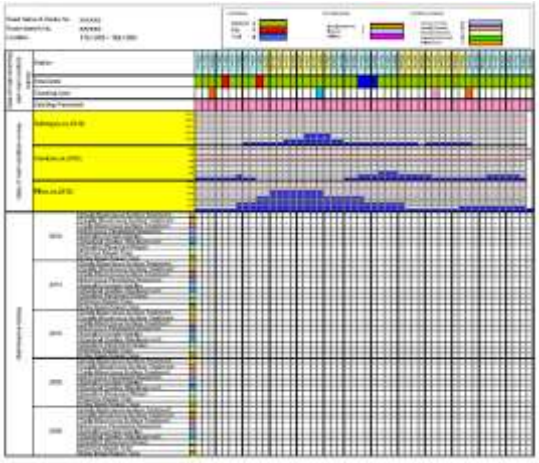
The purpose of PMoS was confirmed in WG-3, which was to support the engineer's work for pavement maintenance and management by easily viewable present pavement conditions. The output is formed in MS Excel, thus users can easily arrange it to their intending report format.

c) Selection of display layout

JICA Project Team proposed two (2) types of display layouts. The first one shows 5 years-maintenance history respecting the discussion in WG-3, with compressed road condition items. The second one shows 3 years-maintenance history with widen road condition items.

As the result of an interview with the participants, the second one was selected.

The First Version



The Second Version

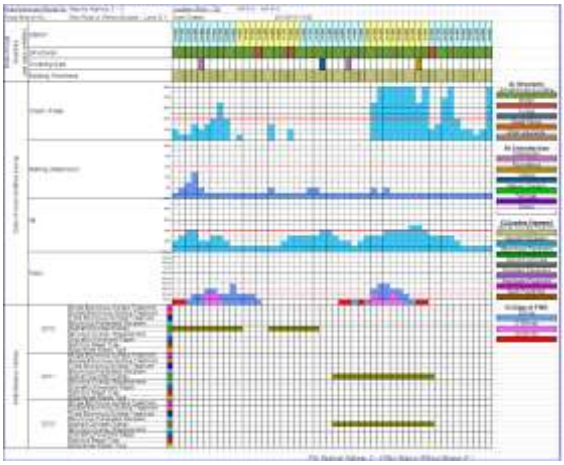


Figure 7.4.10 Two Types of PMoS Outputs

CHAPTER 8 STRENGTHEN OF ROAD MAINTENANCE INSTITUTION

8.1 FRAMEWORK OF IMPROVEMENT IN ROAD MAINTENANCE PROCEDURES

8.1.1 Background

Road development in Vietnam has grown rapidly in a recent decade. However, social interest has been directed to the enhancement of construction quality rather than facility maintenance. Road infrastructures are among important national assets to be taken over from generation to generation. Also, the maintenance period is much longer than the construction period. Moreover, maintenance budget is anytime unstable in amount and is often influenced by the economic status of the times. This causes difficulty in ensuring stability of maintenance budgets over the long course of social infrastructure maintenance, which is seemingly a common phenomenon among European countries, USA, Japan etc. It is therefore important for Vietnam to set out the study on the capacity enhancement of facility maintenance.

8.1.2 Objectives

Objectives of this study are as follows;

- To discuss on the principles of road maintenance,
- To analyze and identify problems lying behind the current maintenance operation in Vietnam, from the viewpoints of legal framework, organization and staff, maintenance plan/project formulation and approval, budget proposal and approval, cost estimate, technical standards, etc.
- To summarize recommendations (1st-phase) on the capacity enhancement of road facility maintenance.

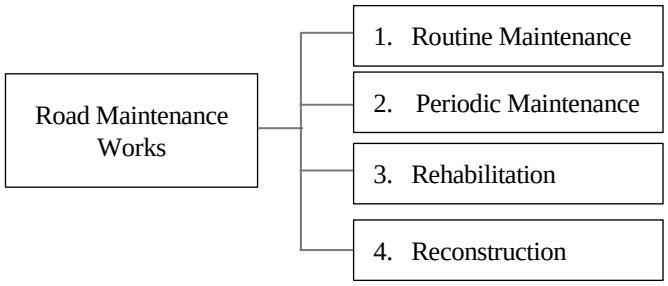
8.1.3 Basic Concept for Road Maintenance

The basic concept for road maintenance is summarized here in this chapter, including definitions, the outlines of activities, the general frameworks and the functional requirements for road maintenance.

8.1.4 Definitions of Road Maintenance Works

(1) Structure of road maintenance works

Figure 8.1.1 shows the structure of road maintenance works, and also **Table 8.1.1** shows the objectives of each activity, followed by the brief explanation. Four (4) maintenance activities are in general incorporated in the long duration of road maintenance with different objectives. As seen in the table, each activity has clear objectives.



(Note)
Unscheduled maintenance which includes the restoration works for disasters and traffic accidents is tentatively categorized in the "Routine Maintenance" in this presentation.

Figure 8.1.1 Structure of Road Maintenance Works

Table 8.1.1 Maintenance Works and Their Objectives

Maintenance Works	Maintain Serviceability	Retard Aging	Maintain Strength	Increase capacity	Activities
Routine maintenance	X				Cleaning of facilities Small repair works (Reactive maintenance) Temporary restoration from the damaged of disasters or accidents etc.
Periodic Maintenance	X	X			Medium/big repair works (Proactive maintenance)
Rehabilitation	X	X	X		Replacement of facilities without functional upgrade
Reconstruction	X	X	X	X	Reconstruction of facilities with functional upgrade

1) Routine Maintenance

- Routine maintenance has an objective to maintain serviceability including safety of the road facilities. It is promptly implemented in response to the development of deficiencies that negatively impact the safe and efficient operation of the facility.
- Main activities categorized in the routine maintenance include patrolling, the cleaning of facilities, small repair works and disaster and accident restoration works, so that the quick detection and the early repair of failures are the key for success of this maintenance.
- Small repair works are categorized as ex post fact maintenance works which are reactive and not proactive to the failures, and are performed aiming to restore a facility to an acceptable level of service. They are not regarded as measures which will give serious impacts on the facility service life, the strength and functions of the facilities.
- Unscheduled maintenance works are those aiming to return facilities back to a minimum level of service, while permanent full-scale restoration is generally carried out later on in the rehabilitation or in the reconstruction process.
- Sample small repair works applied for road routine maintenance include pavement pothole repair works which fill potholes with asphalt repair materials to ensure smoothness in driving and safety.

2) Periodic Maintenance

- Periodic maintenance is a planned strategy of cost-effective treatments to existing road facilities. It has objectives of preserving the facilities, retarding structure deterioration, extending facility life-cycle, thereby maintaining or improving the functional conditions of the facilities (without significantly increasing the structural capacity).
- Periodic maintenance is a key maintenance activity which can retard the aging of road facilities until the time of expensive rehabilitation, thereby contributing to reducing overall maintenance investments. However, it requires strategic and proactive measures in planning and in implementation.
- Main activities consist of medium-scale or large-scale repair works to cope with road facility deterioration and to reinforce structures, which generally require large spending on the works.
- In order to ensure efficiency in planning and in implementation, a mid-term or a long-term maintenance plan is generally incorporated as a base of planning in order to find out repair locations, repair works and repair timings in the long course of maintenance. Also, these maintenance plans are expected to contribute to stabilizing maintenance budgets and investments in the course of maintenance.
- Sample works applied for road maintenance include a pavement overlay which places a new pavement with the thickness of about 3 to 5 centimeters or equivalent on the existing damaged pavements.

3) Rehabilitation

- Rehabilitation is to restore the strength of facilities by replacing a large part of road facilities with the equivalent structure without functional upgrade in general, thereby maintaining the strength of facilities. Rehabilitation is applied to the facilities which have failed in function or become functionally obsolete.
- Rehabilitation results in big investment, so that project formulation, design, contract, and work supervision in principle follow the construction procedures stipulated in the relevant regulations.
- Sample rehabilitation works applied for road maintenance include pavement replacement in the certain section of roadway which demolishes existing damaged pavements and constructs a new pavement.

4) Reconstruction

- Reconstruction aims to upgrade road facilities in conformity with the latest technical standards and to make additional functions to the original facilities like adding two more lanes on a roadway as an example.
- Reconstruction results in big investment, so that project formulation, design, contract, and work supervision in principle follow the construction procedures stipulated in the relevant regulations.

(2) General framework of road facility maintenance

Table 8.1.2 shows the general framework for maintenance works including missions, responsibilities, work types and functional requirements for each activity. The functional requirements explain the functions which each activity is equip with in order to fulfill missions and responsibilities.

(3) Functional requirement for road facility maintenance

The functional requirements listed in **Table 8.1.3** are developed in this section. Difference in functional requirement can be seen in the routine maintenance and periodic maintenance. The objective of the routine maintenance is to maintain serviceability, so that the functional requirement is more focused on ensuring mobility. On the other hand, the periodic maintenance is focused on the retarding aging which foresees a mid-term future and tries to find out the best investment strategy that can reduce life-cycle costs of the facilities. In particular, much attention needs to be paid on the functional requirements for the routine maintenance and the periodic maintenance. It is noted that functional requirements for rehabilitation and reconstruction are basically the same and follow procedures for capital construction projects, so that further explanation on these activities are to be integrated into one column.

Table 8.1.2 General Framework of Road Facility Maintenance

Functional Requirements	1. Routine Maintenance	2. Periodic Maintenance	3. Rehabilitation	4. Reconstruction
1. Missions and Responsibilities	■ Quick detection of incidents ■ Quick countermeasures to the incidents	■ Planned investment by asset management aiming to minimize facility life-cycle costs in the course of maintenance	■ Maintain strength of facilities	■ Upgrade functions of facilities
2. Work Types	■ Daily Patrolling ■ Cleaning of facilities ■ Small repair works ■ Restoration works (Temporary) for the damages given by disasters and accidents	■ Periodic inspection and data preservation ■ Planning mid-term and long-term maintenance plans ■ Medium/big repair works	■ Detail survey and design by consultants ■ Construction project management and quality management, same as those for construction projects	■ Detail survey and design by consultants ■ Construction project management and quality management, same as those for construction projects
3. Functional Requirements	■ Functions specialized for the routine maintenance are required. (1) Regal framework (2) Organization and staff (3) Project formulation and approval (4) Design standards (5) Cost estimate manual (6) Budget proposal and approval (7) Contract management (8) Standards for work and quality management	■ Functions specialized for the periodic maintenance are required. (1) Regal framework (2) Institutional arrangement (3) Project formulation and approval (4) Design standards (5) Cost estimate manual (6) Budget proposal and approval (7) Contract management (8) Standards for work and quality management	■ Same functions as those for construction projects are required.	■ Same functions as those for construction projects are required.

Table 8.1.3 Functional Requirements for Road Facility Maintenance

Functional Requirements	1. Routine Maintenance	2. Periodic Maintenance	3. Rehabilitation / 4. Reconstruction
1.1. Legal Framework	■ Legal framework specialized for routine maintenance is needed.	■ Legal framework specialized for periodic maintenance is needed	■ Legal framework should follow those for construction projects
1.2. Institutional Arrangement 1.3. Organization and staff	■ Maintenance units or taskforces are needed to take prompt action to the incidents, in particular facilities served to the public like roads and bridges.	■ Planning department and planning staff capable of handling databases (PMS, BMS) and planning software for mid-term/ long-term maintenance plans.	■ Same as construction projects
1.4. Inspection and Survey	■ Data collection by daily patrolling	■ Data collection by periodic inspection	■ Detail survey by consultants ■ Results of periodic inspection
1.5. Maintenance Plan/ Projects Formulation and Approval	■ Maintenance plans are formulated based on the projection of maintenance history. ■ Plan approval should be issued on the overall framework only and should not be on the project basis, since individual projects may need to change their details frequently, depending upon incident types. ■ Facility owner should take responsibility for changing the projects flexibly.	■ Mid-term maintenance plans (3 to 5 years plan) need to be approved as an alternative to FS for construction projects. ■ Recently, technology development is being carried out on the maintenance management system like PMS for road pavements and BMS for bridge structures, which can predict future structure deterioration on the basis of inspection data and formulate mid-term maintenance plans.	■ Follow construction procedures
1.6. Environmental Assessment	■ Not necessary since there is no big changes in facilities.	■ Not necessary because periodic maintenance is not with functional upgrade.	■ Not necessary for Rehabilitation without functional upgrade ■ If Reconstruction includes functional upgrade like the widening of a road from 2-lane to 4-lane facility, it may need FS and environmental assessment, in accordance with the scales of additional functions.
1.7. Design	■ Design and work specifications on the small repair works should be standardized preliminary in the Routine Maintenance Standards for easy reference.	■ Design and work specifications on the medium and big repair works should be standardized preliminary in the Periodic Maintenance Standards for easy reference. ■ The medium or big repair works often include the demolishment or the removal of deteriorated old facilities, which make it difficult to apply construction design standards.	■ Follow construction procedures ■ Follow construction design standards

Functional Requirements	1. Routine Maintenance	2. Periodic Maintenance	3. Rehabilitation / 4. Reconstruction
1.8. Cost estimation and Norms	■ Cost Estimate Norm should be specialized for the routine maintenance works. ■ It is not appropriate to apply a Construction Cost Norm to the routine maintenance works due to the differences in construction volumes and in working conditions at the sites.	■ The Work types of medium and big repair works often differ from general construction works as shown in 1.6, the cost estimate for these works should be based on the Cost Estimate Norm specialized for the periodic maintenance.	■ Follow construction procedures ■ Follow cost estimate for construction projects
1.9. Budget Proposal and Approval	■ The budget framework for the routine maintenance and unscheduled maintenance works should be proposed and approved. The proposed amount should include the breakdown of works estimated on the projection of past trend. ■ Approval given to the routine maintenance budget should be only the overall framework of budgets, so that the authority of changing work breakdown is given to facility owners in order to ensure flexibility.	■ Budget plan for periodic maintenance including medium and big repair works need to be proposed on a project basis, following the procedures for rehabilitation and reconstruction projects.	■ Follow procedures for construction projects
1.10. Contractor Selection	■ A call-for contract or a direct appointment of contractors is more desirable than a competitive bidding in order to ensure quick mobilization of contractors.	■ Follow competitive bidding procedures	■ Follow procedures for construction projects ■ Based on competitive bidding procedures
1.11. Technical Standards	■ Work items and procedures needed for the routine maintenance are so special and wide that they should be standardized in the Technical Standards for the routine maintenance. ■ Routine Maintenance Standards should be authorized by relevant ministries. ■ Work items to be standardized are as follows; a. Inspection and survey b. Diagnosis c. Repair work selection d. Repair work specifications e. Maintenance Service levels f. Acceptance criteria g. Data preservation for inspection and maintenance records	■ Periodic inspection on the maintenance facilities should be standardized in the Routine Maintenance Technical Standards. ■ Design standards for the periodic maintenance, including medium and big repair works, should be developed separately from construction design standards, due to the difference in work types, including demolishment or removal of existing facilities.	■ Follow design and technical standards for construction works
1.12. Work Supervision and Quality Management	■ Follow the provisions of the Routine Maintenance Standards	■ Follow procedures for construction projects	■ Follow procedures for construction projects
1.13. Information and Data	■ Maintenance data should be preserved in Road	■ Infrastructure asset database	■ Follow procedures for construction projects

Functional Requirements	1. Routine Maintenance	2. Periodic Maintenance	3. Rehabilitation / 4. Reconstruction
Management	Maintenance Information System (RIMS) ■ Main databases needed for facility maintenance consists of; a. Facility asset database b. Maintenance history database c. Inspection data base d. Facility management and operation database e. Facility user database (Traffic volume etc.)	■ Inspection record database ■ PMS, BMS ■ Maintenance history database	
1.14. Human Capacity Development	■ Patrol ■ Routine maintenance technologies	■ Inspection, planning, maintenance/repair works, database management	■ Capacity development for planning and F/S, construction project management and work supervision.
Note;		■ The works focus on facility maintenance with no additional facility improvement, so that FS and environmental assessment are not in general needed.	

(4) Strategic Periodic Maintenance by Road Asset Management

1) Objectives of LCC Management

Research and development on the LCC management was initiated in Europe and USA to manage independent infrastructure facilities such as roads, bridges, water supply and sewage systems, building works and so forth. In Japan, MLIT, local autonomies, expressway and railway companies etc. currently pay their attention to this new strategic maintenance management. LCC management was already partially incorporated in the practical maintenance activities in the fields. LCC management is to change periodic maintenance to planned or preventive maintenance with special focus on facility deterioration; thereby it is called as strategic maintenance management.

The objectives of the use of LCC management are as follows;

- To reduce annual and overall maintenance spending (Life cycle cost) in the long curse of maintenance
- To prolong structure's life cycle, that is the longevity of the structure, by applying maintenance technologies to be developed aiming to prolong the structures' life cycles.
- To stabilize budget allocation in the course of maintenance.

2) LCC Management

Flow of applying LCC management is briefly stated below. In the flow, a key element of the management is to predict future facility deterioration. Research and development on the prediction theory and logic is now going on worldwide. Advances in developing LCC management are currently seen in the road transport sector. Development of deterioration prediction theory and repair work technologies which can make facility life cycles longer have been actively carried out in particular with focuses on major materials such as asphalt pavement, concrete and paints for steel bridges.

STEP-1 ; To measure current status of facility deterioration and faults periodically at a proper interval (Example; every 2 to 3 years)

STEP-2; To prepare data formats and to record data for LCC management. The database needed for LCC management may include (1) facility asset database, (2) maintenance history database, (3) facility condition database and so forth. The database types may differ depending upon infrastructure sector, so that the database should be specialized by sector. Upon completion of these databases, maintenance and update of information are necessary regularly.

STEP-3; To conduct a causal factor analysis of facility deterioration and to predict the progress of facility deterioration in the mid/long term.

STEP-4; On the basis of the prediction results in STEP-2, an analysis is also done for the selection of repair locations, repair work methods and timings of repair works, with

maintaining maintenance service levels. Computations will be done to find out the best economy of LCC. Computerized planning software in general facilitates these analyses and computations. **Figure 8.1.2** illustrates the concept of LCC management. The figure shows the progress of facility deterioration. In the conventional post fact maintenance, big repair work is generally done when deterioration gets to the management level of service. However, the LCC management employs small or medium repair works repeatedly, making facility life cycle longer and lowering the possibility of costly big repair works, thereby reducing overall maintenance and repair costs until the time when the facility is totally reconstructed. Use of technologies specialized for making facility life cycle longer is also a key factor in the LCC management.

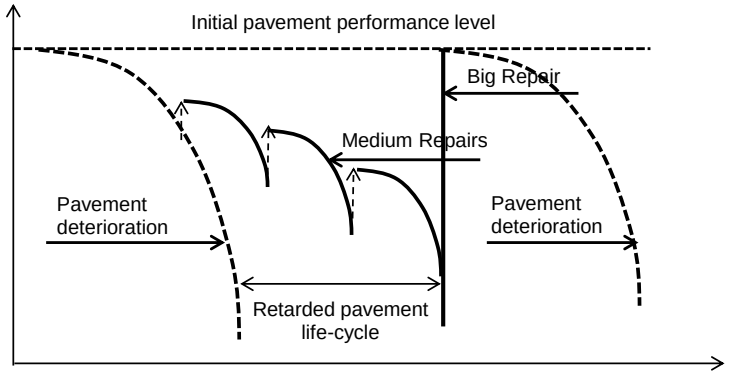


Figure 8.1.2 Road Pavement Life-cycle

8.1.5 Current Status of Road Facility Maintenance in Vietnam

The View points of the analysis are as follows;

- Legal framework
- Organization and staff
- Maintenance procedure manual
- Maintenance plan/project formulation and approval
- Budget proposal and approval
- Cost estimate
- Cost estimate norms for routine maintenance
- Contractor selection
- Technical standards

Major findings will be stated hereinafter;

(1) Legal framework

(Current Status)

- There are many regulations interrelated each other for the facility maintenance including laws, decrees, circulars and decisions, it is very hard for the users to find out information necessary for the facility maintenance.
- Decrees, Circulars and decisions are developed under the relevant laws, so that it is sometimes very hard to understand priority in judgment between similar provisions under different laws.
- There are only a small number of regulations specialized for the facility maintenance. Many regulations promulgated for the purpose of capital construction projects have been applied to the facility maintenance, so that there observed unclear statements, inconsistency in contents between regulations which may cause misunderstanding in interpretation.

(Comment)

Regulations should be established and integrated into maintenance manual with approval between relevant state authorities; The expert study on the road maintenance, there seem to be over 30 regulations as shown in **Table 8.1.4.**

Table 8.1.4 Legal Framework Concerning Road Maintenance

	Regulations	Title
1	Law on Government Organizations	
2	Law on State Budget	
3	Law on Tendering	
4	Law on Construction	
5	Law on Road Traffic	
6	Decree No.12/2009/ND-CP, 12/FEB/2009	Management of investment projects on the construction works
7	Decree No.209/	Construction work quality management
8	Decree No. 31/2005/ND-CP, 11/MAR/2005	Production and supply of public-interest products and services
9	Decree No.71/2005/ND-CP, 6/JUN/2005	Investment management of specific works
10	Decree No.75/2008/ND-CP, 09/JUN/2008	Amending and supplementing a number of articles of the Governments Decree No.170/2003/ND-CP
11	Decree No. 114/2010/ND-CP, 6/DEC/2010	Maintenance of construction facilities
12	Decree No.170/2003/ND-CP, 25/DEC/2003	Detailing the implementation of a number of Articles of the Ordinance on prices
13	Decree No.85/2009/ND-CP	Guiding on implementation of Law on Tendering and selection of contractor in accordance with Law on Construction
14	Decree No.48/2010/ND-CP	Contract in construction activities
15	Joint Circular No.75/2011/ TTLT-BTC-BGTVT, 06/JUN/2011	Guiding elaboration and management of prices of public-interest products and services in management and maintenance of roads, inland waterway by method of ordering and assignning plan to use state budget funds.
16	Joint Circular No.86/2011/TT-BTC	Regulating management, payment of investment and non-business fund with investment nature of state budget.
17	Circular No.39/2011/TT-BGTVT	Guiding implementation of some articles in Decree No.11/2010/ND-CP
18	Circular No. 86/2011/TT-BTC, 17/JUN/2011	Stipulating management, payment of investment capital and non-business funds with investment nature of state budget
19	Circular No.19/2011/TT-BTC	Regulating accounting of completed projects under state budget
20	Circular No.04/2010/TT-BXD	Guiding formulation of management of construction work investment cost

	Regulations	Title
21	Circular No.109/2000/TT-BTC	
22	Circular No.59/2003/TT-BTC	Guiding implementation of Decree No.60/2003/ND-CP
23	Decision No. 256/2006/ QD- TTg, 9/NOV/2006	Regulations of bidding, ordering, assigning plan to implement production and supply of public-interest products and services
24	Decision No. 957/QD-BXD, 09/SEP/2009	Promulgation of cost norm for project management and consultancy of investment in works construction
25	Decision No. 1129/2010/QD-BXD (of which year or subject of document??)	Guidance on conversion of the investment cost for construction works to the handing-over time
26	Decree No.11/2010/ND-CP	Regulating management and protection of road transport infrastructure
27	New Decree under preparation (*1)	Road asset management
28	Joint Circular No.10/2008/ TTLTBTC-BGTVT), 30/JAN/2008	Guiding the regime of management, payment and settlement economic professional budget for management and maintenance of road
29	Circular No.10/2010/TT- BGTVT, 19/APR/ 2010	Providing for road administration and maintenance
30	Circular No.30/2010/TT-BTC, 05/MAR/2010	Guiding the financial management of the task of supplying public-utility products and services in road and inland waterway transport
31	Circular No.07/2010/TT-BGTVT	Regulating Loading and size of road.
32	Circular No.30/2010/TT-BGTVT	Regulating prevention and recovery of flood and storm damage in road sector.
33	Decision No.855/2011/QD-BGTVT (of which year or subject of document??) June 2011	Decision of the Prime Minister on approval of the programs proposed on control of environmental pollution in transport & transportation activities.
34	Decision No. 1270/ QD- TCĐBVN, 28/JUL/2010	Authorization in implementing some rights and responsibilities of Director General of DRVN in works repair investment management on NH system using Road non-business budget and ferry fee
35	Decision No.3479/2001/ QD- BGTVT, 19/OCT/ 2001	Road Routine Maintenance Norm

(2) Organization and staff

(Current Status)

- There used to be subordinate state-owned-enterprises (SOEs) under the state agency or under Provincial-level People's Committees in the regions. The SOEs had shifted to the limited companies or the joint stock companies (RRMCs or PRRMCs) until July 2010 by the Law on Enterprise in line with the government decentralization policy.
- Due to this change, there are no field offices and task forces on the state agency sides which can be mobilized to the incidents or to the emergencies on the roadway.

(Comment)

- It is important for some infrastructures, like roads and bridges, to detect any incidents on the facilities as quickly as possible, to remove incidents, to restore facilities from emergency and maintain their serviceability to the users.
- In order to ensure smooth and timely implementation of these activities, the state agency is requested to maintain the relation with the maintenance companies by making contracts specialized for the routine maintenance works.

(3) Maintenance procedure manual

(Current Status)

Decree No.114/2010/ND-CP stipulates a maintenance procedure manual as follows.

- "Design consultants should be responsible for formulating maintenance procedure manuals. Construction facility maintenance plan should be made annually based on the approved maintenance procedure manual. Facility owners should accept the maintenance procedure manuals produced by consultants and adjust it when some difficulties arise in operation."
- This procedure seems to be more suited to the building work maintenance whose facility owners or authorized persons are in general non-professional.

(Comment)

- Private-sector building works occupy a majority in the building construction sector unlike national asset maintenance, roads, bridges etc., so that the consultants dedicated to building design become capable enough of making a maintenance procedure manual for building facilities.
- Meanwhile, professional facility owners or authorized persons are in general assigned to the maintenance of national assets like traffic infrastructures, agriculture infrastructure and urban technical infrastructures. Overseas practices have explained that government organizations in principle take whole responsibilities for the maintenance of such national assets and take a prime role in developing maintenance procedures as well as maintenance plans without relying on design consultants.

(4) Maintenance plan/project formulation and approval

(Current status)

- Decree 114 stipulates that the facility owner shall take responsibility for formulating facility maintenance plans, decide repair projects less than 500 million VND, and approve repair projects over 500 million VND.
- However, Decree 114 does not stipulate who will approve the routine maintenance plans.

(Comment)

1) Decree 114 stipulates the responsibility for formulating and revising maintenance plans.

- Construction facility maintenance plan should be made annually based on the approved maintenance procedure manual.
- The facility owner or authorized person shall be responsible for formulating and approving the facility maintenance plan.
- The construction facility maintenance plan may be revised, supplemented during implementation process. The facility owner or authorized person shall be authorized for deciding those revisions, supplements for the maintenance plan.

2) Decree 114 also stipulates that repair of facility using State budget, shall be conducted as follows depending on amount of expenses:

- For repair of facility with expenses under VND 500 million, the facility owner or authorized person shall decide repair projects.

- For repair of facility with expenses over VND 500 million, the facility owner or authorized person shall conduct formulation, verification and approval of **economic and technical report (F/S)** or construction investment project.

The above regulations are more likely suited to the periodic maintenance including medium repairs and big repairs which are similar to general construction works stipulated in the Law on Construction. However, the routine maintenance has absolutely different missions. It aims to take prompt action in response to any incidents happening on the facilities, to restore damages, and thereby to maintain serviceability of the facility. Like roads and bridges, delay in response often causes serious consequences to facility users.

The facility owner or authorized person is recommended to approve and revise routine maintenance plans, if needed. Also, routine maintenance consists of patrolling, small repair works, emergency restoration works which are mostly small-scale, fixed pattern and sometimes unpredictable works like disaster restoration, so that it is not necessary to apply F/S, but to approve the overall framework of annual maintenance plans. This would ensure the flexibility of maintenance work selection and minimize delay to be caused by applying F/S.

Differences in plan formulation and budget proposal are summarized in **Table 8.1.5** as reference.

Table 8.1.5 Work Plan & Budget Proposal by Work Type

Maintenance Type	Work Types	Work Plan	Budget Proposal
Routine maintenance	■ Cleaning ■ Small repair ■ Emergency restoration	■ Comprehensive annual plan	■ Comprehensive annual budgets proposal
Periodic maintenance	■ Medium repair ■ Big repair	■ Mid-term plan based (Alternative plan of F/S) ■ Technical design	■ Budgets proposal for individual projects
Rehabilitation	■ Replacement without functional upgrade	■ F/S ■ Technical design	-Ditto-
Reconstruction	■ Reconstruction with functional upgrade	-Ditto-	-Ditto-

(5) Budget proposal and approval

(Current status)

- Law on Budget and Circular 86 deals with conditions of budget proposal for capital construction projects including periodic maintenance (medium and big repairs), rehabilitation and reconstruction works.
- However, it does not stipulate the conditions of budget proposal for the routine maintenance works. Routine maintenance in general consists of small-scale, fixed pattern, many works and unpredictable works like disaster restoration, so that F/S report is not necessary and it is appropriate to approve overall framework of annual budgets rather than approving individual work-based budgets in order to ensure flexibility.

(Comment)

1) Law on Budget stipulates;

- **Prior project formulation** is necessary for capital construction project including medium and big repair works.

2) Also, Circular No.86/2011/TT-BTC stipulates the conditions of budget proposal as follows;

- The investment projects are allocated with investment capital from the state budget every year.
- For investment projects, it is required to have investment decision prior to October 31 of the preceding year of the planned year.
- As basic documents for the domestic capital projects, employer must send project basic documents to the state treasury;
- Economic - technical reports for the projects (F/S Report),
- Investment decisions of the competent authority,
- Written approval of the contractor selection in accordance with the Bidding Law,

The contract documents between the employer and the contractor, and Cost estimate approval of the competent authority for each works.

(6) Cost estimate

(Current Status)

- Remarkable progress has been seen in the facility maintenance and management technologies, such as minimizing facility life-cycle costs, prediction of facility deterioration and maintenance information technologies including databases.
- Methods of payment should follow the changes in technologies and should be flexibility applied to the payment of maintenance projects.

(Comment)

- Decree 114 stipulates that the method of estimating maintenance costs as follows;
- Maintenance cost estimation should be made upon **volumes of facility** identified according to maintenance plan and **construction unit price** for carrying out those facility loads.
- Performance Based Contract (PBC) is currently under study by World Bank TA project to enhance capacity for road maintenance and management. However, PBC does not use a Quantity-based contract, but a Quality-based contract, so that this may need review and modification of Decree 114.

(7) Cost estimate norms for routine maintenance

(Current Status)

- Routine Maintenance Cost Norm, Decision No. 3479/2001/QD-BGTVT was promulgated 2001 and applied to the routine maintenance works.
- Inconsistency of information was observed between Technical Norms on Road Routine

Maintenance 2003 (Technical Standards 2003) and Routine Maintenance Cost Norms 2001.

- Cost estimate for other maintenance activities including periodic maintenance, rehabilitation and reconstruction, construction cost estimate norms have been applied. Works of design and cost estimate are carried out by consultants.

(Comment)

- The work types and working environment between routine/periodic maintenance and general construction works are fairly different each other. The routine and periodic maintenance often need the demolishment and the removal of deteriorated facilities and may need traffic control measures on some occasions at the construction sites, which may often cause cost increase in routine/periodic maintenance compared with general construction works. With these reasons, it is very important to develop a cost norm specialized for the routine and periodic maintenance works separately from construction cost norms.
- Review and revision of the contents of Technical Standards 2003 are now underway by DRVN in cooperation with JICA technical assistance.
- MOT is kindly requested to revise the Routine Maintenance Norms upon completion of the revision of the Technical Norms on Road Routine Maintenance 2003 in order to ensure consistency between two norms.
- Also, MOT is kindly requested to develop Periodic Maintenance Norms separately from the Routine Maintenance Norms and general construction norms.

(8) Contractor selection

(Current Status)

- In Vietnam, the Law on Tendering stipulates contractor selection methods which can be applied to the selection of maintenance works. Article 20 of the Law on Tendering shows some incidents to which direct appointment of contractors can be applied; events of force majeure due to a natural disaster, war or a breakdown.
- However, further details of these applications are not elaborated not only in the Law on Tendering, but in Decree 209, in Decree 12 and in Decree No.71, so that it is hard to apply the direct appointments of contractors to routine maintenance.

(Comment)

- In performing the facility maintenance, it is necessary to select eligible contractors in accordance with maintenance work types, i.e. routine maintenance, periodic maintenance, rehabilitation and reconstruction.
- In Vietnam, the Law on Tendering stipulates contractor selection methods which can be applied to the selection of maintenance works. There are three main tendering methods applicable to the selection of maintenance work contractors; (1) open tendering, (2) limited tendering, and (3) direct appointment of contractors. Basically, the above (1) and (2) can be applied to the periodic maintenance, rehabilitation and reconstruction works. However, in the

case of routine maintenance which contains many of incident responsive works such as small repair works, traffic safety measures and emergency restoration works, it is necessary to select contractors without spending a long time and to mobilize contractors to the incidents as quickly as possible.

- Article 20 of the Law on Tendering shows some incidents to which direct appointment of contractors can be applied; events of force majeure due to a natural disaster, war or a breakdown. Also, the investor or the body responsible for managing the building works or assets affected shall be permitted to immediately appoint a contractor to carry out the work.
- However, further details of these applications are not elaborated not only in the Law on Tendering, but in Decree 209, in Decree 12 and in Decree No.71.

(9) Technical standards

(Current Status)

- MOT disseminated Technical Norms on Road Routine Maintenance, Decision No. 1527/ 2003/ QD-BGTVT dated on 28/5/2003 and applied the Technical Norms to the routine maintenance works.
- Construction design standards have been applied to periodic maintenance works, rehabilitation works and reconstruction works, whose works are fairly large-scale rather than the routine maintenance works.
- Technical Norms on Road Routine Maintenance 2003 is under revision by DRVN in cooperation with JICA technical assistance.

(Comment)

- Technical Norms stipulates the subjects relevant to road inspection, data preservation, diagnosis, selection of maintenance works, facility management levels, work acceptance, and so forth, which are essentials for implementing road routine maintenance.
- It is necessary to develop technical standards on routine and periodic maintenance separately from construction design standards for the facilities, since routine maintenance works are wide in range and small in scale from patrolling, small repairs and emergency restoration. Also, the periodic maintenance, including medium repairs and big repairs, may need the demolishment or the removal of existing facilities. Due to the difference in working environment and work types, construction design standards are hardly applied to the routine maintenance and periodic maintenance works.
- As regards other maintenance works including periodic maintenance, rehabilitation and reconstruction, construction standards can be applicable

8.1.6 Recommendation

(1) Enhance public awareness on road facility maintenance

Road infrastructures are among important national assets to be taken over from generation to generation. Also, the maintenance period is much longer than the construction period. Improper maintenance may cause difficulty in not only ensuring serviceability, but maintaining road functions. State authorities involved in road facility maintenance are recommended to enhance their awareness and acknowledgement to the importance of road facility maintenance.

(2) Review and define road facility maintenance

It is recommended to review and classify existing maintenance works, following the maintenance structure shown in **Figure 8.1.1** and **Table 8.1.2.** Also, management procedures for these maintenance works need to be developed in order to meet their requirement. The procedures may include legal frameworks, organization and staff, project formulation and approval, design, cost estimate and norms, budget proposal and approval, contractor selection, technical standards and so forth as shown in **Table 8.1.3.**

- Routine maintenance
- Periodic maintenance
- Rehabilitation (without functional upgrade)
- Reconstruction (with functional upgrade)

(3) Improve the legal framework for road facility maintenance

It is recommended that state authorities relevant to construction facility maintenance, DRVN, acknowledge the objectives, missions and requirements for each of the road maintenance activities, and simplify and improve the current legal framework in order to make them meet the requirements. The points to be focused on in working out provisions are as follows. The provisions need to be prepared for each maintenance activity, i.e. routine maintenance, periodic maintenance, rehabilitation and reconstruction. Key elements for the facility maintenance are summarized in **Table 8.1.6** by maintenance activity as reference.

- Institutional arrangement
- Formulation of maintenance plan/projects and approval
- Budget proposal and approval
- Cost estimate and cost estimate norms
- Contractor selection
- Technical standards

In addition, it is recommended that ministries promulgating regulations for road facility maintenance should exchange views with state agencies in charge of facility maintenance on the requirements of regulations before drafting regulations.

Table 8.1.6 Summary of Functional Requirements for Road facility Maintenance

Functional Requirements	4. Routine Maintenance	5. Periodic Maintenance	6. Rehabilitation / 4. Reconstruction
1. Legal Framework	■ Legal framework specialized for routine maintenance is needed.	■ Legal framework specialized for periodic maintenance is needed	■ Legal framework should follow those for construction projects
2. Organization and staff	■ Maintenance units or taskforces which can take prompt action to the incidents.	■ Planning department and planning staff capable of handling databases (PMS, BMS) and planning software	■ Same as construction projects
3. Maintenance Plan/ Projects Formulation and Approval	■ Established based on the projection of maintenance history. ■ Approval on the framework of plans and not on the individual works. ■ Environmental assessment is not necessary.	■ Mid-term maintenance plans (3 to 5 years plan) as an alternative to FS ■ Based on asset management concept aiming at minimizing the life-cycle costs. ■ Environmental assessment is not necessary.	■ Follow construction procedures ■ Environmental assessment is not necessary for the rehabilitation without functional upgrade. If reconstruction includes functional upgrade, it may need FS and environmental assessment.
4. Cost estimation and Norms	■ Estimated by the cost estimate norms specialized for the routine maintenance works.	■ Estimated by the cost estimate norms specialized for the periodic maintenance.	■ Follow construction procedures ■ Follow cost estimate for construction projects
5. Budget Proposal and Approval	■ The overall framework of budgets is proposed and approved.	■ Project-based budget proposal is proposed and approved.	■ Follow procedures for construction projects
6. Contractor Selection	■ A call-for contract or an appointed contract in order to ensure quick mobilization of contractors.	■ Follow competitive bidding procedures	■ Follow procedures for construction projects
7. Technical Standards	■ Work items and procedures should be standardized in the Technical Standards for the routine maintenance.	■ Periodic inspection on the facilities should be standardized. ■ Work items and procedures should be standardized in the technical standards for the periodic maintenance.	■ Follow design and technical standards for construction works

(4) Simplify procedures for public facility maintenance

Over 30 regulations are more or less concerned with road facility maintenance. It is expected that more regulations will be needed in order to stipulate further details of the maintenance implementation procedures. With this, state agencies' much energy has been spent on the analysis of regulations rather than the quality enhancement of road maintenance works.

Taking these into consideration, it is recommended that MOT and DRVN prepare maintenance manuals specialized for road maintenance and consolidate information into them in order to avoid misunderstanding and misinterpretation on the concerned regulations. **Figure 8.1.3** shows a schematic view of this simplification. The manuals should be authorized by institutional ministries like MOC and MOF.

The following shows a sample manual structure.

1) Manual for facility maintenance management

The manual should convers administration procedures for road facility maintenance including routine maintenance, periodic maintenance, rehabilitation and reconstruction. The subjects to be included are shown below;

- Plan/Project formulation and approval procedures
- Budget proposal and approval procedures
- Contract management focusing on facility maintenance

2) Technical standards for routine maintenance and periodic

The standards need to cover routine maintenance works as well as periodic maintenance in principle. Rehabilitation and reconstruction works should follow construction design standards. The subjects to be included are shown below;

- Facility inspection standards
- Criteria of diagnosis
- Criteria of work selection
- Work operation guideline
- Work specification for routine maintenance works
- Data preservation in databases
- Acceptance criteria
- Facility management levels

3) Cost estimate norms for routine maintenance and periodic maintenance

- Routine maintenance cost norms
- Cost estimate norms for maintenance patrolling
- Cost estimate norms for facility cleaning
- Cost estimate norms for small repair works

- Cost estimate norms for emergency restoration
- Periodic maintenance cost norms
- Cost estimate norms for periodic inspection
- Cost estimate norms for medium repair works
- Cost estimate norms for big repair works

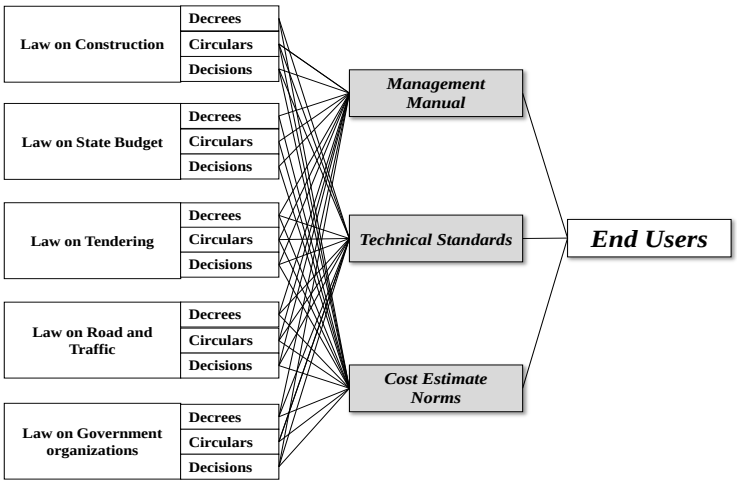


Figure 8.1.3 Simplification of Procedures by Manual

4) Methodology for developing manuals and guidelines

The following procedures show the general flow of developing manuals and guidelines.

a. Identify information requirement for road maintenance activities

For field engineers involved in road maintenance, in particular in road facility inspection, practical information which can contribute to field activities is needed more than that stipulated in regulations and standards, in particular information on where to see defects and deteriorations, how to diagnose structure defects and deterioration, how to select repair works based on diagnosis. The Project recommends that DRVN develop the following manuals and guidelines deemed beneficial to field engineers to perform their duties.

- Road facility inspection guidelines
- Supervision and work acceptance for routine maintenance and periodic maintenance
- Field and laboratory tests for maintenance works and materials
- Labor safety and traffic control during maintenance works

b. Define information tools for disseminating information and demarcate their functions

Various information tools have been incorporated to disseminate information on road maintenance activities. The following is the typical tool to disseminate information;

- Regulations (Laws, Decrees, Circulars and Decisions)
- Standards (Technical standards, cost norms and specifications)
- Manuals (Guidelines etc.)

Regulations have been widely used in Vietnam to disseminate administrative information including responsibility assignment between stakeholders. Information in the regulations is in principle compulsory and applied commonly to all stakeholders related. However, their document formats are very much official purposes and specialized for regulations, so that it is hard to disseminate specific technical information which may need more flexible format in information dissemination. In order to supplement regulations, standards including technical standards, cost norms and specifications, have been widely used in infrastructure construction and maintenance in order to disseminate more specific information to users. Standards are in general compulsory in application, if they are specified in regulations and contract documents.

In addition to these regulations and standards, manuals and guidelines have been used in the foreign countries in order to disseminate reference and voluntary information to users including technical information and procedures. Reference information, which is often shown with illustrations, photos and tables, is very much informative for users who wish to know more detailed information. Manuals and guidelines are also used to supplement information and to provide guidance to regulations and standards.

Ministries in charge of developing regulations are requested to demarcate information tools and select the most appropriate tools which can meet information requirements. For example, a current status survey conducted in the Project has explained that construction work specifications have been widely used for international tendering in Vietnam. However, there observed many overlaps in information between relevant regulations and contract documents, which often caused conflicts in interpretation between project owner and contractors. Clear demarcation is needed in order to avoid confusion in interpretation.

c. Classify information

Upon acknowledging functional demarcation between regulations, standards and manuals, most appropriate information tools need to be selected in order to meet the information demand discussed in "a" of this paragraph. The current status survey has reported that there are many provisions overlapped each other in between construction specifications and relevant regulations under Construction Law. In order to avoid misunderstanding or misinterpretation of provisions, clear demarcation is needed between construction work contracts and provisions in the relevant regulations.

(5) Application of LCC management to the infrastructure management in Vietnam

Currently, infrastructure construction is growing rapidly in recent years in Vietnam and thus infrastructure stocks have been piling up rapidly. The Vietnam Government is recommended to take timely actions in order to prepare for the times of infrastructure maintenance including formulating strategic plans and their implementation guidelines for infrastructure maintenance at an early stage.

LCC management is now expected to be the most prospective and the most strategic management system for infrastructure maintenance. It is recommended that Vietnam Government set out preparation at an early stage. The following is the brief description of these prior conditions.

1) To set management level for LCC maintenance management

It is necessary to select management indexes for infrastructure maintenance. Taking road infrastructure as an instance, crack ratio, rutting depth and roughness are among those often selected as indexes to express pavement deterioration. Also, the management levels of these indexes need to be predetermined.

2) Measurement of Facility Deterioration

Based on the indexes selected in the above "(1)", facility deterioration is to be measured in the fields and recorded into the facility condition databases. In general, two time series data, which are the deterioration data observed in two different years with more than 3 years of interval, are needed in order to predict future facility deterioration.

3) Development of Databases

LCC management is basically operated on the databases, so that all necessary information for LCC management needs to be registered in advance in the database formats. Typical databases needed for LCC management are shown as follows;

- Asset database which accommodates facility inventory information including year of operation etc.
- Facility condition database which registers periodically measured facility conditions,
- Facility maintenance history database which register the locations and the date of maintenance/repair works and the types of maintenance/repair works

4) Development of prediction system for facility deterioration

There are many countries now tackling to develop prediction systems for facility deterioration. In general, the prediction system now available consists of the following computation modules; (1) an evaluation module of current status of facility deterioration, (2) a factor analysis module on the influential elements on facility deterioration, and (3) a facility deterioration prediction module.

5) Development Maintenance Planning System

In order to formulate facility maintenance, repair and budget plans based on the predicted future deterioration, it is necessary to develop maintenance and repair work planning systems equipped with work selection logic and cost estimation logic. Before their installation, it is necessary to standardize the logic.

6) Organization Arrangement and Human Capacity Development

In order to implement LCC management, it is necessary to arrange responsible organizations and staffs capable of handling the databases and the systems discussed above.

8.2 RECOMMENDATION ON THE STRENGTHENING OF INSTITUTION

8.2.1 Background

Road maintenance and management technologies have been growing rapidly in recent years and becoming more systematic. The Project for Capacity Enhancement in Road Maintenance aims to enhance DRVN's capacity for managing road information, for planning road maintenance plans and for developing maintenance technologies and training programs.

8.2.2 Objectives

Objectives of this paper is to show measures of institutional strengthening in order to disseminate the outcomes of this Project to all stakeholders involved in the national road maintenance and management in Vietnam, and to further enhance the qualities of technologies and the functions of software systems developed by the cooperative studies between JICA team and DRVN working groups. It would be highly appreciated if DRVN could take account of these recommendations as part of comprehensive renovation plans in order to pave the way to the future more efficient national road maintenance and management.

8.2.3 National road Maintenance and Management Organizations in Vietnam

(1) DRVN Comprehensive Renovation Plan Official Number

DRVN developed a renovation plan of DRVN organization mechanism and submitted it to the Government for amendment, supplementation to the Prime Minister's decision No. 107/2009/QD-TTg which stipulates function, duties, authorities and organizational mechanism of DRVN.

1) Renovation plans for DRVN Departments

Information shown below is on the renovation plan of the DRVN departments.

- Transfer the duty of infrastructure management and duties relating to unexpected repair, rehabilitation of black point from the Infrastructure and Transport Safety Dept. to Road Maintenance and Management Dept.
- Rename the current Road Maintenance and Management Dept. to the Department of Road Infrastructure Management and Maintenance.
- Transfer the duty of traffic safety management duty from the current Infrastructure and Transport Safety Dept. and
- Rename the current Transport and Legal Dept. to be Transport & Traffic Safety Dept.
- Newly establish a Department of International Cooperation and Public Relation.

- Establish the Institute for Road Technique based on the Road Technical Center to study development policies and road maintenance technology, to receive and provide training for transfer technique and high profession to the base levels.

2) Renovation plans of DRVN organization structures

a. Renovate the current two-level management model to a three-level management model.

Joint stock companies have been converted to State Capital Investment Corporation (SCIC) and in the future one-member limited companies shall be transferred to CIENCOs. Thus, the upper level - lower level relationship and administrative command between the RRMBs and the companies shall be ended.

Level-1: DRVN.

Level-2: Regional Road Bureau ("RRMB") or PDOTs for the delegated national highways.

Level-3: Basic Road Management Unit ("RMU"). RMU may be a sub-unit operating as an non-business administrative agency.

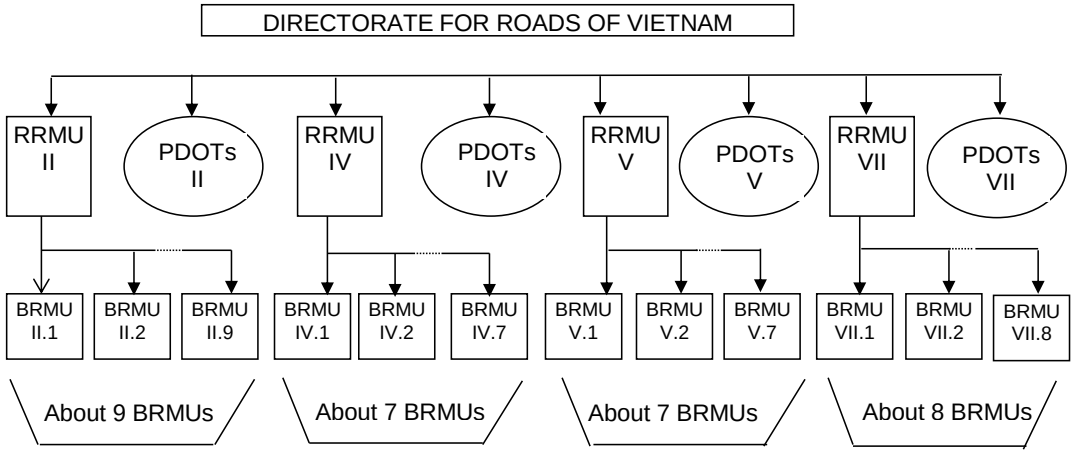


Figure 8.2.1 DRVN Organization

Source) Project for Comprehensive Renovation in Management, Maintenance of National Highway System, June 2012, Ministry of Transport

(2) DRVN legal status and Organization Structures

In line with the above reform plan, a new Prime Minister's Decision1, No.60/2013/QD-TTg, was enforced on the 21st of October 2013, which stipulates new functions, tasks, powers and

1 Prime Minister's Decision, No.60/2013/QD-TTg dated on 21 October 2013, on "To regulate Function, Duty, Authority and Organization Mechanism of Directorate for Roads of Vietnam under Ministry of Transport".

organization structures for DRVN. The new Decision was enforced pursuant to the previous Prime Minister's Decision2 No.107/2009/QD-TTg dated on 26th August 2000.

1) Duty and Authority

Decision 60 stipulates that DRVN is the agency which is directly under MOT, acting the function as counselor and assistant of Minister of Transport concerning state management and law execution organization in road transportation of nation-wide and carrying out public services in road transportation in accordance with the laws. DRVN has legal entity, stamp with national emblem, separate account in National treasure and headquarter located at Hanoi city.

Tasks and powers stipulated in Decision 60 are shown below:

- Formulate and submit the drafts of laws, acts, legal documents on road transport to MOT for approval. Formulate and submit strategies, planning long-term, five-year and annual plans on road transport development.
- Formulate and submit national standards, national technical regulation and eco-technical norms on road sector to MOT for promulgation.
- Provide guidelines for the implementation of legal documents, policies, strategies, etc.
- Disseminate road transport laws
- Manage, operate and implement maintenance of road infrastructure
- Manage road transport infrastructure construction
- Manage vehicles and drivers
- Manage road transport
- Road traffic safety
- Environment protection in road transport
- Implement international cooperation
- Implement researches and transfer technologies in road transport sector
  + Implement personal management
  + Manage finances and budgets
  + Implement bidding, orders and assignment of plans

2) Organization structures

a. DRVN State management organization

- Planning and Investment Department
- Financial Department
- Traffic Safety Department (Reformed)
- Road Management & Maintenance Department
- Science, Technology, Environment and International Cooperation Dept.
- Transportation Department (Reformed)

2 Prime Minister(s Decision, No.107/2009/QD-TTg dated on 26th August 2000, on "To Promulgate Function, Duty, Authority and Organization Mechanism of Directorate for Roads of Vietnam under Ministry of Transport"

- Vehicle and Driver Management Department
- Personnel & Organizing Department
- Legal and Inspection Department (Reformed)
- Administration Office
- Road construction & Management Bureau
- Expressway management Bureau
- Road Management Bureau I (RRMB I, Reformed)
- Road management Bureau (RRMB II, Reformed)
- Road management Bureau (RRMB III, Reformed)
- Road Management Bureau (RRMB IV, Reformed)

b. Non-business Units under DRVN

- Northern Transport Intermediate School
- Southern Transport Intermediate School
- Road Mechanical Vocational School
- Vietnam Road magazine
- Road Technical Center

c. Road Management Bureau (RRMB)

Position, Functions duty and authority for RRMBs are stipulated in the DRVN Decisions shown below;

- Decision No. 2173/QD-TCDBVN dated on 10th December 2013 for RRMB I
- Decision No. 2174/QD-TCDBVN dated on 10th December 2013 for RRMB II
- Decision No. 2175/QD-TCDBVN dated on 10th December 2013 for RRMB III
- Decision No. 2176/QD-TCDBVN dated on 10th December 2013 for RRMB IV

The above decisions has stipulated that RRMB is the subordinate of DRVN and is functioned in state management in road transportation and management, maintenance and operation of national highway systems in the specified area for each RRMB. RRMB has legal status, own stamp and account in local State treasury.

A total of four (4) RRMBs, including RRMB I, RRMB II, RRMB III and RRMB IV, have been founded, following Decision 60. Major tasks, authorities of RRMB are shown below;

- Participating in formulation of Long term, 5-year, annual planning, plans, programs, projects, proposal on road transportation in its jurisdiction; Regulations, standards, codes, economical-technical norms on management, maintenance and operation of road infrastructures.
- Implementing and conducting inspection on compliance of regulations, policies, mechanism, national programs, planning, plans, projects in road transportation in their management area; conduct dissemination and trainings on legal documents on road transportation.

- Conducting management, protection of infrastructures and conducting traffic organizing in highway sections that are assigned to its jurisdiction.
- To conduct maintenance and operation of road facilities in assigned highway sections.
- Regarding highway system which is delegated to Localities: To cooperate with PDOTs in planning and managing highways and in case of disaster, and conduct inspection on Localities' maintenance.
- Regarding local traffic: To compile and report to DRVN on status of road infrastructure and road development in the region;
- Regarding construction investment management of road infrastructures: To act as POs in road construction projects as decentralized, delegated by DRVN; and acts as supervisor level in BOT, BT, BTO, PPP projects.
- Regarding management of transportation, vehicles and drivers: To conduct management on vehicles, specific vehicles; trainings, examinations, issuance of driving license as decentralized, delegated by DRVN.
- Regarding road traffic safety: To conduct disseminations on traffic safety; guidance and inspection on implementation of traffic safety measures in regional highways;
- To conduct inspection, supervision on environment protection in road construction projects, road maintenance projects in the region as decentralized, delegated by DRVN.
- To conduct application of advanced science and technology transfer in road transportation; to develop and maintain website of the Bureau.
- To conduct inspectorate tasks in the jurisdiction against organizations, individuals who violate regulations on protection of road infrastructures; to deal with complaints and denunciations, anti-corruption…
- To manage the organization, personnel, and to use staffs as regulated; to conduct payment, policies, reward, disciplining, trainings; to manage Bureau's subordinates as delegated by Director General of DRVN.
- To manage assigned assets, finance; to manage allocated state budgets as regulated and as delegated by DRVN. To directly manage, settle the road assets in highway sections (inclusive of infrastructure assets delegated to Localities.

3) Road Management Sub-bureau under RRMBs

MOT Decision3 No.4038/QD-BGTVT dated on 9th December 2013 has stipulated that Road Management Sub-bureau is an administrative agency under regional RRMB, implementing state management function on road and management organization, maintenance, protection of assigned national highway. RRMB has legal status, own stamp and account in local State treasury where the RRMB locates.

A total of twenty six (26) sub-bureaus have been founded, following Decision 4038.

3 Decision No.4038/QD-BGTVT dated on 9th December 2013 on "Establishing Road Management Sub-bureau under Regional Road Management Bureau I, II, III and IV – DRVN".

- Eight (8) sub-bureaus under RRMB I
- Six (6) sub-bureaus under RRMB II
- Five (5) sub-bureaus under RRMB III
- Seven (7) sub-bureaus under RRMB IV

Major tasks, authorities of Road Management Sub-bureau are shown below;

- Management, protection of infrastructures of assigned national roads
- To monitor technical status of road works; to update technical status into road database
- To check, supervise, monitor and accept road routine maintenance and repair of Road maintenance Units
- To implement road patrol works in accordance with regulations of MOT
- To assist Director of Regional road management Bureau to implement specific inspection to protect infrastructure on assigned national roads
- To directly instruct road maintenance units to overcome road and bridge problem, to ensure traffic as road and bridge problem or natural disaster happens
- To manage and preserve backup material warehouse to ensure traffic; to implement coordination work for road salvage.
- The General Director of DRVN shall regulate in details about tasks, authorities and management scope of sub-bureaus on national roads under Regional road management bureau I, II, III and IV.

8.2.4 Overseas practices – Practices in Japan

(1) Road Classification and Management Organization

Road networks in Japan comprise expressways, national highways, prefecture roads and municipal roads, 1,271 thousand kilometers in total according to Road and Traffic Census survey conducted in 2010. **Table 8.2.1** shows road classes and management organizations.

Table 8.2.1 Road Classification in Japan

Class	Length (km)	Operators
Expressways	9,208	● East Nippon Expressway Company Ltd. ● Central Nippon Expressway Company Ltd. ● West Nippon Expressway Company Ltd. ● Honshu-shikoku Bridge Expressway Company
National Highways	67,298	・ Designated sections Ministry of Land Infrastructure, Transport and Tourism (MLIT) ・ Other sections Prefectural Government
Prefecture Roads	142,369	Prefectural Governments
Municipal Roads	1,052,699	City/Town/Village Government
Total	1,271,572	

(Source) MLIT data, from Road and Traffic Census 2010

(2) Characteristics of Road Development in Japan

Some of the notable features of road development in Japan are listed below. Detail of these features is explained hereinafter in the following paragraphs.

- Road development financed by special account
- Principles of national highway construction and maintenance
- MLIT strong leadership in road development
- Development of technical standards through cooperative study with professional organizations
- Technical support and human capacity development to regional governments

(3) Road development finance by special account

a. Establishment

Special account for road development in Japan was established in 1953 with the promulgation of Act on State's Special Financial Measures on Road Construction and Improvement Projects. The special account is based on the beneficiary pays principle, saying that road users who receive benefits from road development should assume part of road development costs. It has contributed to supporting the socio-economic growth in Japan over 50 years since its establishment

b. Fund source

The source of the account consists of Gasoline Tax, Liquefied Petroleum Tax and Automobile Weight Tax which are the national taxes, and Diesel Oil Delivery Tax and Automobile Acquisition Tax which are the regional taxes. Total amount of tax incomes in 2007 is about 56 billion USD comprising 34 billion USD of national tax income and 22 billion USD of regional tax income (1 USD = 100 JPY) .

c. Schemes financed by the special account

Most of the financial support is directed to road development in Japan, but the support has been expanded to other schemes deemed relevant to road network improvement in recent years, as shown below.

- Flyover and underpass construction crossing rail transportation
- Installation of optical fiber cable along roadways
- Construction of common underground utility ducts
- Maintenance of roadside planting
- Subsidy for the procurement of Diesel Particulate Filter equipment
- Installation of ETC lanes
- Subsidy for lease contract of ETC on-board unit
- Construction of underground parking facility
- Construction of underground shopping centers
- Other relevant improvement

d. Terminate its role and transfer to General Account

In April 30th in 2009, the Act on State's Special Financial Measures on Road Construction and Improvement Projects was revised and this special account was abolished. However, its funding raising system was transferred to the General Account.

(4) Principles of National Highway Construction and Maintenance

National highways in Japan fall into two sections; designated sections, 41% of all national highways in length, and non-designated sections, 59%. Maintenance and operation for the designated sections are done by MLIT and those for the non-designated sections are done by regional governments, i.e. prefectures. Each section is defined as follows;

a. Designated sections (Refer to Figure 8.2.2)

- National highways forming area-wide arterial road networks together with expressway networks.
- National highways playing an important function in linking important cities.
- National highways linking urban areas with important transportation facilities including sea ports and airports.

b. Non-designated sections

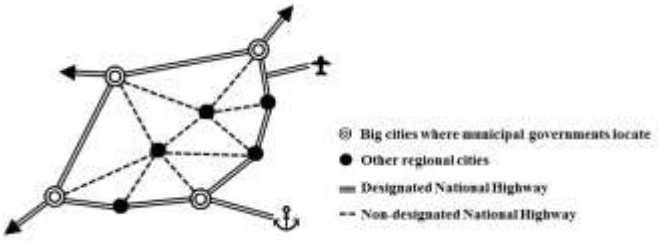
- National highways playing an role in linking regional cities
- National highways linking to the designated national highway networks.

Table 8.2.2 shows the difference in financial responsibilities between MLIT and prefectures. Maintenance fees for non-designated sections, except for repair costs, need to be borne by prefecture budget in principle.

Table 8.2.2 Financial Responsibilities for National Highway management

Class	Length (km)	Financial responsibility for national highway management
Designated sections	26,691 (41%)	■ **New construction** MLIT bears 2/3 of the construction cost. Prefectural government bears 1/3 of the construction cost. ■ **Maintenance and repair** MLIT bears 55% of the maintenance and repair cost. Prefectural government bears 45% t (42 %) of the maintenance and repair cost.
Non-designated sections	39,606 (59%)	■ **New construction** MLIT bears 1/2 of the construction cost. Prefectural government bears 1/2 of the construction cost ■ **Maintenance and repair** MLIT bears 1/2 of the repair cost. Prefectural government bears 100% of the maintenance cost and 1/2 of the repair cost.
Total	67,298 (100%)	

(Source) MLIT data, from Road and Traffic Census 2010



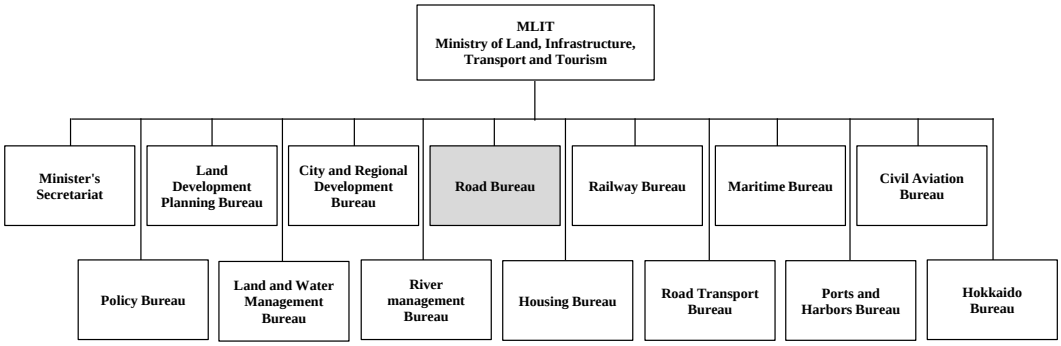
(Source) Produced by Project Team

Figure 8.2.2 Designated National Highway Network

(5) MLIT Strong Leadership in Road Development

1) MLIT Organization Structure

MLIT is a huge organization governing 13 bureaus as illustrated in **Figure 8.2.3**, which is responsible for many infrastructure management including land development, water, rivers, roads, housings, railways, road transport, maritime, ports and harbors, civil aviation. Road Bureau is one of these bureaus.



(Source) Homepage, MLIT

Figure 8.2.3 Bureaus at the MLIT headquarters

2) Road Bureau - Headquarters

Road Bureau is responsible for road administration of all road networks in Japan, where there are seven (7) divisions under its responsibility. Major responsibilities of the bureau include drafting of regulations for road administration, planning of policies and long-term plans, preparation of technical standards for design and construction, preparation of cost norms and so forth. In other words, Road Bureau plays a role similar to the Decision Maker in Vietnam. Further information is shown in **Table 8.2.3**. Of these divisions in the road bureau, Planning Department plays a coordination role in the bureau as a representing division in the bureau.

Table 8.2.3 Responsibilities of Road Bureau

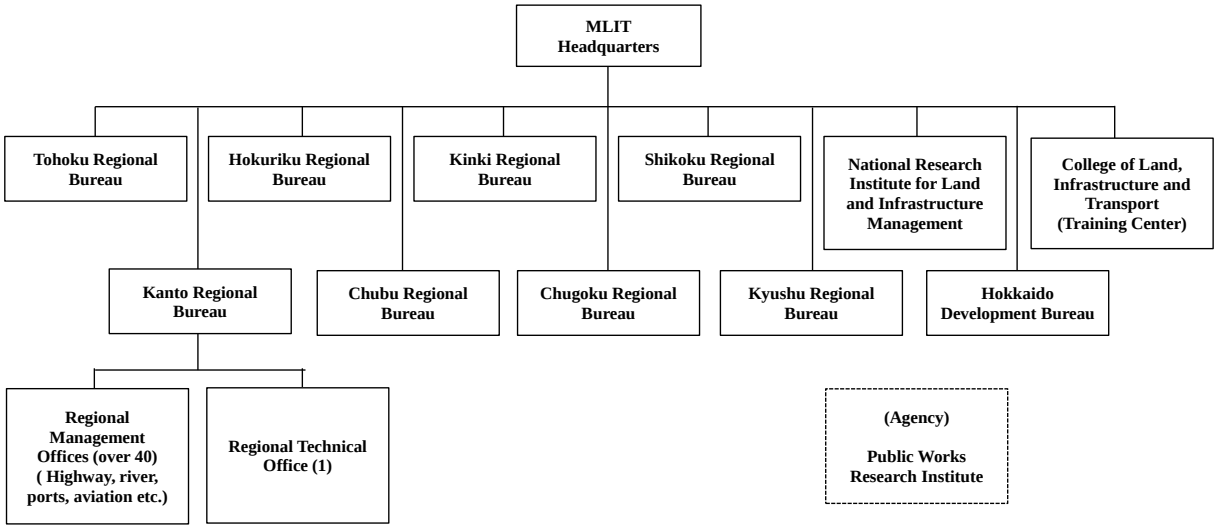
Divisions	Major Responsibilities
General Affairs Division	a. Overall coordination on the business procedures in the Road Bureau
	b. Planning of policies and long-term plans for road development, management, operation.

Divisions	Major Responsibilities
	c. Others
Road Administration Division	a. Draft regulations for the road bureau.
	b. Administration supervision
	c. Planning of road network standards and expressway road network including designation of expressways and national highways.
	d. Others
Road Traffic Control Division	a. Planning of traffic control policies.
	b. Planning of information technology for road development
	c. Others
	d. Traffic safety of the designated sections of national roads,
Planning Division	a. Planning of national highway development plans.
	b. Development road standards for design and construction
	c. Development of cost norms
	d. Others
National Highway and Risk Management Division	a. Administration of expressway and national highway development
	b. Planning of road disaster prevention and restoration plans and maintenance plans.
	c. Others
Environment and Safety Division	a. Planning of policies for road environment protection and traffic safety strategies.
	b. Designation of regional roads under the heavy snow region special measure law.
	c. Others
Expressway Division	a. Planning of expressway development policies.
	b. Technical examination for the approval of implementation plans on expressway development issued by the Japan Expressway Holding and Debt Repayment Agency
	c. Others

(Source) Decree No.255 on MLIT Organization, June 7, 2012

3) MLIT Regional Bureaus

As seen in **Figure 8.2.4,** under the headquarters of MLIT, there are eight (8) regional bureaus, a research institute (National Research Institute for Land and Infrastructure Management) and a training center (College of Land, Infrastructure and Transport). Also, under each regional bureaus, there are regional infrastructure management offices for highways, river, ports and civil aviation, and a regional technical office.



(Source) Homepage, MLIT

Figure 8.2.4 MLIT Organization Structure

a. Responsibilities

Decision Maker's role is given to the road bureau in the MLIT headquarters, likewise regional bureaus play a role of Project Owners. Many responsibilities in infrastructure development are delegated to the regional bureaus, so that regional bureaus in general is responsible for conducting surveys, designs and F/S, selecting contractors, signing contracts with contractors and consultant and conducting construction work supervision.

b. Divisions

In order to perform these responsibilities, each of the regional bureaus installs four (4) departments including Administration Department, Planning Department, Road Department, Construction Management Department, and River Management Department, regional offices for highways/rivers/ports/civil aviation management and a regional technical office under the bureau. **Table 8.2.4** shows major responsibilities for these departments.

Table 8.2.4 Responsibilities of Regional Bureaus

Department	Divisions under Department	Major Responsibilities
Administration Dept.	a. Personnel Division b. Administration Division c. Accounting Division d. Procurement Division e. Welfare Division	a. Personnel management b. Administration and information management c. Budgets and expense management d. Bidding and contract management e. Staff welfare management
Planning Dept.	a. Planning Division b. Area Planning Division c. Risk Management Division d. Engineering	a. Overall management of public works planning b. Coordination in public work planning between central and regional plans c. Planning of disaster countermeasures against road facilities and restoration works.

Department	Divisions under Department	Major Responsibilities
	Management Division e. Engineering Survey Division f. Construction Work Planning Division g. Information and telecommunication Technology Division	d. Improvement of cost estimate standards. Inspection of construction works. Examination of bidding results.
		e. Survey on the market prices of construction materials and labor forces, and survey on the recycling of construction and waste materials.
		f. Planning, inspection, maintenance and development of design standards for mechanized construction works and operator capacity enhancement
		g. Planning, design, construction supervision and inspection of electric and electronic facility
Road Dept.	a. Road Administration Division b. Road Planning Division c. Regional Road Division d. Road Construction Division e. Road Maintenance and Operation Division f. Traffic Management Division	a. Administration national roads
		b. Planning of national road maintenance and environment protection
		c. Coordination on the planning and maintenance of regional roads (Prefecture, city, etc.)
		d. Implementation design, supervision and inspection on the designated sections of national roads
		e. Maintenance and operation of the designated sections of national roads.
		f. Traffic safety of the designated sections of national roads,
Construction Management Dept.	a. Planning Management Division	a. Management of city planning and urban development projects
	b. Construction Industry Division	b. Management of procedures for Construction Business Law
	c. Urban Development Division	c. Management of urban development projects
	d. Housing Development Division	d. Management of housing projects
	e. Construction Safety Division	e. Management of construction safety measures
Description about River Management Department and Land and Right-of-Way Department is omitted.		

(Source) Circular No.21 on the organization of regional development bureaus in MLIT, January 6th, 2001

4) MLIT national highway office

Highway offices are located under MLIT regional development bureaus consisting of eight (8) bureaus nationwide.

a. Responsibilities

Major responsibilities of national highway offices under MLIT regional development bureaus are to supervise survey and planning, maintenance and repair works, rehabilitation and new construction of the designated sections of national highways.

b. Divisions

Table 8.2.5 shows an organization structure of representing national highway offices. An example of this office has explained that about 80 staff, consisting of 45 engineers and 35 administrators, are stationed in the North Kyusyu National Highway Office.

Table 8.2.5 Responsibilities of National Highway Offices (MLIT)

Division	Major Responsibilities
Administration Division	Staff management (Salary, social welfare, etc.)
Accounting Division	Budget management, contract management, procurement of equipment, management of national assets
Land Procurement Division	Procurement of lands for public works including compensation
Engineering Division	Planning, design, cost estimate and contracts of public works
Survey Division	Survey and planning of public works
Maintenance Division	Survey, planning and contract for road maintenance and repair work and planting projects
Traffic management Division	Survey, planning and contract of traffic safety measures. Information gathering of road traffic. Approval of special vehicles

(Source) MLIT Homepage

5) MLIT regional technical office

Regional technical offices are located under MLIT regional development bureaus. In principle, there is only one regional technical office under each regional development bureau.

a. Responsibilities

Major responsibilities of the regional technical office include the following: Information shown below is referred in the homepage posted by the Kyusyu Technical Office under the MLIT Kyusyu Regional Bureau.

- Implementation of surveys and pilot studies on the improvement of work execution technologies
- Implementation of surveys and pilot studies on the improvement of machineries and machinery repair works.
- Implementation of surveys and experiment on the material resource of public works
- Information gathering of public work technologies
- Implementation of training programs including those for public work machine operation (Planning of training programs are excluded)
- Coordination on the mobilization of machineries for disaster restoration works.

Concrete tasks given to the regional technical offices are shown below;

- Supervision of pavement condition surveys
- Tracking and information collection of pavement performance for revising technical standards and for deciding pavement maintenance service levels.
- Follow-up study on road pavement deterioration and on evaluation indexes
- Implementation of bridge status surveys
- Data evaluation and update of road inventory databases.

b. Divisions

- Administration Division

- Accounting Division
- Disaster Protection and Technology Division
- Public Work Execution and Survey Division
- Quality Survey Division

6) Research Institute - National Institute for Land and Infrastructure management (NILIM)

a. Responsibilities

The National Institute for Land and Infrastructure Management (NILIM) was founded April 2001 as a national research and experimental institute that performs technological policy research etc. work that must be performed directly by the national government, and is a part of MLIT. It plays a role of bridging research and policy regarding land and infrastructure management, performing the following comprehensive surveys, testing, research, and development concerning the planning and drafting of policies regarding infrastructure management.

(1) Enactment of technical standards by joint research (Refer to **Figure 8.2.5**)

Research and development concerning the enactment of technical standards in conformity with laws and regulations

(2) Policy support to MLIT

Research and development R&D to help propose policies and draft policies

(3) Technical support to MLIT regional development bureaus

Technical guidance with research and development necessary for project implementation and management for MLIT and for regional public bodies.

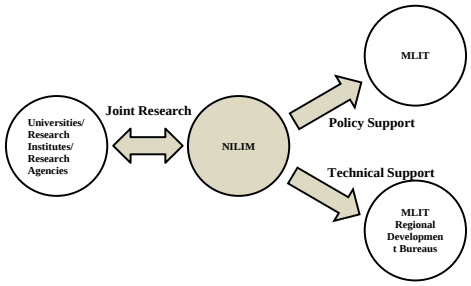


Figure 8.2.5 Responsibilities of NILIM

(Source) Homepage, National Institute for Land and Infrastructure Management (NILIM)

b. Organizations

Figure 8.2.6 illustrates the organization structure of NILIM.

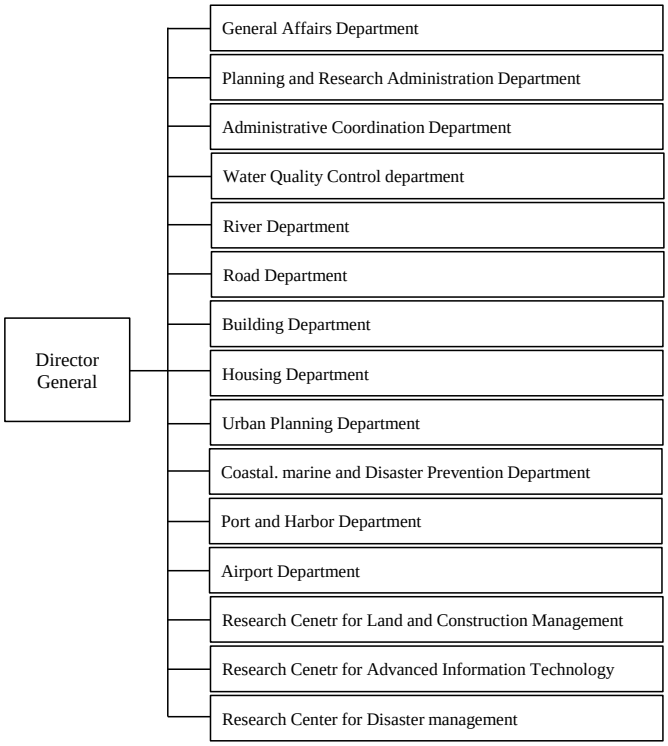


Figure 8.2.6 NILIM Organization

(Source) Homepage, National Institute for Land and Infrastructure Management (NILIM)

7) Research Agency - Public Works research Institute (PWRI)

a. Responsibilities

In 2001, as part of administrative reforms, PWRI and the Civil Engineering Research Institute of Hokkaido were established as Incorporated Administrative Agency, and then in 2006, the two organizations were merged and begun anew.

NILIM performs surveys, research and technology development closely linked to MLIT infrastructure management. On the other hand, PWRI performs survey, research and technology development which private-sectors hardly tackle, but are deemed beneficial for public. There are many Joint research works with NILIM.

b. Organizations

Figure 8.2.7 shows an organization structure of PWRI.

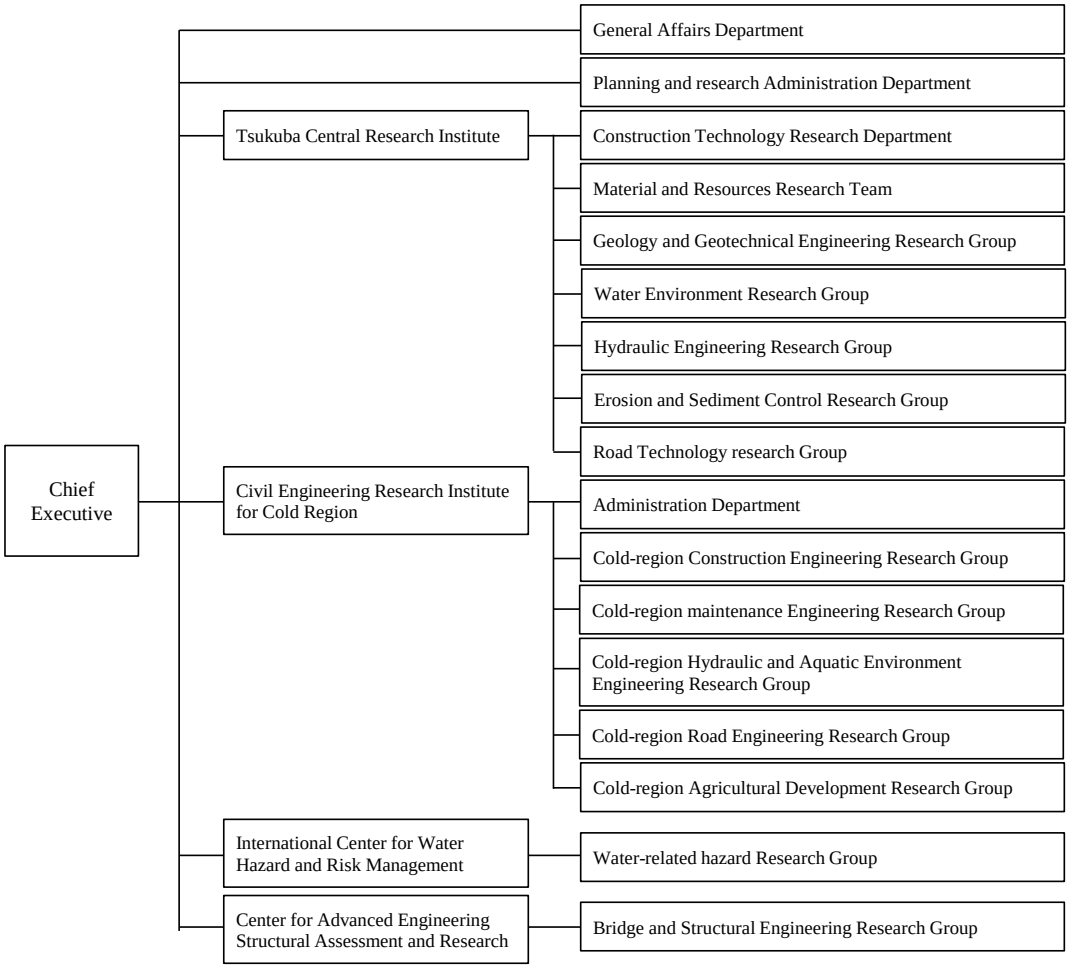


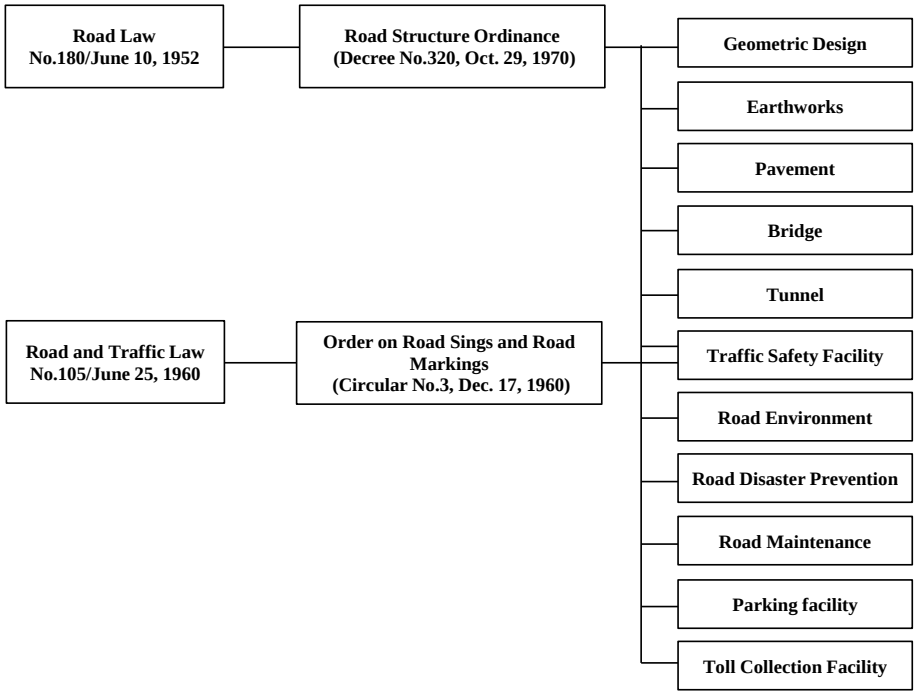
Figure 8.2.7 PWRI Organization

(Source) Homepage, Public Works research Institute (PWRI)

8.2.5 Development of Technical Standards through Cooperative Study with Professional Organizations

(1) Framework of technical standards

Figure 8.2.8 illustrates a framework of road technical standards developed by MLIT. There are two major laws stipulating roads and traffic in Japan; Road Law and Road and Traffic Law. Technical standards under Road Law stipulate details of major road structures.



(Source) MLIT homepages

Figure 8.2.8 Framework of MLIT Road Technical Standards

Table 8.2.6 shows major technical standards including guidelines which are currently applied for survey, planning, construction and maintenance of MLIT public works. As seen in the table, technical standards are in general promulgated by the names of Director General of bureaus or Directors of relevant divisions in MLIT. Also, technical standards are followed by guidelines which stipulate interpretation and details of technical standards. Guidelines are in principle published by the name of the Japan Road Association which is a public foundation whose establishment was approved by MLIT.

Table 8.2.6 Major Technical Standards and Guidelines – MLIT in Japan

Field	Category	Name	Publisher
Geometric design	Standard	Standards on standard road widths , 1975	D_City Planning Division, D_Planning Division
	Standard	Design standard for motorcycle roads, 1974	DG_City Planning Bureau DG_Road Bureau
	Guideline	Guideline on Design standard for motorcycle roads, 1974	JRA
	Standard	Standards on pedestrian pass general structures, 2005	DG_City & Regional Development Bureau DG_Road Bureau
Road earthworks	Guideline	Guideline for road earthworks, 2009	JRA
	Guideline	Guideline for road earthworks – Embankment, 2010	JRA
	Guideline	Guideline for road earthworks - Cut slope/slope stabilization, 1999	JRA
	Guideline	Guideline for road earthworks – Retaining wall , 1999	JRA
	Guideline	Guideline for road earthworks – Culvert, 2010	JRA
	Guideline	Guideline for road earthworks – Soft ground countermeasures, 1986	JRA
	Guideline	Guideline for road earthworks – Temporary facilities,	JRA

Field	Category	Name	Publisher
		1999	
	Guideline	Design guideline for common utility ducts, 1986	JRA
Road pavement	Standard	Technical standards on pavement structures, 2001	DG_City & Regional Planning Bureau DG_Road Bureau
	Guideline	Guideline on technical standard on pavement structures, 2001	JRA
	Guideline	Guideline for pavement design and work execution, 2006	JRA
	Guideline	Guideline for pavement performance evaluation, 2006	JRA
	Guideline	Guideline for pavement design, 2006	JRA
	Guideline	Guideline for pavement construction works, 2006	JRA
	Guideline	Guideline for pavement recycling, 2010	JRA
	Guideline	Guideline for pavement survey and laboratory tests, 2007	JRA
	Guideline	Guideline for asphalt mixing plant, 2006	JRA
Bridges	Standard	Technical standards for bridges and viaducts, 2012	DG_City Planning Bureau DG_Road Bureau
	Guideline	Bridge design guideline - Common edition, 2012	JRA
	Guideline	Bridge design guideline - Metal bridge edition , 2012	JRA
	Guideline	Bridge design guideline - Concrete bridge edition, 2012	JRA
	Guideline	Bridge design guideline - Substructure edition, 2012	JRA
	Guideline	Bridge design guideline - Earthquake resistant design edition, 2012	JRA
	Standard	Technical standards for bridges and viaducts, 1984	D_City Street Division, D_Planning Division
	Guideline	Design guideline for small suspension bridges, 1984	JRA
	Guideline	Design guideline for road concrete bridges, 1994	JRA
	Guideline	Construction guideline for road concrete bridges, 1998	JRA
	Guideline	Design guideline for steel bridges, 1980	JRA
	Guideline	Construction guideline for steel bridges, 1985	JRA
	Guideline	Fatigue design guideline for road steel bridge, 2002	JRA
	Guideline	**Guideline for paint and corrosion control for steel bridges, 2005**	JRA
	Guideline	Design and construction guideline for pre-stressed concrete T-girder bridges employing precast concrete , 1992	JRA
	Guideline	Guideline for road bridge expansion joints, 1970	JRA
	Guideline	Guideline for road bridge shoes, 2004	JRA
	Guideline	Design guideline for pile foundation, 2007	JRA
	Guideline	Construction guideline for pile foundation, 2007	JRA
	Guideline	Construction guideline for steel plate foundation, 1997	JRA
	Guideline	**Maintenance guideline for road bridges, 1979**	JRA
	Guideline	Wind-resistant design guideline for road bridges, 2008	JRA
	Guideline	Water-proof design guideline for road bridges, 2007	JRA
Road tunnels	Standard	Road tunnel technical standards, 1989	D_City Street Division, D_Planning Division
	Guideline	Guideline for road tunnel – Ventilation facility, 2008	JRA
	Guideline	**Maintenance guideline for road tunnel, 1993**	JRA
	Guideline	Survey and measurement guideline for road tunnel, 2009	JRA
	Guideline	Safety construction guideline for road tunnel, 1996	JRA
	Guideline	Design and construction guideline for shield tunnel, 2009	JRA
	Standard	Design and construction standard for road emergency facility, 1999	D_City Street Division, D_Planning Division
	Standard	Standard specification for road tunnel emergency facility, 1967	D_Planning Division
	Standard	Standard specification for road tunnel emergency facility (Alarm), 1968	D_Planning Division
	Standard	Countermeasures to prevent vehicle fire accidents in road tunnel, 1979	DG_Road Bureau
Traffic safety facilities	Standard	Design and construction standard for road signs, 1986	DG_City Planning Bureau DG_Road Bureau
	Guideline	Guideline for design and construction standard for road signs, 1987	JRA

Field	Category	Name	Publisher
	Standard	Standard for road traffic safety facilities, 1965	DG_City Planning Bureau DG_Road Bureau
	Standard	Standard for road marking formats, 1974	D_City Street Division, D_Planning Division
	Standard	Standard for the display of regional names on road signs, 2005	D_City Street Division, D_Planning Division
	Standard	Standard for foundation of road miscellaneous facilities, 1975	D_Planning Division
	Standard	Technical standard for grade separation facility, 1978	DG_City Planning Bureau DG_Road Bureau
	Guideline	Guideline for technical standards for grade separation facility, 1979	JRA
	Standard	Technical standard for design and construction of guardrail facility, 2004	DG_Road Bureau
	Guideline	Guideline of technical standard for design and construction of guard rail facility, 2008	JRA
	Standard	Technical standard for guardrail performance tests, 1998	D_Road Environment Division
	Standard	Technical standards for vehicle guardrail standard specifications, 1999	D_Road Environment Division
	Guideline	Guideline for technical standards for vehicle guardrail standard specifications, 2004	JRA
	Standard	Technical standard for design and construction of road lighting facilities, 2007	DG_City Planning Bureau DG_Road Bureau
	Guideline	Guideline for technical standard for design and construction of road lighting facilities, 2007	JRA
	Standard	Technical standard for design and construction of delineators, 1984	DG_City Planning Bureau DG_Road Bureau
	Guideline	Guideline for technical standard for design and construction of delineators, 1984	JRA
	Standard	Technical standard for road information display facilities, 1972	D_Planning Division
	Guideline	Guideline for design and construction of convex mirrors, 1980	JRA
	Standard	Technical standard for raised paving blocks for the visually impaired, 1985	D_City Street Division, D_Planning Division
	Guideline	Guideline for technical standard for raised paving blocks for the visually impaired, 1985	JRA
Road environment	Standard	Standard for environmental assessment for road projects, 2006	DG_Road Bureau
	Manual	Manual for road environment protection, 1999	JRA
	Standard	Standard for right-of-way acquisition and management for road environment protection, 1974	DG_City Planning Bureau DG_Road Bureau
	Standard	Standard for road planting, 1988	DG_City Planning Bureau DG_Road Bureau
	Guideline	Guideline for standard for road planting, 1988	JRA
Road disaster prevention	Guideline	Guideline of snow protection for road facility, 1990	JRA
	Guideline	Guideline for countermeasures against earthquakes (Disaster preparation and restoration), 2006	JRA
	Guideline	Guideline for falling stone countermeasures, 2000	JRA
Road maintenance	Standard	Implementation standard of road maintenance for designated national highways, 1962	DG_Road Bureau
	Standard	Standard for road maintenance and repair works, 1962	DG_Road Bureau
	Guideline	Guideline for road maintenance and repair works, 1978	JRA
	Standard	Technical standard for road marking applied to road construction sites, 2006	DG_Road Bureau
Parking facility	Standard	Design and construction standard for parking facilities, 1992	D_Planning Division

Field	Category	Name	Publisher
	Guideline	Guideline for design and construction standard for parking facilities, 1992	JRA
	Standard	Standard of road occupancy for parking facilities, 1992	D_Road Administration Division
Toll collection facility	Standard	Design and construction standard for toll collection facilities, 1999	DG_Road Bureau

(Source) Homepage, Kyushu Regional Bureau, MLIT
(Note) DG: Director General, D: Director, JRA: Japan Road Association

1) Standardization

As seen in the table, specifications for survey, design and construction works are all standardized and commonly used at all level of MLIT organizations.

2) Regional governments

In addition, regional governments have authority to develop their own technical standards, however, they in general follow MLIT technical standards and apply them to their own public works with minor customization.

3) Development bodies

MLIT technical standards have been in general developed through cooperative studies between engineering departments at all levels of the MLIT organization, research institutes and Japan Road Association. Research institutes include National Institute for Land and Infrastructure Management (NILIM), Public Works Research Institute (PWRI). NILIM belongs to MLIT and PWRI and BRI are affiliated agencies under the supervision of MLIT. Various technical committees are in general organized with participation of academics and experts from external professional organizations in order to exchange views on the draft standards. In particular, JRA plays an important role in organizing such committees and developing technical standards.

(2) Development of Technical Standards by Japan Road Association (Public Foundation)

1) Background of foundation

Japan Road Association (JRA) is a public foundation approved by MLIT and was founded in 1947. JRA has contributed to the development of road and traffic in Japan through various activities over the past 60 years, keeping pace with rapid socio-economic development in Japan.

2) Objectives

JRA supports road administration in Japan by disseminating knowledge and technologies needed for road administration, thereby contributes development of road and traffic in Japan.

3) Membership

RS memberships are: (1) individual members, (2) special members consisting of regional governments, business organizations and other organizations and (3) honorary members. The number of the membership is about 7,000 in total.

4) Financial source

Membership fees and business commitment from public organizations

5) Activities

The following are major activities;

- Coordinate road conference
- Hold road seminars and training courses
- Conduct researches by technical committees
- Publish technical standards, guidelines and manuals
- Library
- Publicity and campaign

a. Researches by technical committees

JRA installs eight (8) technical committees in the organization, consisting of academics and experts from universities, research institutes and other professional engineering entities. The committees are listed below. The technical committees conduct research works on the practical technical standards, guideline and manuals needed for road construction, maintenance and operation. The results of the research works are published to the public.

- Traffic engineering technical committees
- Bridge technical committee
- Pavement technical committee
- Road Earthworks technical committee
- Tunnel technical committee
- Road Earthquakes technical committee
- Road maintenance and repair work technical committee
- Library committee

b. Technical standards published by JRA

As an activity, JRA published 87 technical standards including guidelines, manuals and handbooks edited based on the research works by the technical committees. **Table 8.2.7** shows the list of publications currently released by JRA.

Table 8.2.7 Technical standards published by JRA

Field	Technical Standards (including Guidelines/Manuals/Handbook)	The number of publications
Traffic engineering	Design and construction standards for bicycle lane, at-grade inter sections, road lighting, delineator, traffic sign, planting, delineators, blocks for visually impaired, parking lots, toll collection facilities, guardrails and others	13
	Guideline for Road structure ordinance	1
	Traffic volume manual	1
	Clothoid pocketbook	1
	Reference guide on converting technical standards into SI units	2
	Traffic engineering reference book	3

Field	Technical Standards (including Guidelines/Manuals/Handbook)	The number of publications
Bridge	Design and construction standards for bridge superstructure, sub structures, foundations, earthquake resistant design. Structural fatigue	20
	Case studies for reinforcing bridge structures	1
	Bridge annual reports	4
	Handbook for bridge shoes, concrete deck water proofing,	2
	Reference material for bridge design and construction	5
Pavement	Design and construction standard for road pavement	2
	Pavement work standard specifications	1
	Handbook for pavement materials, survey and testing, construction methods, asphalt mixture recycling	7
	Guidebook for pavement performance evaluation, porous asphalt pavement	3
Earthworks	Design and construction Guideline for earthworks, slope works, culvert works, embankment works, retaining walls, soft ground treatment, temporary facilities and others.	7
	Design and construction guideline for common ducts	1
	Handbook for snow protection, falling rock prevention facilities and others.	3
Tunnel	Design and construction technical standards for road tunnel structures, ventilation systems, monitoring systems, emergency facilities, and others	6
	Guideline for safe tunnel construction	1
Road Disaster	Handbook for road disaster prevention	3
	Total	87

(Source) From JRA homepage information, August 2013.

8.2.6 Assessment of Institutions for National Road Maintenance

Brief assessment of the institutional issues for DRVN national road maintenance was conducted before issuing recommendations in the next section of this report.

(1) Reform of institutions

An institutional reform plan is now in progress in DRVN, so that DRVN institutions including headquarters and regional organizations have been strengthened step by step in these years. However, there is a concern that the number of staff is not proportionate to the national road length; about 228 staff for DRVN Headquarters and another 664 staff for regional bureaus including sub-bureaus, which are deemed not to meet the requirement for national road maintenance and management. DRVN is advised to review current staff assignments to comply with the requirements for national road maintenance and management.

(2) Review of business methods

In order to enhance business efficiency, in particular under the limited number of staff, it is important to integrate business functions as much as possible, eliminate barriers in information exchange between departments and systematize labor intensive woks. Currently, when new a project arises, a temporary PMU is in general established and allowed to hire an appropriate number of staff to conduct management of this project. However, under this system, it is hard to accumulate management technologies to existing DRVN organizations, since PMU will be dispersed upon completion of projects. It is therefore recommended to reduce the number of PMU use as much as possible and make best use of existing departments to conduct management.

This could accumulate management technologies to the existing departments and enhance their management capacity.

(3) Enhancement of planning capacity

Planning of road maintenance plans is a very important responsibility for DRVN headquarters to stabilize investment in the long course of road maintenance. However, due to the lack of planning system tools, low reliability of databases and shortage of qualified staff in operation, a DRVN planning function does not function well, so that DRVN is advised to take immediate actions to develop a database system and a planning system, and enhance staff capacity through training programs.

(4) Development of Road asset database

DRVN is now tackling computerization of databases and expansion of internet use in its business domain in line with the Government's E-Document policy. Although deployment is strongly urged in DRVN, DRVN has set out its development and is now standing at the starting point in system development. In fact, practices of foreign countries have also explained that it takes a long time to develop database systems, so that DRVN is kindly advised to take a step-by-step action to the goal of development. Upon completion of database format development and data input system development in the Project, DRVN is kindly advised to study the following; (1) review of priority data, (2) responsible organization for data validation, (3) data validation methods, and (4) Database operation system. It is important to develop database systems under the supervision of professional departments until their development is totally settled and until they can be transferred to Information Center for operation.

(5) Enhancement of R&D capacity

It is beneficial to apply advanced technologies to the national road maintenance and management. However, current status survey has reported that DRVN R&D function has not functioned well, so that priority has been placed on purchasing technologies rather than developing technologies. However, it is known that direct application of market technologies, such as road asset databases and maintenance planning systems, is in general very hard in the field of road maintenance and management. Requirement of new technology development, customization of existing technologies, system update etc. are needed any time, which may require R&D capacity enhancement for DRVN.

(6) Enhancement of training functions

According to the current status survey, advanced technologies have been already introduced to the national road management in Vietnam, such as a PMS database system, a maintenance planning system and a bridge registration system, up until recently since the year 2000. However, the lack of training opportunities to the DRVN staff made them difficult to fully use these advanced technologies.

(7) Development of road facility inspection standards

Road facility inspection is an important responsibility among road maintenance activities, playing an important role in detecting defects and deterioration of road facilities. However, road inspection has yet to be institutionalized as a regular activity of road maintenance in the routine maintenance standards. Also, guidelines for road facility inspection have not been well prepared. It is therefore recommended to immediately institutionalize road facility inspection as a regular inspection and develop guidelines for inspection as early as possible based on the inspection guideline developed in the Project.

(8) Review of responsibility assignment between DRVN organizations

Of many inspection facilities, bridge and pavement facilities need advanced knowledge and expertise in implementing inspection and diagnosis, so that it is important to assign qualified professional engineers to these inspections. Current status survey clarified that inspection has been done by general engineers or sometimes by technicians, which may need review of implementation methods.

The Project provides DRVN with a unit of pavement condition survey vehicle equipped with advanced laser censors, so that it is important to assign qualified engineers capable of conducting measurement and analysis of pavement condition data including the maintenance of these equipment.

(9) Review of responsibility assignment between DRVN and PPC DOTs

Currently, national roads under the jurisdiction of Provincial People's Committee (PPC) are managed by Department of Transportation (DOT) under PPC. It is assumed that similar inspection methods to DRVN practices have been applied to the national roads. However, as discussed above, a pavement facility inspection by pavement condition survey vehicle and a bridge facility inspection need to be conducted by qualified professional engineers, so that it is important to review responsibility assignment for inspection and integrate responsibilities to DRVN relevant organizations.

(10) Enhancement of training programs for PPC DOT staff

Field survey conducted to DOTs has clarified that there have been a small number of training opportunities given to DOT staff. Their demand for more training programs is very high.

8.2.7 Recommendation

Based on institutional assessment discussed in the previous section, recommendations were made on the following issues. Details of each recommendation are explained in the following sections.

(1) Recommendation structure

1) Recommendation on Project Product Management

- Overall Project Product Management
- Database Management
- Road Maintenance Planning System (PMS)
- Road Pavement Monitoring System (PMoS)

2) Recommendation on Institutional Capacity Enhancement

- Strengthening of leading department capacity
- Strengthening of planning capacity
- Strengthening of R&D capacity
- Strengthening of training capacity
- Review of responsibility assignment for road inspection survey
- Review of responsibility assignment between DRVN and PPCs
- Establishment of Regional Road Department

(2) Overall Project Product Management

Table 8.2.8 summarized the short-term recommendations on the management, operation, data input, system upgrade and technical support for the outputs produced in this Project. In the table, left is responsible organization for technology development of the products which is the current status underway in this Project. On the other hand, right is a recommended plan of the responsible organization for maintenance, operation, data input, system upgrade and technical support of these products.

Table 8.2.8 Responsible Organizations for Project Product Management

WG	Product	Technology Development during the Project		Maintenance and Operation after the Project		
		Technology Development	Software/DB Development	Supervision of Operation	Data Input	System Upgrade and Technical Support
WG-1	Road Inventory Database	■ Road Infrastructure and Traffic Safety Dept. ・ Science, Technology, Environment and International Dept. ・ Road Maintenance and Management Dept. ・ RRMB I	・ JICA Project Team ・ UTC	■ Road inventory database ・ Road Infrastructure and Traffic Safety Dept. ・ Information Center ■ Pavement condition database ・ Science, Technology, Environment and International Dept. ■ Maintenance history database ・ Road Maintenance and Management Dept.	・ RRMU ・ PDOTs ・ RTCs ・ Sub-bureaus ・ Outsourcing	・ Road Infrastructure and Traffic Safety Dept. ・ University of Transport and Communications (UTC)
WG-2	・ Pavement condition survey	■ Planning and Investment Dept. ・ Science, Technology, Environment and International Dept. ・ Road Maintenance and Management Dept. ・ Financing Dept. ・ Road Infrastructure and Traffic safety Dept. ・ RRMB I	■ Survey and data analysis by JICA Study (PASCO Team)	・ RTC Central	・ RTC Central	・ RTC Central
	・ PMS data set formation ・ Pavement maintenance planning system		■ PMS Data Conversion System ・ JICA Project team ・ UTC ■ Road Maintenance Planning System ・ JICA Project Team ・ UTC ・ Kyoto University ・ PASCO	■ PMS data conversion ・ RTC Central ■ PMS and planning system supervision ・ Planning and Investment Dept. ■ Planning of annual maintenance plans, given PMS data set ・ RRMBs/PDOTs ■ Planning of mid-term maintenance plans, given PMS data set ・ Planning and Investment Dept.	■ Preparation of PMS data set ・ RTC Central	・ RTC Central ・ University of Transport and Communications (UTC)
WG-3	Road inspection manual Routine road maintenance manual	■ Science, Technology, Environment and International Dept. ・ Road Maintenance and Management Dept.		・ Science, Technology, Environment and International Dept.		・ Collaboration with RTCs, ITST, UTC, UTT, VFCEA and VIBRA ・ Hired consultant or IT company.

WG	Product	Technology Development during the Project		Maintenance and Operation after the Project		
		Technology Development	**Software/DB Development**	**Supervision of Operation**	**Data Input**	**System Upgrade and Technical Support**
	Pavement monitoring system (PMoS)	・ Road Infrastructure and Traffic Safety Dept. ・ RRMB I ・ RTC Central ・ RTC 2	■ Pavement Monitoring System (PMoS) ・ JICA Project Team ・ Computer Aided Design & Computer Aided Manufacturing Center (CAD/CAM technology Center) TEL: +84-4-37669856	・ Data conversion from source databases; road inventory DB, Pavement condition DB, Maintenance History DB and Traffic volume DB		・ RTC Central ・ University of Transport and Communications (UTC) ・ Software Company
WG-4	Recommendations on the capacity enhancement plan on maintenance procedures	■ Road Maintenance and Management Dept. ・ Science, Technology, Environment and International Dept. ・ Planning and Investment Dept. ・ Organization and Personnel dept. ・ Transport and Registration Dept. ・ RRMB1 ・ RTC Central		・ Road Maintenance and Management Dept.		
	Recommendations on the capacity strengthening plan for DRVN institutions			・ Planning and Investment Dept. ・ Road Maintenance and Management Dept. ・ Science, Technology, Environment and International Dept. ・ Road Infrastructure and Traffic Safety Dept.		
WG-5	Recommendations on training programs	■ Organization and personnel Dept. ・ Science, Technology, Environment and International Dept. ・ Planning and Investment Dept. ・ Road maintenance and Management Dept. ・ RRMB I ・ RTC Central		・ Organization and Personnel Dept. in cooperation with other DRVN departments, RTC Central and academic institutes.		

(Note) ●: Working Group Leader

(3) Database Management

1) Work Plan for Database System Development

DRVN Road Asset Database to be developed in this Project falls into the following five (5) individual databases. **Table 8.2.9** shows work plans for database development. As seen in the table, task sharing was made between JICA Project Team and DRVN relevant organizations. Database formats for three (3) databases including data input computer systems have been developed by the Project and trial operation of data input into these formats have been made by RRMB I. Referring to the RRMB I comments addressed through this trial operation, the Project has upgraded the data input system step by step.

Table 8.2.9 Work Plans for Database Development

Seq.	Database Type	System Development	Data Input
1	Road Asset Database (Road Inventory database)	Newly developed by WG-1 in Excel Format.	By RRMB I
2	Pavement Condition Database	Newly developed by WG-1 in Excel Format	By RRMB I
3	Maintenance History Database	Newly developed by WG-1 and PASCO in Excel Format	By RRMB I
4	Traffic Volume Database	Modified from DRVN database in Excel Format	Road Infrastructure and Traffic Safety Dept., DRVN
5	General Road Management Database	Developed by DRVN	By DRVN

a. Road Asset Database (Road Inventory Database)

Database formats for road inventory database have been newly developed by the Project Team in cooperation with WG-1. It is known in general that database data input is fairly labor intensive and time consuming, so that direct operation by government officials is impractical. DRVN is therefore requested to take either one of the following measures to alleviate government official's work load for data input.

i) Data input for new roads after construction

The following two (2) measures are to be studied:;

- To commit initial data input tasks to the existing construction contracts and oblige contractors to input data. Appropriate design change should be incorporated with reasonable financial support.
- To make an independent contract after the facilities are taken over to the maintenance sectors and to commit the tasks of an initial data input to database consultants.

In order to ensure smooth implementation of these measures, legalization of regulations is needed in particular for Decree No. 114 under Construction Law.

ii) Data input for existing roads now in service

For existing roads, two data input cases need to be taken into consideration; (1) initial data input and (2) future information update.

- Initial data input

Foreign practices has explained that data input tasks are in general outsourced to consultants specialized for data processing in order not to impose much workloads to government officials, but to ensure data reliability. If it is hard to outsource data input, it is necessary to oblige RRMBs, sub-bureaus or RTCs to fill out databases with proper financial arrangement, limiting the number of data to highly prioritized and frequent use data.

- Future information update

Future information update is often needed whenever big repairs including rehabilitation (widening etc.) are implemented. In order to ensure smooth implementation of data input and data reliability, it is recommended to outsource these works to construction contractors, to repair work contractors or to consultants specialized for data processing. In order to make this feasible, improvement in making contract is needed.

b. Pavement Condition Database

Pavement condition survey has never been standardized as a regular inspection in the current DRVN Routine Maintenance Technical Standards. DRVN is recommended to include this pavement condition survey as a regular inspection and implement it regularly. IRIs and rutting depths can be automatically measured by special vehicle equipped with advanced technologies. Also, crack ratio can be calculated by manually analyzing video data. With these, DRVN is recommended to assign a technologically professional organization, RTC Central, the tasks of implementing pavement condition surveys, analyzing data and inputting data into databases. In addition, it also needs to assign responsibilities for vehicle maintenance, management and operation to the RTC Central.

c. Maintenance History Database

A maintenance history database is one registering maintenance and repair works in the past for national roads in Vietnam. The current status survey conducted in this Project has reported that maintenance and repair work history data have been preserved in a hard copy format and not yet to computerized, so that initial data input should be managed by RRMBs including relevant sub-bureaus directly involved in maintenance and repair tasks.

However, regarding future update of information needed on the occasions of road maintenance and repair works, outsourcing of data input to maintenance and repair work companies would be more practical than direct data management by DRVN staff. For this arrangement, preliminary legalization of procedures is needed.

d. Traffic volume database

The traffic volume database has been developed by DRVN and is currently available as an off-line database. Sub-bureaus currently in charge of inputting data into the database.

2) Database Management

a. Database management at DRVN

DRVN departments shown in **Table 8.2.10** are requested to supervise operation of relevant databases in cooperation with the Information Center in DRVN. In particular during the time of database development, DRVN relevant departments should play an important role to select database elements to be registered in the databases and to supervise development. If database is settled in development well enough to move into an operation stage, database management can be transferred to the DRVN Information Center from supervision departments.

Table 8.2.10 DRVN Departments in charge of Supervision of Database Operation

Database Type			DRVN Departments in Charge of Supervision of Database Operation
1	New	Road Asset Database (Road Inventory database)	Road infrastructure and Traffic Safety Department Information Center
2	New	Pavement Condition Database	Science, Technology, Environment and International Department Information Center
3	New	Maintenance History Database	Road Maintenance and Management Department Information Center
4	Existing	Traffic Volume Database	Traffic Safety Department Information Center

3) Upgrade database operation system

a. Data input

The Project developed database formats and data input control software based on Microsoft Excel. Based on these systems, RRMB I and its subordinate organizations conducted a trial data input. The following DRVN organizations are expected to be involved in data input. But, it will be impractical to let government organizations involved in data input except for general data, which is main detail.

- RRMBs
- PDOTs
- Sub-bureaus under RRMBs
- RTCs

With this, outsourcing is now recommended in the future in order to alleviate data input workloads to the DRVN staff, in particular for the input of detailed facility data.

- Outsourcing to construction contractors for newly construction road facilities
- Outsourcing to maintenance and repair work companies
- Outsourcing to consultants specialized for data processing

b. Internet-based database management

In addition, database users are spreading all over the country. A centralized information management system applying internet-based information management including data input and data use would enable all stakeholders to access road databases and input data. DRVN is recommended to study on the DRVN's current information management systems including evaluation of hardware capacity as well as software capacity and to develop new database information management systems. In developing internet-based database management, particular note is to develop data validation system which can ensure data credibility. The following are key points to be studied in developing internet-based data management systems.

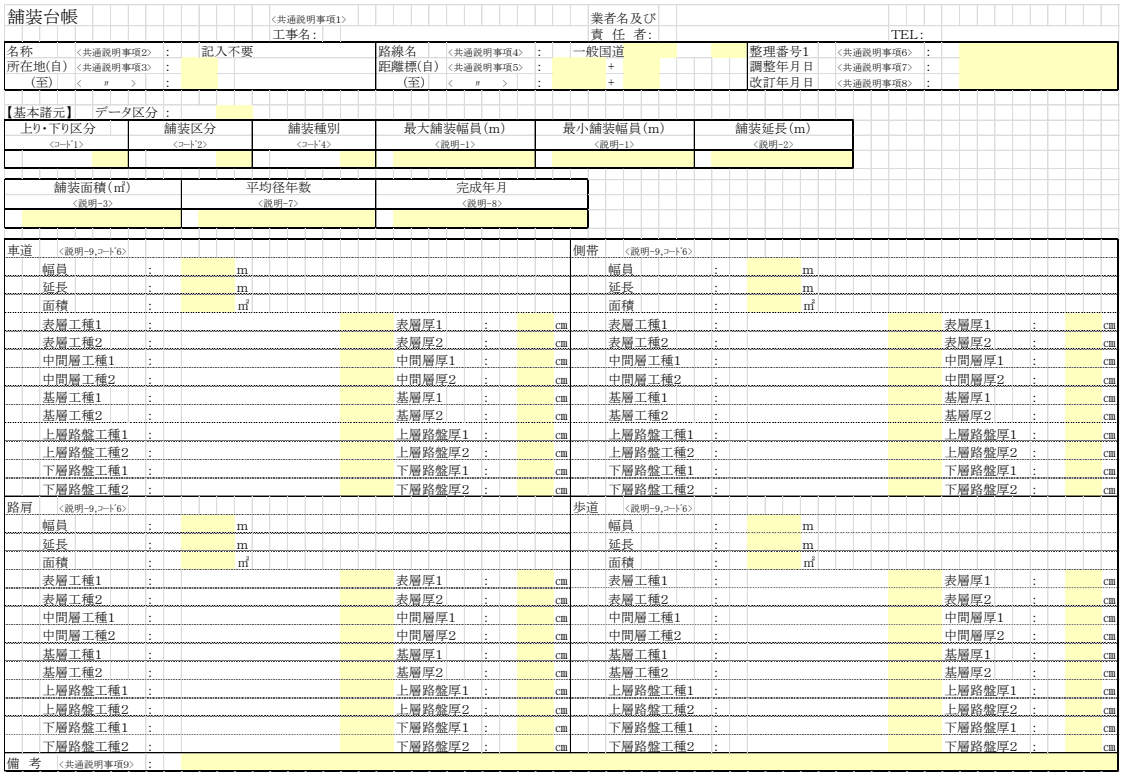
- Analysis on users including those for data input and data use
- Analysis on hardware and software capacity of current information management systems
- Analysis on the requirements of data input and processing
  - + For priority data and detailed road facility data
  - + User interface data input format or Microsoft Excel-based data format
  - + Input data control
- Analysis on data update requirement
  - + Data update system required
  - + Analysis on database security control requirements
  - + Analysis on the management methods of internet-based database operation

(Reference - Practice in Japan)

In Japan, MLIT has developed and applied an internet-based Road Inventory Database Management System which incorporates Excel formats for data input. Automatic Data validation check by computer program is applied when data input is completed. Operation flows are shown below:

- Download the software of MLIT Road Inventory Database Management System
- Download data input Excel formats and copy them onto user computer
- Input detailed facility data into Excel formats (59 Facilities)
- Input data management information
- Check input data control
- Input photos and drawings
- Register and store data

DRVN is recommended to choose an appropriate database management system most fitted to the existing DRVN's road information management system.



舗装台帳 〈共通説明事項1〉

工事名：　　業者名及び責任者：　　TEL：

名称 〈共通説明事項2〉	：	記入不要	路線名 〈共通説明事項4〉	：	一般国道	整理番号1 〈共通説明事項6〉	：
所在地(自) 〈共通説明事項3〉	：		距離標(自) 〈共通説明事項5〉	：	+	調整年月日 〈共通説明事項7〉	：
(至) 〈 〃 〉	：		(至) 〈 〃 〉	：	+	改訂年月日 〈共通説明事項8〉	：

【基本諸元】　データ区分：

上り・下り区分 〈コード1〉	舗装区分 〈コード2〉	舗装種別 〈コード4〉	最大舗装幅員(m) 〈説明-1〉	最小舗装幅員(m) 〈説明-1〉	舗装延長(m) 〈説明-2〉

舗装面積(㎡) 〈説明-3〉	平均径年数 〈説明-7〉	完成年月 〈説明-8〉

車道 〈説明-9,ｺｰﾄﾞ6〉						側帯 〈説明-9,ｺｰﾄﾞ6〉					
幅員	：	m				幅員	：	m			
延長	：	m				延長	：	m			
面積	：	㎡				面積	：	㎡			
表層工種1	：		表層厚1	：	cm	表層工種1	：		表層厚1	：	cm
表層工種2	：		表層厚2	：	cm	表層工種2	：		表層厚2	：	cm
中間層工種1	：		中間層厚1	：	cm	中間層工種1	：		中間層厚1	：	cm
中間層工種2	：		中間層厚2	：	cm	中間層工種2	：		中間層厚2	：	cm
基層工種1	：		基層厚1	：	cm	基層工種1	：		基層厚1	：	cm
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下層路盤工種2	：		下層路盤厚2	：	cm	下層路盤工種2	：		下層路盤厚2	：	cm
路肩 〈説明-9,ｺｰﾄﾞ6〉						歩道 〈説明-9,ｺｰﾄﾞ6〉					
幅員	：	m				幅員	：	m			
延長	：	m				延長	：	m			
面積	：	㎡				面積	：	㎡			
表層工種1	：		表層厚1	：	cm	表層工種1	：		表層厚1	：	cm
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中間層工種2	：		中間層厚2	：	cm	中間層工種2	：		中間層厚2	：	cm
基層工種1	：		基層厚1	：	cm	基層工種1	：		基層厚1	：	cm
基層工種2	：		基層厚2	：	cm	基層工種2	：		基層厚2	：	cm
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下層路盤工種2	：		下層路盤厚2	：	cm	下層路盤工種2	：		下層路盤厚2	：	cm

備　考 〈共通説明事項9〉 ：

Figure 8.2.9 MLIT Database Management System – Pavement Data Input Excel Format

4) Database technical support

It is strongly requested to assign responsibilities including system maintenance, system upgrade and technical support to professional organizations in computer engineering. Either of Information Center or RTC Central is requested to play a key role in managing technical issues of nationwide software systems including system maintenance, system upgrade and technical supports to PDOTs and subordinate organizations.

In order to perform these responsibilities, Information Center or RTC Central is requested to establish close cooperation with external universities, research institute and private IT companies. In particular, UTC has participated to develop road database systems as a professional entity during this Project implementation, so that UTC can fully support the technical tasks.

5) Roadmap of Database Development

Table 8.2.10 summarizes the roadmap of database development for short-term, mid-term and long-term periods. Particular note here is that when road facilities are taken over for maintenance and operation upon completion of construction, DRVN is requested to develop drawings to be used for maintenance and operation based on the as-build drawing taken over from construction, which will play an important role in providing source information to road asset databases. The drawings, base of maintenance and operation, help support all maintenance activities in the field.

Table 8.2.11 Roadmap of Database Development

No.	Database Type		Road Type	Input Stage	Data Type	Short-term	Mid-term	Long-term
						1-2 years	3-5 years	After 5 years
1	Road Inventory Database	New DB	New roads construction / Road reconstruction	Initial data input	All data	・ Legalize responsibility assignment for data input	・ Outsourcing to construction contractors ・ Outsourcing to consultants specialized for data processing	
			Existing roads	Initial data input	Priority data	・ RRMBs/PDOTs ・ Sub-bureaus ・ RTC-RRMBs		
					Detailed data	・ Outsourcing to consultants specialized for data processing		
				Future update by road rehabilitation (widening, etc.)	All data	・ Legalize responsibility assignment for data input	・ Outsourcing to construction contractors ・ Outsourcing to consultants specialized for data processing	
				Future update by repair works	All data	・ Legalize responsibility assignment for data input	・ Outsourcing to consultants specialized for data processing ・ Outsourcing to repair work contractors	
2	Pavement Condition Database	New DB	Existing roads	Periodic update	All data	・ RTC-Central		
3	Maintenance History Database	New DB	Existing roads	Initial data input	All data	・ RRMBs/PDOTs ・ Sub-bureaus		
				Future update by maintenance works	All data	・ RRMBs/PDOTs ・ Sub-bureaus ・ Maintenance work companies		
4	Traffic Volume Database	Existing DB	Existing roads	Periodic update	All data	・ Sub-bureaus		

(4) Road Maintenance Planning System (PMS)

1) Pavement condition survey

A unit of pavement condition survey vehicle was provided to DRVN in this Project which is capable of measuring three pavement deterioration indexes including cracks, rutting depth and IRIs. The vehicle can also take video data while operation. Analysis of video data can also give us additional data including the location data of road facilities, but major purposes of this equipment are to measure pavement deterioration. Basically, data input needs to be conducted manually.

The vehicle is equipped with advanced technologies which need daily maintenance and require professional knowledge and experience in performing measurement, so that DRVN is requested to give responsibilities for the management, maintenance and operation of this vehicle to the professional organization in engineering. RTC Central is the most qualified organization for these purposes.

2) Preparation of PMS data set

PMS software developed in this Project incorporates a data conversion system from four source base databases to the PMS data set, which include (1) road inventory database, (2) pavement condition database, (3) road maintenance history database and (4) traffic volume database. This could avoid direct manual data input to a PMS data set, reduce data input errors and save workloads to formulate a PMS data set. However, operation of data conversion software requires professional knowledge and expertise in operation.

In this Project, development was conducted for two PMS data sets as described below;

a. PMS data set formulation for the year 2012

The Project was first intended to use RoSyBASE 2009 as a source database of road inventory data, traffic condition data and road maintenance history data to formulate PMS data set. However, DRVN requested the Project not to apply RoSyBASE data due to low data reliability and agreed to newly prepare road inventory data and road maintenance history data. With this, the Project needed to change strategies and tentatively studied solutions for the formulation of PMS data set which will be the base data set for road maintenance planning software. Design concept of PMS for this case is to apply years of construction or big repair works, assuming there is no pavement deterioration when these construction or repair works are performed (Initial pavement deterioration condition). 2012 pavement condition data are also applied as the latest pavement condition. As a result, two time-series pavement deterioration data, initial condition and 2012 condition for this case, are applied to formulate PMS data set. **Table 8.2.12** explains step-by-step information on the formulation of 2012 PMS data set.

Table 8.2.12 Formulation of 2012 PMS data set

Step-1	Step-2	Step-3
Conduct pavement condition surveys in 2012 as a JICA Study.	Develop pavement condition database 2012 by JICA	Data conversion from pavement condition database to PMS data set by developed conversion software
RRMBs newly prepared road inventory data.	Data integration into pavement conditions database 2012 by manual.	
RRMB1 newly prepared road maintenance history data.	Data integration into pavement condition database by manual.	
Apply existing Traffic volume database.	Data conversion to pavement condition database 2012 by developed conversion software.	

b. PMS Data set formulation after the year 2015

In addition to the PMS data set for the year 2012, the Project developed data conversion software capable of converting data from the following source databases to the PMS data set format developed in this Project. Design concept of this data conversion software is to make use of two time-series road pavement condition data, 2012 data and 2015 data as an example. However, some of source databases are not available now, so that slight customization may be required in the future upon completion of the source databases applicable for the data conversion to the PMS data set.

- Road Inventory database
- Pavement condition database 2012
- Pavement condition database 2015 (after 2012)
- Road Maintenance history database
- Traffic volume database

Under these conditions, the database conversion software developed in the Project may need professional knowledge and expertise in operation until they are fully examined, so that RTC Central is requested to prepare PMS data set and to provide information to planning organizations including, DRVN Planning and Investment Department, RRMBs and PDOTs. This treatment should be maintained until source road databases become available which include road inventory database, road condition database and road maintenance database, and thus operability of PMS software for data conversion is functionally ensured.

3) System Management and Operation

Organizations shown in **Table 8.2.13** are requested to supervise and operate PMS and planning systems.

Table 8.2.13 DRVN Departments in charge of Maintenance Planning System

	System Supervision and Operation	DRVN Department in Charge
1	PMS and Planning system supervision	・ Planning and Investment Dept.
2	Planning of mid-term road maintenance plans, given PMS data set	・ Planning and Investment Dept.
3	Planning of annual road maintenance plans, given PMS data set	・ RRMBs ・ PDOTs

4) System upgrade and technical support

Following the case of system maintenance, upgrade and technical support for road inventory system, it is strongly requested to assign professional responsibilities including system maintenance, system upgrade and technical support to professional organizations in engineering, RTCs.

(5) Road Pavement Monitoring System (PMoS)

1) System Supervision and Operation

Organizations shown in **Table 8.2.14** are requested to supervise and operate PMS and planning systems.

Table 8.2.14 DRVN Departments in charge of Maintenance Planning System

Seq	System Supervision and Operation	DRVN Department in Charge
1	Data conversion software for PMoS data set	・ Science, Technology, Environment and International Dept.
2	Preparation of PMoS data set	・ RTC Central
3	Supervision of Pavement Monitoring System Software (PMoS)	・ Science, Technology, Environment and International Dept.
4	Operation of PMoS software	・ RRMBs ・ PDOTs ・ Sub-bureaus

2) Preparation of PMoS data set

PMoS software developed in this Project incorporates data formulation converting data from four source databases to the PMoS data set, which include road inventory database, pavement condition database, maintenance history database and traffic volume database. But, operation of this software may require professional knowledge and expertise, in particular for data conversion, so that RTC Central is requested to prepare PMoS data set and provide information to relevant organizations until time source databases become available, conversion software becomes operable and data conversion is successfully performed.

3) System upgrade and technical support

Following the case of system maintenance, upgrade and technical support for road inventory system, it is strongly requested to assign professional responsibilities including system maintenance, system upgrade and technical support to professional organizations in engineering, RTCs.

(6) Recommendation on Institutional Capacity Enhancement

1) Strengthening of leading department capacity

In order to enhance DRVN's national road maintenance management functions, it is important to integrate maintenance and management functions as much as possible, strengthening coordination and communication functions between departments in the headquarters and

between central and regional organizations. With this, it is important to strengthen the capacity of a leading department and ask it to play a focal role of information and coordination.

For this purpose, DRVN is recommended to strengthen the capacity of Planning and Investment Department as a leading department over all departments in the DRVN headquarters. With the extension of national road network, the role the Planning and Investment Department will become very important in authorizing DRVN opinions and in coordinating with external organizations like MOT for the development of strategic plans.

Lessons learned has explained that the Planning Department in principle is assigned to play a leading role in the MLIT headquarters Road Bureau.

2) Strengthening of planning capacity

Planning and Investment Department is a key organization in DRVN, playing an important role in planning strategic plans including long-term or mid-term road development and maintenance plans.

The Project developed road maintenance planning systems in cooperation with counterpart members chaired by the Head of Planning and Investment Department. In order to ensure successful implementation of this planning system upon completion of system development, the Planning and Investment Department should be capable of handling the system.

With these reasons, it is strongly recommended that DRVN strengthen the role and the responsibility of the Department and accumulate managerial experience and knowledge to the Department personnel. For this purpose, incorporation of the International Division would further enhance managerial functions of the Department.

3) Strengthening of R&D capacity

a. Lessons learned

MLIT in Japan has been playing a leading role in developing technologies not only for construction management, but also for road maintenance and operation. In order to enhance its R&D functions, MLIT established its own research institutes including National Institute of Land and Infrastructure Management (NILIM) and Public Work Research Institute (PWRI) for developing policies, strategies and technologies for infrastructure construction, maintenance and operation.

In addition to these own research institutes, MLIT also enhanced the function of research collaboration with professional research groups including academics, professional experts belonging to external research institutes. With this, Japan Road Association, a public foundation whose foundation was approved by MLIT, has been playing a focal point of cooperative research with external professional groups.

Research outcomes produced by the research institutes and through research cooperation have been widely incorporated not only in MLIT infrastructure development, but also in regional government infrastructure development projects.

b. Maintenance technologies which require professional knowledge and expertise

Table 8.2.15 shows technologies which have been widely applied to road maintenance and operation in many countries. Some of the technologies marked with (*) are ones developed by the Project for the national road maintenance and operation in Vietnam.

Many of the road maintenance and operation technologies are in general not sold in the market as products like Microsoft Software, but need technology development or customization in order to comply with national road environment in Vietnam. With this, DRVN is recommended to strengthen its R&D capacity and conduct studies in developing policies, technologies, systems, standards or manuals on its own including those for their maintenance and operation.

Table 8.2.15 Advanced Road Maintenance and Operation Technologies

	Advanced maintenance and Operation Technologies	Policy Development	Technology Development	System Development	Standard/ Manual Development
*	Road inventory database system			X	X
*	Pavement condition survey and analysis		X		X
*	PMS and road maintenance planning system	X		X	X
*	Diagnosis of pavement and bridge deterioration			X	X
*	Pavement repair technologies		X		X
*	Pavement monitoring system			X	X
	Bridge management system (VBMS)	X		X	X
*	Bridge inspection technologies		X		X
	Road asset management policies	X			X
	Life-cycle-cost management policies	X			X
	Electronic toll collection system (ETC)		X	X	X
	Road information system (Variable signs, etc.)		X		X
	Integrated Transport Systems (ITS)	X	X	X	X

(Source) JICA Project team
(Note) (*): Road maintenance technologies associated with JICA Project

c. Strengthening of DRVN Science, Technology, Environment and International Cooperation Department and research collaboration

The Project herein recommends that DRVN's research functions for the development of road maintenance and operation technologies should be strengthened in order to cope with rapidly growing technological renovation in road maintenance and operation. Decision No.60 stipulated that the authority of developing technical standards including their legalization was already delegated to DRVN to enhance its technology development functions.

Here in this Project, recommendations are issued on responsibility sharing between stakeholders in research collaboration. Collaborative researches with professional stakeholders have been widely incorporated in many countries in order to develop maintenance technologies including software systems and technical standards. There are several organizations under MOT which are deemed professional in doing research works and engineering studies. These are Science, Technology, Environment and International Department and regional technical centers under DRVN, and UTC, UTT and ITST under MOT. By enhancing linkage between these organizations and by establishing collaborative research works, DRVN can meet the demand of developing maintenance technologies, computer systems and technical standards for national road maintenance and operation, as shown in **Figure 8.2.10**.

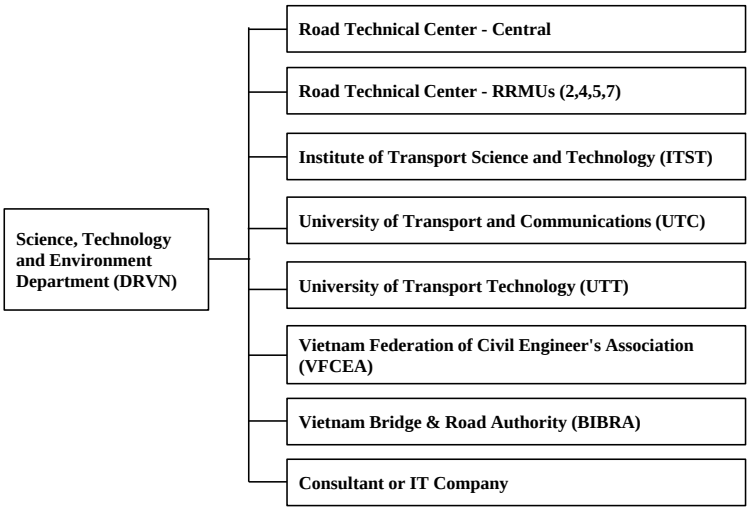


Figure 8.2.10 Expected DRVN Research Collaboration

(Source) JICA Project Team

Research stakeholders shown in the above figure can be classified into the following five (5) groups: Responsibility assignments between stakeholders are briefly described as follows;

Group-1: DRVN Science, Technology, Environment and International

+ To find out needs of technology development
+ To take a leading role in research group
+ To participate in discussion
+ To authorize the draft plan of technologies
+ To develop regulations and propose legalization, etc.

Group-2: RTC Central and RTC-RRMBs

+ To take a leading role in collecting and analyzing data including field surveys, pavement condition surveys, etc.
+ To participate in the discussion
+ To implement field experiments and pilot studies

+ To supervise development of software system
+ To maintain and update software systems, etc.
+ To transfer professional technologies to the stakeholders under DRVN

(Note)
It should be noted that in developing computer software including PMS, VBMS and road maintenance planning systems, it is important to maintain technical support functions including system maintenance, technical support and system upgrade during operation of these systems. These tasks should be ensured, assigning professional technical organizations to take care of these tasks separately from IT Department's management and operation.

Group-3: ITST, UTC and UTT

+ To conduct laboratory tests with their own equipment, as demand arises
+ To support field survey, experiments and pilot study
+ To participate in the discussion
+ To support development, maintenance and update of software systems, etc.

Group-4: VFCEA and VIBRA

+ To participate in the discussion with their professional knowledge and expertise, etc.

Group-5: Consultants and IT companies on a contract basis

+ To conduct data collection and analysis
+ To participate in research works
+ To draft revision plan of technical standards
+ To develop computer software systems
+ To prepare reports on research works, etc.

Also, **Table 8.2.16** and **Table 8.2.17** show general steps of R&D, in particular in developing maintenance technologies and computer software systems as samples. The tables show where research stakeholders can contribute to the steps of R&D activities.

Table 8.2.16 Road Maintenance Technology Development

No	Steps of Technology Development	STEI Dept.	RTC_Central	RTC_RRMBs	ITST	UTC	UTT	VFCEA	VIBRA	Consultant
1	Planning and clarification of the framework of research	X								
2	Field survey, data collection and analysis		X	X						
3	Laboratory tests		X	X	X	X	X			
4	Pilot studies in the fields		X	X						
5	Drafting of standards and manuals									X
6	Discussion and information exchange	X	X	X	X	X	X	X	X	X

No	Steps of Technology Development	STEI Dept.	RTC_Central	RTC_RRMBs	ITST	UTC	UTT	VFCEA	VIBRA	Consultant
7	Authorization of draft standards	X								
8	Drafting of regulations	X								
9	Propose MOT for approval, if needed	X								
10	Technology Transfer	X	X		X	X	X			
11	Upgrade of maintenance technologies	X	X		X	X	X			

(Note) STEID: Science, Technology, Environment and International Department

Table 8.2.17 Database and Software Development

No	Steps of Software Development	STEI Dept.	IT Center	RTC_Central	RTC_RRMBs	ITST	UTC	UTT	VFCEA	VIBRA	IT Company
1	Planning and clarification of the framework of research	X									
2	Field survey, data collection and analysis			X	X						
3	Development of algorithm and system configuration						X				X
4	Development of computer software						X				X
5	Test run, system examination and review			X	X		X				X
6	Discussion and information exchange	X		X	X	X	X	X	X	X	X
7	Authorization of drafted systems	X									
8	Drafting of operation guideline										X
9	Drafting of regulations	X									
10	Proposal of MOT approval, if needed	X									
11	Technology Transfer	X		X	X	X	X	X			
12	Software system maintenance and upgrade	X		X			X				X
13	Software system website management		X								

(Note) STEID: Science, Technology, Environment and International Department

(7) Strengthening of Training capacity

Recommendations on the training capacity enhancement are totally summarized in "Chapter 9 Enforcement of Human Capacity Development".

(8) Review of responsibility assignment between DRVN and PPC DOTs

Work items shown in **Table 8.2.18** Improved Responsibility Assignment indicate major works for national road maintenance. Forty nine DOTs are currently involved in national road maintenance which covers 8,700 kilometers of the nationwide national road network. Recommendation on the improvement of these functions was made in this Project including the

development of road inventory database, implementation of pavement condition surveys by vehicle, development of planning system for mid-term road maintenance plans. Upon completion of the Project, responsibility assignment between DRVN and DOTs needs to be reviewed and rearranged. The following are the improvement plans for DOT responsibility assignment.

1) Data input in road inventory database

Road inventory database including operation systems is newly established in the Project. Database system can support various activities in the national road maintenance, so that DOT's own database management is important. It is necessary to clearly define new responsibility assignment of database data management in the existing DOT responsibility assignment.

2) Pavement condition survey and bridge inspection

The most important thing for road operator is to precisely know the current status of road conditions, in particular pavement and bridge conditions through inspections. In order to realize this objective, the Project has recommended pavement condition surveys by survey vehicle and bridge inspection by applying a bridge inspection manual now under development. However, these pavement surveys and bridge inspections also require special knowledge and expertise in implementation to operate the survey vehicle, to conduct inspection and to diagnose facility defects and deterioration. With these reasons, DRVN is recommended to assign responsibilities for pavement condition surveys and bridge inspections to technologically professional organizations such as RTCs, intending to accumulate knowledge and experience and also survey data to RTCs.

3) Planning of mid-term road pavement maintenance plans

Main purposes of applying mid-term pavement maintenance plans are to provide the following information to national road operators.

+ Precise pavement condition data
+ Benchmarking information for sections showing unusual data (Request of FWD surveys)
+ Mid-term (3 to 5 years) pavement repair plans which can show appropriate investment timing of periodic maintenance (Overlays etc.)

With these purposes, DRVN is recommended to assign the responsibility for planning mid-term road maintenance plans to the Planning and Investment Department in DRVN headquarters and oblige the department to feedback information to RRMBs and DOTs to formulate annual maintenance budget plans based on the mid-term plans.

It is noted that system development of mid-term pavement maintenance planning system was conducted for the targeted road network under RRMB1 jurisdiction. In addition, database operation software was also developed including data input by the Project. The planning system will become operable when databases are set ready after data input.

Table 8.2.18 Improved Responsibility Assignment

Work Items	Current System	Improvement Plan
Fill in road inventory database	Not available now	DOTs, PPCs
Pavement condition survey	DOTs, PPCs	RTC Central, by road condition survey vehicle
Bridge inspection	DOTs, PPCs	RTCs
Road inspection (Other facilities)	DOTs, PPCs	DOTs, PPCs
Judgment on inspection results	DOTs, PPCs	DOTs, PPCs
Formulate mid-term maintenance and repair plans	Not available now	Planning and Investment Department, DRVN
Annual budget plans and budget proposals	DOTs, PPCs	DOTs, PPCs
Tendering and contract	DOTs, PPCs	DOTs, PPCs
Maintenance and repair works	PRRMC	PRRMC
Work supervision and acceptance	DOTs, PPCs	DOTs, PPCs
Monitoring of road conditions		

(9) Establishment of Regional Road Department

Nearly a half of national road network is managed under the jurisdiction of Provincial People's Committees. DRVN is recommended to establish Regional Road Department in the DRVN Headquarters and provide intensive supports to the Department of Transportation (DOTs) belonging to Provincial-level People's Committees. It is expected that DRVN's supports would contribute not only to the national road maintenance and management under PPC jurisdiction, but also to those for all provincial-level roads including provincial, district and commune roads.

Current status survey on regional DOTs has explained that they have been asking DRVN to provide strong supports to their activities. The following are programs which DOTs wish DRVN to provide supports.

1) Provide more technical standards and software systems for road maintenance and operation

Technical standards deemed necessary in performing national road maintenance in the regions are shown below. DRVN is requested to standardize these technologies and provide them to DOTs.

a. Inspection guideline on the national road facilities

In particular, inspection technical guidelines including pavement and bridge inspections for national road are extremely important.

b. Design standards for medium and big repair works

They should be developed separately from construction design standards, due to difference in work types and work environment.

2) Increase in training opportunities

The past interview survey to DOTs has clarified that there are a small number of training programs given to DOTs. DRVN is recommended to provide more training opportunities to DOTs including training programs for the following technologies produced by the Project.

+ Database management system
+ Road maintenance planning systems (Annual maintenance plans)
+ Pavement monitoring system

3) Provide regional technical supports

DRVN is requested to provide technical supports to DOTs for the technologies shown below:

a. Pavement condition survey

A pavement condition survey vehicle is provided to DRVN in this Project in February 2014. DRVN is recommended to apply this survey vehicle not only to the DRVN road networks but also to the national road networks managed by DOTs. However, pavement condition surveys, data analysis and vehicle maintenance and management require professional knowledge and expertise specialized for these surveys, so that DRVN including DOTs is recommended to assign pavement condition surveys, data analysis and survey vehicle management to a professional technical organization, RTC Central.

b. Bridge inspection

Bridge inspection in general requires much knowledge and experience specialized for the inspection rather than other facility inspections. Foreign practices has explained that there are many road administrators assigning bridge inspection tasks to those specially trained for this purpose. DRVN is recommended to assign RTC Central or RTC-RRMBs as professional organization for bridge inspection, giving training courses for bridge training. RTC Central and RTC-RRMBs are requested to perform inspections for bridges under RRMU and PDOT jurisdictions in the regions.

(10) Long-term Plan

1) Capacity Enhancement of Maintenance Department

It is expected that DRVN's responsibilities for national road maintenance and management will increase in the future in in accordance with the extension of national roads to the regionals. In parallel with the expansion of responsibilities, DRVN should have more administration and engineering staff for national road maintenance and management, so that DRVN is recommended to study an institutional reform and reinforce organizations by upgrading its headquarters' organizations in the future. The following shows an example of institutional reinforcement for the DRVN headquarters.

a. Road Management & Maintenance Department (Present)

- Road Maintenance & Management Bureaus (Future)

b. Transport Legislation Department, and Vehicle and Driver Management Department

- Road Transport and Vehicle Management Bureau

c. Road construction & Management Administration

- Road Construction and Management Bureau

CHAPTER 9 REINFORCEMENT OF HUMAN CAPACITY DEVELOPMENT

9.1 FRAMEWORK FOR REINFORCEMENT OF HUMAN CAPACITY DEVELOPMENT

9.1.1 Background

Human capacity development in road maintenance sector have been examined at "Vietnam Transport Sector Study[1]", and pointed out for following issues.

(1) DRVN Capacity Development Program

Although there have been many training courses conducted by donor countries since the year 2000 in conjunction with database and planning system development, however, technology transfer has not been accomplished well enough to raise the planning capacity of DRVN staff and to provide technical support to the regional agencies such as RRMUs[2] and PDOTs. DRVN is requested to be capable enough to support regional maintenance activities.

(2) RRMUs and PDOTs Capacity Development Program

The field survey has clarified that regional agencies are given a few opportunities to undertake training courses and have strong demand for training courses. Their interest on the training courses include those on the road inspection technology, data registration, database operation and planning of annual budgets. Also, they show demand for DRVN technical support, in particular, to the advanced database and planning system like VBMA and RoSyBASE. As these database systems generally require high knowledge and expertise in operation, regular technical supports from either DRVN or the supplier is indispensable.

9.1.2 Aim and Objectives of Activity 5

From the above findings, capacity reinforcement of DRVN on human capacity development is regarded crucial for successful technical transfer of the Project. Thus Activity 5 focus on enhancement of DRVN human capacity development, so that required trainings for operation of project outputs are provided during and after the Project sustainably, and to ensure technical transfer to nationwide in Vietnam.

1 Vietnam Transport Sector Study, February 2010, Almec corporation

2 RRMU(Regional Road Maintenance Unit) have been replaced to RRMB(Regional Road Management Bureau) , under the Decision No.60/2009/QD-TTg, 21st October 2013.

9.1.3 Scope of Study

Project activities are focused on three (3) phases of trainings on project outputs in Phase 1: During the project term and Phase 2: 1-2 years after the project completion, which followed by human capacity development for future road maintenance at Phase 3: 3-5 years after the project completion. Following shows the objective of each phase.

a. Phase 1: Trainings on project outputs (During the Project term)

During the project term, recommendations and training program focus on the technology transfer of project output are developed and trainings are delivered for development of trainers under the project counterparts of RRMU II[1] jurisdiction.

b. Phase 2: Trainings on project outputs (1-2 years after the Project completion)

Recommendations and training program are developed focus on the dissemination of project outputs to nationwide staff by trainers develop at phase 1, after the project completion. It aims to operate and utilize project outputs in Vietnam.

c. Phase 3: Human capacity development for future road maintenance (3-5 years after the Project completion)

After the successful deployment and operation of project outputs nationwide Vietnam, recommendations are developed for human capacity development of comprehensive road maintenance addressing all stakeholders involved in road maintenance including provincial level, aiming to establish and operate road maintenance cycle in Vietnam sustainably.

9.1.4 Methodology

(1) Baseline Survey

The survey was conducted on current status of training offered to staff involved in national road maintenance in Vietnam and Japan.

(2) Development of Recommendation for DRVN on Human Capacity Development

Based on the above survey, recommendations were formulated to reinforce human capacity development of DRVN on road maintenance.

(3) Development of Training Programs

Training programs for above mentioned three (3) phases were developed through identifying training requirements.

[1] RRMU II has been replaced to RRMB I, under the Decision No.60/2009/QD-TTg, 21st October 2013.

(4) Delivery of Trainings and Workshops

Based on training program developed, training plans for "During the Project" were further developed and delivered to project counterparts to develop trainers.

9.1.5 Project Output

- Recommendations for DRVN human capacity development
- Training programs
- Training courses, workshops, and trainers

9.2 BASELINE SURVEY

9.2.1 Introduction

(1) Aim and Objectives

The baseline survey was conducted to examine current status of trainings offered to staff in road maintenance sector in Vietnam and Japan, so that from findings, recommendation are drawn for successful technical transfer of the project outputs. Objectives of study are listed in below.

- To identify target stakeholders requiring capacity development
- To investigate training subjects to be offered on road maintenance
- To clarify needs and priorities for capacity development.
- To identify institutional and organization system for implementation of training and training environments.
- To set a baseline indicator for continuous monitoring and evaluation on capacity enhancement of human capacity development

(2) Scope of Study

1) Targeted organizations

Study was conducted targeting below stakeholders for both country.

Table 9.2.1 Targeted organizations

Vietnam	Japan
・ DRVN ・ RRMU II ・ RTC Central ・ RTC 2 ・ RRMCs under RRMU II[1]	・ MLIT ・ Regional Development Bureau ・ Consultant and Contractors

[1] RRMC has been replaced to Sub Bureau (SB) under the Decision No.4038/QD-BGTVT, 9th December 2013.

2) Items Examined

Followings are main items examined through the survey for both Vietnam and Japan.

- Staff involved in road maintenance
- Training offered to staff in road maintenance in last 3-5 years
- Legal documents relevant to training on road maintenance
- Implementation process of training in road maintenance including planning, delivery, monitoring and evaluation

(3) Methodology

Information was collected through following methods.

- Questionnaire
- Meetings and Interviews
- Existing published documents
- Web sites

9.2.2 Current Status of Road Maintenance Trainings in Vietnam

(1) Organization and Staff Involved in Road Maintenance Sector

Organizations and staff involved in road maintenance are summarized in below **Table 9.2.2**. It shows that a broad range of organizations from central to regional state management agencies to enterprises, and also staff includes from state management staff, professional staff and technical and site workers.

Table 9.2.2 Organization and Staff

Organization			Organization status	Staff status	Staff category	Role and Responsibility
Central Government	Central Agencies	MOT	Ministry	Civil servant/ Non-productive official	Management /Professionals	State Authority of National road management
		DRVN	Government agency	Civil servant/ Non-productive official		State Agency managing National road under MOT
		RTC Central	Public Non Business Units	Civil servant(Director)/ Public Official / Staff	Management /Professionals /Technicians	Survey, design, supervision and material testing service
	Regional Agencies	RRMUs	Public Non Business Units	Civil Servant / Public Official / Staff	Management /Professionals /Technicians	Conduct and mange maintenance and emergency work for National Road
		RTCs	Public Non Business Units	Civil servant(Director)/ Public Official / Staff		Survey, design, supervision and material testing service
		RRMCs	Enterprise (Sate limited liability Companies)	Public Official /Enterprise staff		Road maintenance work
			Enterprise (Joint Stock Companies)	Enterprise staff		
Provincial Government		PPCs	Government agency	Civil servant/ Non-productive official	Management/Professionals/Technicians	State Agency managing Provincial road under MOT
		PDOTs	Government agency	Civil servant / Non-productive official	Management /Professionals	Conduct and manage maintenance and emergency

				/Technicians	work for Provincial road
	PRRMCs	Enterprise	Enterprise staff	Professionals /Technicians/site workers	Road maintenance work
Private company	VEC	Enterprise (Sate limited liability Companies)	Public Official/ Enterprise staff		Manage Expressway
	Contracted Companies	Enterprise	Enterprise staff		BOT/BT contracted for Road maintenance work

(2) Legal Framework on School Education and Training of Road Maintenance

In Vietnam, school education, vocational training and continuous training are stipulated under legal documents listed below table, which road maintenance sector has to comply with. There are no comprehensive legal documents stipulate specifically state management of education and training on road maintenance.

Table 9.2.3 Legal Documents on Training

Legal Documents		Doc no.
Laws	Law on Education	No.38/2005/QH11
	Law on the Government Organization	No: 32/2001/QH1
	Law on Cadres and Civil servant	No.22/200/QH12
	Law on Public Officials	No: 58/2010/QH12
	Law on Enterprise	No. 60/2005/QH11
	Law on State Enterprise	No: 14/2003/QH11
	Code of Labor 2010	
	Law on Vocational training	No.76/2006/QH11
Decrees	The Government Decree on Training and retraining for Cadres and Civil servant	No.18/2010/ND-CP/2010

1) Legal Documents on Education and Vocational Training

In Vietnam, all legal documents on school education is under Law on Education (No: 38/2005/QH11), with its amending and supplementing articles of Law on Education (No. 44/2009/QH12), which stipulates the formal education in general. In this law, Article 32 defines the category of professional education into the two main categories, professional upper secondary education and vocational training.

Table 9.2.4 Categorization of Professional Education (Article 32 of Law on Education)

Category of Education		Duration	Requirement level for entry
Professional upper secondary Education		3 to 4 years	Lower secondary education diplomas
		1 to 2 years of studies	Upper secondary education diplomas
Vocational Training	Vocational upper secondary and college program	1 to 3 years	(not noted)
	Preliminary vocational program	Less than 1 year	(not noted)

Source: Law on Education (No: 38/2005/QH11),

2) Legal Documents on Civil Servant Training

Training for civil servants is stipulated under Law on Cadres and Civil Servants (No.22/2008/QH12), and Government Decree on Training and Retraining of Cadres and Civil servants (No.18/2010/ND-CP), which targets civil servants under ministries, ministerial-level

agencies, government-attached agencies and provincial people's committees and centrally run Cities. It stipulates training details including training subject, duration and frequency, assigned training implementing institution, training program and materials, monitoring and evaluation etc.

Document stipulates following four (4) type of training covering four (4) subjects of state management, political theory, professional knowledge and skill and others, corresponding to managerial post, civil servant rank and professional field, which are;

- Training and re-training by leading and management titles
- Re-training based on civil servant rank criteria
- Re-training professional knowledge and skill[1].
- Probation guidance

Implementation of above trainings is assigned to organization[2] as shown below **Table 9.2.5**.

Table 9.2.5 Organization assigned for implementation of Civil servant training

Training program	Managed by	Assigned training body
Training and re-training according to leading and management titles	The Ministry of Home Office	・ The Ho Chi Minh National Academy of politics and Public Administrations ・ Politics schools of provinces and centrally run cities
Re-training based on civil servant rank criteria	The Ministry of Home Office	・ The Ho Chi Minh National Academy of politics and Public Administrations ・ Politics schools of provinces and centrally run cities
Probation guidance		・ Unit employing civil servant
Re-training on professional knowledge and skill	Ministries, ministerial level agencies and government attached agencies	・ Cadre and civil servant training and refresher training institutes, schools and center of ministries, ministerial level agencies and government attached agencies ・ Politics schools of provinces and centrally run cities

Source: the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP)

3) Legal Documents on Public Officials Training

Training for Public officials is stipulated under Section 4 of Law on Public Officials (No.58/2010/QH12), which is newly stipulated in 2012 by separating from Law on Cadres and Civil servants (No.22/2008/QH12). The Law details on regime, responsibilities for public officials training, as well as responsibility and benefit of officials on trainings. Implementation of trainings is also delegated to non-business unit employing public officials. A decree stipulate further detail is yet to be developed for public officials, and meanwhile Law on Cadres and Civil servants (No.22/2008/QH12) has been continuously applied to public officials.

According to the above law, four (4) type of trainings by work post and professional title are stipulated, which are;

[1] Article 4 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP)

[2] Article 13 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP)

- Training and re-training based on management post
- Re-training based on professional title
- Re-training to supplement and update professional knowledge and skills
- Probation guidance

4) Legal Documents on Private Company Staff Training

Law on Enterprise (No.60/2005/QH11), Law on Enterprise (No. 14/2003/QH11), and Labor Code 2007, state on training of staff under private companies, and in general staff training is delegated to each company.

5) Legal Documents for Qualification

For those trainings proposed to issue qualification and certificate requires approval from authority of DRVN or MOT for implementation of trainings. Training details needs to be submitted prior to training for approval, and training results to be reported after trainings. Certificate of training is highly valued for staff due to its consideration to staff evaluation at the end of year. Currently there is no statutory qualification required for road maintenance activities in Vietnam.

(3) Strategy on Human Capacity Development of Transport Sector

In Vietnam, human resource development is analyzed and evaluated every decade and prepared a strategy for next decade. Currently the Strategy on Development of Vietnam Human Resources for 2011-2020 (No.579/QD-TTg) is in effective and requests all sectors to develop their human resources development strategy in line with the national strategy and pursuant to the legal framework.

Accordingly, Ministry of Transport formulates Human Resource Development Plan of Transport Sector 2011-2020 (No.1576/QD-BGTVT), targeting state management agencies and enterprise under transport sector. Two (2) phased implementation plan of 2011-2015 and 2016-2020, and annual plans are also formulated to achieve the proposed strategy by 2020 in coordination with other ministries, sectors and localities for implementation.

(4) Current Status of Education and Vocational Training for Road Maintenance in Vietnam

Ministries who are responsible for the state management of school education in the transport sector are Ministry of Education and Training (MOET), Ministry of Transport (MOT), and Ministry of Labor, and Invalids and Social Affairs (MOLISA). MOET is responsible for the state management of all type of school education while MOT functions for the state management in transport sector with MOET for professional upper secondary education and vocational program for less than one year within the frame work of vocational training.

MOT has established 12 school education and vocational training institutions under direct management of MOT and four (4) schools under DRVN. Qualifications and certificates of graduation from those schools are essential to work for road maintenance agencies, and graduates are regarded to have sufficient knowledge and skill to conduct their assigned tasks without further trainings.

However, under the current school education system, schools offer subjects on road maintenance is very limited. Currently only University of Transport and Communication covers as a small subject. Vocational training is offered by Northern Transport Secondary School to staff of RRMCs under the contract with DRVN.

Table 9.2.6 Training Institutions under MOT / DRVN

Category		MOT	DRVN
Professional upper secondary Education		・ The University of Transport Technology ・ Ho Chi Minh City University of Transport ・ Vietnam Maritime University ・ Central Transport college ・ Transport College 2 ・ Transport College 3 ・ Vietnam Aviation Academy	
Vocational Training	Vocational upper secondary and college program	・ Central Vocational College of Transport 1 ・ Central Vocational College of Transport 2 ・ Central Vocational College of Transport 3 ・ Road transport vocational secondary school ・ Automotive Technology secondary school	・ Northern Transport Secondary School ・ Southern Transport Secondary School
	Preliminary vocational program		・ Motor Vehicle Mechanic Vocational School ・ Road Transport Vocational School

Source: Ministry of Transport official website: http: //www.mt.gov.vn

(5) Current Status of Road Maintenance Trainings at Road Maintenance Agency in Vietnam

Trainings offered to staff under the project counterparts of DRVN, RRMU II and RTCs were examined through collected information and documents. Full list of trainings are referred to **Appendix-A4**.

1) Type of trainings on road maintenance

Trainings on road maintenance are currently delivered through mainly following three type of trainings.

- Trainings under Civil Servant and Public Official Training :

  Trainings implemented under training on professional knowledge and skill and probation guidance. For those training implemented under professional knowledge and skill training, legal documents are generally issued by DRVN or MOT. Whereas probation guidance is unstructured guidance offered to newly assigned staff only by senior member of staff at unit level, and not requires legal documents.

- Training on Particular Topic under Legal Documents
- Training not Under Civil Servant and Public Official Training nor Particular Topic

2) Training at Road Maintenance Agencies

a. Trainings at DRVN headquarter

Training offered for civil servant and officials of DRVN headquarters is summarized in **Table 9.2.7**. As seen from the table, training relevant to road maintenance for DRVN officials, are very much limited in subjects as well as frequency. Besides traffic safety training established under ODA projects, trainings are randomly offered by mostly international agencies to accomplish their technical transfer, or by foreign private companies to introduce their technology and products. Trainings on HDM4 and RoSYBASE have not been implemented since 2009, as a result the system is not in operation.

Table 9.2.7 Summary of Training for DRVN Civil Servant and Officials

Category		Training style	Training Subject	Year	Frequency	No trainee	Training implementer
Civil Servant training	Professional knowledge and skill training	Seminar/ Workshop	・ Pavement recycling	2008/2009	2	50*	IC
			・ Bridge Engineering (Cantho bridge)	2010	1	4	IA
			・ Traffic Safety Examiner class 1	2009/2010	6	103*	Traffic Safety Project
			・ Traffic Safety Examiner class 2	2010	2	53*	
		Training course	・ Rosy and HDM-4	2005, 2006,2009	4	-	IA
	Probation guidance	Probation guidance	・ Road maintenance planning ・ Budget training		-	-	DPI
Training on particular topic with qualification		Training course	・ Cost appraisal	2011	1	21*	NTSC
			・ Supervision consultant	2011	1	21*	
			・ Project management	2011	1	31*	
			・ Professional skill on bidding	2012	-	-	Foreign Trade University
Training on particular topic without qualification		Seminar/ Workshop	・ Pavement repair technology	2011	1	1	IC
			・ Traffic Safety	2011	1	1	NTSC
Others		Seminar/ Workshop	・ Construction technology	2011	2	90*/ 130	IC
			・ Follow up of bridge man	2006	1	4	RRMU II
		other	・ Road safety audit	2007	1	32*	RRMU II

** Number of trainees shows the total no of participants. Department of Planning and Investment :DPI, National traffic safety committee :NTSC, International companies: IC, International Agency: IA*

b. Trainings at RRMU II

Training offered for RRMU II officials and staff is summarized in **Table 9.2.8**. It shows that trainings related to road maintenance are very much limited in subject as well as frequency.

Trainings have been offered by not only international agencies and companies as mentioned at DRVN, but also by RRMU II to enhance staff professional capacity, which are OJT training courses on Construction training and Road ROW management training. Construction training covering construction investment, bidding and quantity survey. The other OJT of Road ROW management training including facility management, securing congested traffic etc. every two to three year depends on financial availability of RRMU II. Besides probation guidance are provided for road maintenance related topic. Trainings on HDM4 and RoSYBASE have not been implemented since 2009 as same to DRVN.

Table 9.2.8 Summary of Training for RRMU II Officials

Category		Training style	Training subject	Date	Frequency	No trainee	Training implementer
Public official training	Professional knowledge and skill training	Seminar/ Workshop	Pavement recycling	2008/2009	2	50*	IC
		Training course	Construction investment(OJT)	2008	1	32	RRMU II /VBRA
			Construction bidding(OJT)	2008	1	32	RRMU II
			Construction quantity survey (OJT)	2010	1	84*	RRMU II
			Rosy and HDM-4	2005/2006/2009	4	-	IA
	Probation guidance	Probation guidance	Road maintenance		-	-	Unit
Training on particular topic with qualification		OJT	Road safety audit	2006/2007	2	160*	International traffic safety association
Others		Seminar/ Workshop	Construction technology	2011	1	90*	IC
			Pavement technology		1	100*	IC
			Follow up of bridge man	2006	1	30*	RRMU II
			Road maintenance and ROW		biannual	-	RRMU II
		Competition	Competition for good manager and experience exchange		biannual	35*	DRVN/RRMU II/labor union
			Road safety audit	2007		32*	RRMU II

** Number of trainees shows the total no of participants, International companies: IC, International Agency: IA*

c. Trainings at RTC Central

Training offered for officials of RTC Central is summarized in **Table 9.2.9**. As shown on table, trainings offered are dramatically decreased in number and subject, comparing to above two agencies. Training by international agencies and companies are limited, on the other hand, RTC Central implements more trainings such as OJTs on construction material, road data collection, targeting to their staff and relevant agencies including RRMUs and RRMCs.

Thus, limited number of trainings specific to road maintenance is offered, and furthermore they are not practical and applicable technical training, which sufficient enough to conduct their

assigned tasks of research and development on road maintenance technology. Comprehensive training courses are also not offered.

Table 9.2.9 Summary of Training for RTC Central Officials

Category		Training style	Training subject	Year	Frequency	No trainee	Training implementer
Public official training	Professional knowledge and skill training	Training course	Rosy	2006	1		IA
			Laboratory management	2010	1	3	-
			Quantity survey	2011	1	4	-
			Assayer	2010	1	10	-
			Road and bridge maintenance	2006-2015	-	5	-
	Probation guidance	OJTs	・ Construction material, ・ Road data collection				RTC Central
Others		-	Bridge checking	2010	1	10	RTC Central

d. Trainings at RRMCs

Unlike above civil servant and public officials, staff of RRMCs has been hardly received training on road maintenance besides vocational training from Northern Transport Secondary School. Probation guidance has been offered by experienced staff of RRMCs, on patrolling, inspection and repair and management.

Table 9.2.10 Summary of Training for RRMC Staff

Category	Training style	Training subject	Year	Frequency	No trainee	Training implementer
Others	OJT	・ Road data collection		-	-	RTC Central
	Probation guidance	・ Patrolling ・ Inspection ・ Repair and maintenance work		-	-	RRMCs

Note: Northern Transport Secondary School: NTSS

(6) Training Implementing Organizations

Currently trainings related to road maintenance mentioned above have been provided by various organizations under MOT such as ITST, NTTS, and road maintenance agencies of RRMU II and RTC Central. These organizations generally develop training program and training material, organize trainers, and implement trainings.

1) International Agencies and Companies

International agencies such as SIDA, WB, JICA offer trainings as a part of their technical transfer projects, international programs etc. covering wider range of stakeholders. International companies also provide workshops on their specialized field of technologies and products. Training program, curriculum and materials are usually prepared by the agencies and implemented with their funds during the project term only.

2) Research and Training Institutions under MOT

a. Institute for Transport Administration and Management Cadres (ITAMC)

The Institute is the assigned training institution for cadres, civil servant and public officials under Transport sector [1] and currently trainings focused on political theory and state management training is provided. The institute develops training programs including training curriculum and materials[2]. Following table shows training courses currently offered.

Table 9.2.11 Trainings provided at ITAMC

Training programs	Courses	Participants
Political theory	63	5135
Re-raining on knowledge of state management	30	2082
Re-training on knowledge of enterprises management	186	8478
Re-training on qualifications	88	6272
Re-training on qualification of transport inspectorate and inspectorate managerial posts	21	2171
Re-training on WTO integration	2	166
Continuous education for excellent workers	6	133
Re-training on knowledge of foreign language	42	1913
Training on Accounting, administration	6	2480

b. University of Transport Technology (UTT)

In June 2011, Transport College was upgraded to the University of Transport Technology under the MOT governance. UTT has conducted research and science works receiving commitment from MOT. Of about 40 research works formulated by MOT, UTT has been involved in 4 to 5 research projects. In addition, UTT has offered 100 short-term training courses annually with 1,000 participants from officials and staff of government to private companies mostly for the road sector. Training fees are charged to each participant. UTT has lecturers of about 500 people and teaching staffs over 300 people, and also has a responsible department on short-term training called Irregular education Department. Besides, UTT also offers training courses for national engineering qualifications, workshops and seminars.

Trainings relevant to road maintenance are listed in below table, however currently none of trainings is offered to road maintenance agencies under DRVN. UTT has not so far accepted commitments for providing training courses for DRVN, but accepted VEC (Vietnam Expressway Corporation) commitments for providing expressway training courses focused on construction, toll collection and maintenance aiming at raising the capacity of VEC technicians.

Currently UTT also receives JICA Technical Cooperation Project for Enhancing Capacity of UTT covering human resource, technology, and facility focusing on expressway construction, operation and maintenance.

[1] Under the Government Decree on Training and Retraining for Cadres and Civil servant (No.18-2010ND-CP)

[2] Article 9 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP)

Table 9.2.12 Short-term Training Courses by UTT

Training course	Target	Frequency / Duration	Method
Supervision on transport works construction	Construction supervisor	Regular / 10-12 days	OJT
Assayer on checking transport works quality	Technician	Regular / 10-12 days	OJT
Patrolling professional skill in road technical management	Technician	Regular / 14-21 days	OJT
Professional skill of road Unit Chief in road technical management	Unit Chief	Regular / 1month	OJT
Basic professional skill on road inspection	Inspector	Regular / 40 days	OJT

c. University of Transport and Communication (UTC)

Besides educational training, UTC under MOET also provides short-term training courses utilising their experts, facilities and equipment, and conduct scientific research and technology transfer programs cooperating with domestic and international organisations. Currently collaboration project on asset management with Kyoto University is on-going. Lectures of UTC have cooperated to RRMU II to provide a series of construction trainings.

d. Northern Transport Secondary Schools

The school has the status of a preliminary vocational college under DRVN. Currently full time training courses (1- to 2-year course, currently 3 courses) and short-term courses (about 20 courses) are offered. Focus of the school is to enhance capacity for technicians and workers with practical training courses on road/bridge construction technologies, machine operation technologies and accounting knowledge of construction enterprises under finance of DRVN. The school has 100 staffs including teachers (66), master engineer (10) and others.

e. Institute of Transport Science and Technology（ITST）

ITST is one of leading institute among 42 national research institutes under MOT, and responsible for implementing scientific research and technology development for state management of MOT, consulting services, and also implementing international cooperation projects in the field of infrastructure construction, transport operation, environmental protection and traffic safety.

ITST has dedicate section for training called, Center of Information and Training, which conducts training courses in the fields of transport science and technology for the improvement of professional skills for laboratorial technicians, inspectors and project managers. Table below shows training courses relevant to road maintenance provided from 2010 to 2012.

The Center develops training programs including curriculum and materials, and provides regular trainings in regions targeting staff and officials under road maintenance agencies. Trainers are from ITST as well as invited experts from NUCE and UTC. Some of those trainings are implemented under contract or charging training fee from trainees.

In 2010, under the request of DRVN, ITST drafted a training program for road maintenance targeting RRMUs and site workers, however it have not been implemented yet.

Table 9.2.13 Training implemented 2010-2012 by ITST

	Training course	2010		2011		2012	
		No. of classes	No. of trainees	No. of classes	No. of trainees	No. of classes	No. of trainees
1	Supervision Consultant	9	334	6	144	3	60
2	Quality Verification of Piles and SAMH	1	22	1	20		
3	Short-term Laboratorian	11	421	10	251	10	247
4	Long-term Laboratorian	1	36	1	43	1	22
5	Extension for Laboratorian			1 (ĐN)	10	1	39
6	Manager of Laboratory	6	157	7	64		
7	Labor Safety			1	18		
8	Chief Manager of Site			1	15		
9	AL chịu lực và CNSPH CLCT			1	29	1	20
10	Assessment Engineer			1	11		
11	Investigator of Road Traffic Safety					3	217
12	Training TCVN					4	429
Total		**28**	**970**	**30**	**605**	**23**	**1034**

3) Road Maintenance Agencies under MOT

a. RRMU II

RRMU II, as Non Business Units, is responsible for providing professional knowledge and skill training and assigns Organization and personnel Dep. to prepare training plans, organizing training funds, implementing trainings and organizing condition for staff to attend training[1].

Accordingly RRMU II organized two OJT training. Construction training was implemented in cooperation organizations, whereas Road ROW management training was implemented with all internal resource of RRMU II. However, due to limited financial resources, RRMU II is unable to develop and implement trainings to meet demand of their staff.

b. RTC Central

RTC Central also as Non Business Units, offers OJTs on technical aspects of their managing field, to engineer and technicians of RTCs, RRMUs and RRMCs, depends on demand and available budget. RTC Central assigns Administration and Personnel Department to develop training curriculums and materials, provide trainers and implement trainings. However due to the limited resources such as budget, facility and equipment, and staff capacity, sufficient trainings have not been offered.

[1] Section4 of Law on Public Officer（No: 58/2010/QH12）

c. Units under Road Maintenance Agencies

Probation guidance for newly assigned staff is offered at Unit level of DRVN, RRMU II, as well as at RRMCs. It is demand based unstructured OJT by experienced members of staff, and training materials are generally not offered.

(7) Planning, Implementation and Monitoring Evaluation of Trainings

1) Civil Servant Training

Department of Organization and Personnel（DOP）of MOT is assigned to formulate master plan for civil servant training under Transport sector[1], and delegated to DOP of DRVN including management and planning of training, securing of training budget, and monitoring and evaluation of trainings[2]. Training quality, implantation of trainings and training budget are monitored and progress reports are submitted to MOT. DOP have also drafted training procedure[3], which is under the process of approval. Unit managing civil servant is delegated to implement probation guidance, select training to offer their staff, and organize environment for their staff to attend trainings[4].

Organization involved in civil servant training under DRVN is stipulated as shown on below table.

Table 9.2.14 Organizations involved in civil servant training under road maintenance sector

Role and responsibility	Tasks	Assigned agencies	Assigned agencies under DRVN
Management of training[5]		Ministries, ministerial-level agencies and Government-attached agencies	DRVN
Assigned training implementing body[6]	Organize implantation of professional knowledge and skill trainings for civil servants as well as others as assigned by authority	Cadre and civil servant training and refresher training institutes, schools and center of ministries, ministerial level agencies and government attached agencies	VARIES
Management of training program[7]	Develop, appraise and evaluate training program, approve, promulgate and guide for implementation	Ministries, ministerial-level agencies and Government-attached agencies	DOP of DRVN
Evaluation of training Quality[8]	・ Evaluate relevance of program contents ・ Capability of trainers, training	Managing agency, units employing civil servant ad training institutions of ministries, ministerial level agencies and	DRVN

[1] The Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP).

[2] Decision stipulating on functions, duties, authorities and organization structure of Organization & Personnel Department (No. 369/QD-TCDBVN)

[3] The procedure of Training and refresher training for staff, official of DRVN based on ISO9001:2008

[4] The Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP).

[5] Article 26 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP).

[6] Article 13 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP).

[7] Article 9 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP).

[8] Article 16 of the Government Decree on Training and retraining for Cadres and Civil servant (No. 18-2010ND-CP).

Role and responsibility	Tasks	Assigned agencies	Assigned agencies under DRVN
	methods ・ Assigned training body capacity ・ Civil servant learning knowledge and skill and application to tasks.	government attached agencies or hired independent evaluation agencies	

a. Planning of Training

DOP of DRVN has gathered training needs of civil servants, and formulated Training and Retraining Plan for Phase 2011-2015 (No.4485/TCDBVN-TCCB/2011), and annual training plan which is submitted annually to DRVN leading Board prior to submit MOT[1] for approval. Upon approval of this plan, budget is allocated by MOT. These plans are limited in targeted trainees of DRVN Offices, DRVN Inspector, Road Construction Management Bureaus, and shows target number of staff to be trained by subject, civil servant ranks, management post, specialization, and working positions as stipulated under legal documents.

Based on training plans submitted by managing agencies of civil servants under MOT, MOT has further developed Training and Retraining Plan for Staff and Civil servant of Transport Sector for 2011-2015 (Decision No.2379/BGTVT-TCCB), currently in effective. It includes target number of trained staff, resolution and role and responsibility of relevant agencies.

b. Implementation of Training

Currently DRVN does not implement civil servant trainings, and depends on external organization. Training courses and assigned organizations to conduct civil servant trainings are informed to DRVN from MOT or directly from assigned training implementing organizations. Then DRVN or assigned organizations nominate trainees or request agencies and units managing staff to nominate their preferred trainees, which need approval from DRVN. Trainees are selected according to relevancy of staff position to the training topic rather than civil servant grade or level. Civil servants can also inform their willingness to take trainings, although they are not able to specify training courses to participate.

c. Monitoring and Evaluation

DOP submit a report on progress of training implementation with a summary of implemented training courses includes number of participants, training target, date, assigned implementing institution, cost etc. Evaluation of training quality is also stipulated to conduct.

[1] Decision stipulating on functions, duties, authorities and organization structure of Organization & Personnel Department (No. 369/QD-TCDBVN)

Civil servants are assessed annually[1], and results are taken into account for training and refresher training. However it is reported that the assessment is too general and insufficient to form training needs.

2) Public Official Training

Units managing public officials are responsible from planning of training, source training funds, implementation of training, organize trainee environments, and training program required prior approval of MOT[2]. To respond this, Organization and Personnel Department[3] of RRMU II and Administration and Personnel Department of RTC Central have been assigned to be in charge of training tasks.

Detail of training procedure for public officials are yet to be formalized, therefore current procedure for civil servant training is applied. According to regulation, non business unit of RRMUs and RTCs assign responsible departments and person to organize and implement trainings[4].

Table 9.2.15 Organizations Involved in Public Officials Training under Road Maintenance Sector

Role and responsibility	Assigned agencies under Law on Public Officials	Assigned road maintenance agencies
Manage trainings	Public non business unit	RRMUs / RTCs
Develop training program[5]	Ministries, ministerial-level agencies assigned to perform the state management of field of operation of public officials	DRVN/ MOT
Implement training	Public non business unit	RRMUs / RTCs
Assigned training implementing body	Public non business unit	RRMUs / RTCs

a. Planning of Training

Non Business Unit gathers need and demand of training for their managing staff and public officials, however, unlike civil servant training, currently formulation of training plan is not formulated.

b. Implementation of Training

Non Business Unit of RRMU II and RTC Central have developed training programs include curriculum and materials for their trainings, and implement training. In case of RRMU II

[1] Section 6 Evaluation / Assessment of Civil Servant in Decision No.22/2008/ QH12 stipulated in 13th November 2008 in the Law of Civil Servant

[2] Law on Public Officer (No: 58/2010/QH12)

[3] Decision on Promulgating Regulations on Organization and Activities of Project Management Units under Directorate for Roads of Vietnam (No. 1728/QD-TCDBVN)

[4] DECISION ON Promulgating function, duty, authority and organizational mechanism of Regional Road Management Unit II under Directorate for Roads of Vietnam (No. 1671/QD-TCDBVN), Decision, Function, Responsibility, Duties, Authority and Structure of Road Technical Center Central under the leadership of Directorate for Road of Vietnam(No 1013/QD-TCDBVN)

[5] Article 33 of Law on Public Officer（No: 58/2010/QH12）

trainings has been carried out in collaboration with association and academic institutions. Units are assigned to implement trainings and probation guidance, and to create condition for employee to attend training.

c. Monitoring and Evaluation

Public official training is not stipulated for monitoring and evaluation. Units managing official carries out annual staff assessment, which varies by units.

3) Technical Transfer Training

Implementation of trainings provided under ODA projects have been differs case by case. Normally project teams of donor agency plan and develop training program, curriculum, and materials and deliver trainings with their funds, whereas PMU TA[1] coordinates and manages trainings in cooperation with the project counterparts departments and units. However responsibility and authority of PMU TA on training are not clarified in any documents. Information on trainings is not shared with DOP of DRVN.

4) Qualification Training

Trainings issuing certificate and qualification, have to go through mandatory process to obtain approval from authorities mentioned earlier. This also applies to technical transfer trainings.

(8) Training Resources

Educational and research institutions, and training institutions, are generally equipped with training facilities and equipment require for road maintenance training, however not for road maintenance agencies. DRVN headquarter have facilities and equipment to utilize, however not equipped with training program, training curriculum, trainers and training materials, due to lack of experience in implementation of trainings. RRMU II and RTC Central have some training courses, training materials and trainers, but lack in equipment and facilities to provide technical training for their specialized tasks. In addition, those training resources such as training material, manuals, and books in road maintenance sector have not been accumulated in any agencies within the road maintenance sector.

(9) Training Funds

Training expense and available funds for them varies by trainings. In case of civil servant and public official training, in addition to cost for venue, trainers, materials etc., cost for trainee allowance including per-diem, travel expense, and stay allowance (meals and accommodation) [2] is stipulated in circular of Ministry of Finance (No. 97/2010/TT-BTC).

[1] Decision on Promulgating Regulations on Organization and Activities of Project Management Units under Directorate for Roads of Vietnam (No. 1728/QD-TCDBVN)

[2] Article 49 of Law on Carder and Civil Servant, Article 35 of Law on Public Officials

DRVN receives state budget for training of civil servant according to budget requested by an annual training plan submitted to MOT[1]. On the other hand, RRMUs and RTCs of Non Business Units have to self-finance trainings for public officials[2], however training budget is not set aside at each unit. Therefore units need to raise funds like RRMU II, who have received funds from VBRA. RRMCs also have to finance not only their internal trainings but also for vocational training[3].

9.2.3 Current Status of Road Maintenance Trainings in Japan

(1) Organization and Staff Involved in Road Maintenance

Following seven (7) agencies and companies are involved in road maintenance in Japan, as shown on **Table** 9.2.16. Further details are to be referred to Activity 4.

- Ministry of Land, Infrastructure, Transport, and Tourism (MLIT)
- Road Bureau of MLIT
- Road Department of Regional Development Bureau (RDB)
- National Highway office under RDB
- Technical office under RDB
- Prefectures (Local Government)
- Contractors and construction companies

Table 9.2.16 Staff and Organization Structures on Road Maintenance in Japan

Category	Organization		Staff status	Staff category	Responsibility
Central Government	Central agency (MLIT)	MLIT	Civil servant	Management /Professionals	Manage national infrastructure
		Road Bureau	Civil servant	Management /Professionals	Draft regulation, plan policies and long term plans, prepare technical standards, prepare cost norm.
	Regional agency (RDB)	Road Department	Civil servant	Management /Professionals	Conduct survey, design and F/S, select contractors, sign contracts, and conduct construction work supervision.
		National Highway office		Management /Professionals	Supervise survey and planning, maintenance and repair work, rehabilitation and new construction of designated section of national highways
		Technical Office		Management /Professionals	Conduct survey and pilot studies on improvement of work execution technologies, machinery and machinery repair work, survey and experiment material resources, implement trainings on machine operation, coordinate on mobilization of machinery for disaster restoration etc.

[1] Article 23,the Government Decree on Training and Retraining of Cadres and Civil servants (No.18/2010/ND-CP)

[2] Article 34 of Law on Public Officer (No.58/2010/QH12)

[3] Article 57.3 of Law on Vocational training (No.76/2006/QH11)

Category	Organization		Staff status	Staff category	Responsibility
Local Government	Local Agency	Prefectures/ Municipals	Civil servant	Management /Professionals	Manage approval and demolish of national road and bridge, traffic safety, road maintenance and management under the jurisdiction,
Private companies		Construction Companies	Enterprise staff	Professionals / Technical	Conduct maintenance work under contract with RDB and Prefectures.

(2) Legal Documents on Training for Road Maintenance

Relevant legal documents applied to training for staff involved in road maintenance in Japan are summarized in **Table 9.2.17**.

Table 9.2.17 Legal Documents Relevant to Training on Road Maintenance in Japan

	Legislation	Ref
1	Rules of the National Personnel Authority	Article 4, June 25th 1981amended March 18th 2009
2	Law on National Civil Servant	Article 3, 18, 71, 74, Oct 21st, 1947, Law No 120
3	Basic Act for Reforming national Civil servant system	Article 5 & 6, June 13th , 2008 Law No 68,
4	Ordinance of MLIT on MLIT Organizations	Article 199, Jan 6th 2001 Ordinance No1, amended 28th June 2013, Ordinance No 52
5	Ordinance of MLIT on College for Land, Infrastructure, Transport and Tourism	Jan 6th 2001 MLIT Ordinance No14, amended 29th June 2012, MLIT Ordinance No 63
6	Ordinance of Regional development bureau	Jan. 6th, 2001 Ordnance No21
7	Law on Local Government officials and civil servant	Section 7, Dec.13th 1950 Law No 261

1) Legal Document on Training for Civil servant of Central Government

Civil servant training is stipulated in several legal documents, which delegate to each ministry. MLIT as state management for infrastructure sector, has established College of Land, Infrastructure, Transport and Tourism (MLIT College) under the above listed Ordinances of MLIT, and provides necessary comprehensive trainings for civil servant and officials under MLIT. Regulation specifying road maintenance related training is limited to Ordinance of Regional Development Bureau. It stipulates technical offices of RDBs to provide trainings on construction machinery and equipment to staff under planning, construction, river and road.

2) Legal Document on Training for Civil Servant of Local Government

Local government is also stipulated to provide necessary training to their civil servants under the separate law for civil servant of central government, Law on Local Government Officials and Civil servant, and monitored by National Personnel Authority.

3) Legal Document on Training for Staff of Private Companies

There is no legal document stipulating staff training of private company. It is only the contract between employee and employer which can specify requirements of training, therefore requirements differs by companies. Besides some of road maintenance works requires valid qualification for staff, which requires to taking exam and training.

(3) Current Status of Road Maintenance Training

1) Characteristic of Training on Road Maintenance in Japan

- Training implementation institution for staff and official of central and regional authorities as well as private companies involved in infrastructure development are established and provided regular intensive training relevant to managing field of MLIT.
- MLIT College providing regular intensive official training for capacity development of staff and officials of MLIT, also offers trainings to staff and officials of regional authorities and agencies.

2) Type of Current Training on Road Maintenance

Staff under road maintenance sector is offered following six (6) types of trainings.

- Civil Servant Training:
- Regional Official Training
- RDB Technical Training
- Internal training
- Workshop/seminars:
- Qualification training:

Table 9.2.18 Type of Training Offered by Staff Status

	Type of training	Road Dep. MLIT	RDB	Local Gov.	Contractors
1	Civil Servant Training	X	X		
2	Regional Official Training	X	X	X	X
3	Technical Training		X	X	X
4	Internal training		X	X	X
5	Workshop/seminars	X	X	X	X
6	Qualification training				X

3) Training at Road Maintenance Agencies

a. Trainings at Road Department of MLIT

Officials under Road Department of MLIT are offered regular comprehensive training courses on road maintenance focusing on administrative and management at MLIT College. Besides, they can also take training courses under JCTC, workshop/seminars organized by various originations, and training organized under other ministries. Internal training is not offered.

b. Training at Regional Development Bureau, under MLIT

Officials of RDB, as well as national highway offices, branch offices, and technical offices under RDB, are offered training mainly from MLIT College as well as RDB. MLIT College provides official training to manager level officials of RDB, who are regarded as key staff at road maintenance, focused on professional and technical aspects. Whereas RDB organizes

technical trainings for officials under RDB management, according to professional fields and job rank (newly employed, officer, assistant manager, and manager). Technical trainings and workshops are also offered by RDB and technical offices covering from basic technical knowledge and skill to regional specific issues. Besides, they can also take training courses under JCTC, Workshop/Seminars, and training organized under other ministries.

c. Training at Consultants / Contractors

Training at private companies varies in its condition and program. There is no comprehensive road maintenance training for contactor and consultant provided by MLIT, however most of companies develop their own training program and offer internal trainings. Staff is also provided opportunities to attend external trainings offered at JCTC, Local government, RDB etc. As mentioned above, contractors also stipulated to have a qualification to carry out certain tasks in road maintenance, which needs to attend trainings and exams.

(4) Training Implementing Organizations

In Japan, trainings on road maintenance are offered mainly from following three (3) organizations, which demarcated by targeted staff and specialized field.

- College of Land, Infrastructure, Transport and Tourism (MLIT College)
- Regional Development Bureau
- Japan Construction Training Centre (JCTC)

Table 9.2.19 Training Implementation Institution

Training Institution	MLIT College	RDB	JCTC
Organization status	Ministry attached agency	Ministry attached agency	Incorporation Foundation
Training style	Short term residential training courses	Training courses/ Seminar/Workshop	Short term residential training courses, Exam, Workshop
Target Trainee	・ Civil servants under MLIT and RDB ・ Regional government officials, ・ independent agencies relevant to MLIT	・ Civil servants under RDB ・ Local government officials ・ Consultant& Contractors	・ Regional government officials, ・ Consultant& Contractors
Subject	Comprehensive state management & Professional training on subjects under MLIT	Comprehensive state management & Professional training on subjects under MLIT	Construction, Statuary qualification training related construction
Training program on Road	10 courses ・ Road management ・ Road structure1&2&3 ・ Road maintenance ・ Road planning 1&2 ・ Road traffic safety 1&2 ・ Road environment	Depends on RDB	7 courses ・ Road management ・ Road Comprehension ・ Rod planning ・ Regional and municipal road ・ Traffic safety on regional & municipal road ・ Pavement technology ・ Road technologies
Duration /Frequency	1 - 2 weeks / min. once a year		1 -2 weeks/ once a year

1) College of Land, Infrastructure, Transport and Tourism (MLIT College)

MLIT College is comprehensive training institution targeting civil servants and staff involved in the state management of MLIT. The College with two (2) branches offer total of 185 residential courses to 7,600 staff in 2011.

a. Characteristics

Following shows characteristic of the College.

- To provide training opportunities not only to MLIT officials but also to regional government and agency officials and staff.
- To provide high-level training programs, inviting academics and experts actively involved in national road administration.
- To provide intensive training programs with accommodations

b. Objectives

MLIT College is an organization specialized for civil servant training under MLIT, aiming to give systematic training programs to those who are involved in road administration, operation and management in cooperation with external training institutes. The College manage, plan, develop, deliver, monitor and evaluate training.

c. Target Trainees

Trainings are targeting staff and officials of MLIT, local governments, independent administrative institution, and other ministries. 70% of participants are from central government and 20 % are officials from regional governments, and 10% are from others. Each course is set further detail criteria for accepting participants by work position and experiences.

d. Training Program

The College offers three (3) training programs listed below covering all subject managed by MLIT, including road maintenance. The College formulate annual training plan, which outlines training courses offered in the year with details including aim, target trainees and its numbers, date and duration, curriculum, assigned trainer, material and cost. Every year training courses are reviewed and revised training plan is disseminated to relevant organizations and units. Table 9.2.20 shows the training plan for the year 2013.

- Training by Job Rank : Training provides comprehensive state management training requires for civil servant under MLIT.
- Training by Professions: Training provides professional knowledge and skill and relevant administrative management according to professional field and assigned department, which require for official and civil servant under MLIT.
- Special training ： Training to update on latest issues on administrative management.

Table 9.2.20 Training Plan in 2013 – MLIT College

Classification	Training Programs	The number of courses	Origins and the number of participants					
			MLIT	Other Ministries	Regional Governments	Agencies	Others	Total
Class-I officer	Training for new employer	2	73					73
	Professional training (Measurements, technologies)	2	46					46
	Administration and management training	6	328		30	5	45	408
	Official position training	4	87					91
	Total	14	534		30	5	45	
Class-II/III Officer	Training for new employer training	3	210			2		212
	Professional training (Measurements, technologies)	3	35	1				36
	Administration and management training	2	90					90
	Official position trainings	8	897	4		4		905
	Total	16	1232	5		6		
Common over Class I/II/III	New manager training	4	310					310
	Professional training (Measurements, technologies)	2	14					13
	Compliance trainer training	1	30					30
	Construction management training	2	54	2				56
	Management technology training	2	78	2				80
	Crisis and security management	7	159	1	30			190
	Total	18	645	5	30			
General	International construction technology	1	8			1		9
	PPP/PFI	1	12	1	11	1		25
	Special technologies	1	10					10
	Intensive training for selected subjects		150					150
	Others	1						
	Total							
Business procedures, Tendering Construction and businesses	Business procedures	10	244	10	31	17	4	306
	Tendering	2	50	2	8	2	2	64
	Construction businesses	2	37	2	31	5	10	85
	Cost saving	2	50	2	14	2	2	70
	Evaluation of technologies and contractor work performance	2	50	2	14	2	2	70

Classification	Training Programs	The number of courses	Origins and the number of participants					
			MLIT	Other Ministries	Regional Governments	Agencies	Others	Total
	Total							
Disaster/Risk management	Measures against earthquakes and tsunami	1	21	1	4	2	1	30
	Risk management	4	98	5	28	3	6	140
	Total							
Road	Road administration	2	56	3	13	6	2	80
	Road structures	3	69	3	40	6	2	120
	Road planning	2	44	2	36	6	2	90
	Road traffic safety	2	50	2	68			120
	Road environment	1	18	1	7	3	1	30
	Total							
GIS/Topographic survey	Topographic survey and mapping	7	36	7	162	7	2	214
	GIS	9	94	17	85	11	21	228
	Total	16	130	24	247	18	23	

Source: Homepage information of College of MLIT, August 2013
Note: Duration of training courses per training
Training for Class-I officer: 3 days average
Training for Class-II/III Officer: 5 days average
Common training over Class I/II/III: 3 to 9 days
General training: 3 to 4 days
Training of Business procedures, Tendering and Construction businesses: 4 to 5 days
Training of disaster and risk management: 3 to 5 days
Road sector training: 4 to 10 days
GIS and topographic survey: 5 to 10 days

e. Training Program on Road Maintenance

Training program in 2013 offered 10 courses on road sector, as shown below training plan. Training courses of road maintenance & management and road structure are further detail in following sections.

Table 9.2.21 Training Plan 2013 on road program at CLIT

	Name of course	Target organization						Date	Duration (days)
		MLIT	Other ministry	Regional Gov.	Independent agency	Others	Total		
1	Road management	29	1				30	28.Oct	5
2	Road structure1- manager	29	1				30	7.Oct	5
3	Road structure 2-assistant manager (design & construction)	20	1	20	3	1	45	4.Jul	12
4	Road structure 3-assistant manager (maintenance)	20	1	20	3	1	45	18.Nov	12
5	Road maintenance & management	27	2	13	6	2	50	3.Jun	12
6	Road planning (survey & analysis)	22	1	23	3	1	50	16 Oct	10
7	Road planning (function & Operation)	22	1	13	3	1	40	25.Sep	10
8	Road traffic safety 1 (prevention)	25	1	34			60	3.Sep	4
9	Road traffic safety 2 (pedestrian / cycler)	25	1	34			60	9.Sep	4
10	Road environment	18	1	7	3	1	30	19.Aug	12
	Total	237	11	164	21	7	440		86

Source: Annual Training Plan 2013, College of land, Infrastructure, Transport and Tourism

i) Training Course for Road Maintenance and Management

This 2 weeks residential course targets assistant manager level covering 6 essential fields for state management of road maintenance. Trainings are offered by lectures, mock practice, and map exercises as appropriate to contents. The course offers to management and professional staff was combined in 2013, considering that administrative management staff also acquires basic understanding on road maintenance.

Table 9.2.22 Training course for Road maintenance & management

Name of course	Road Maintenance and Maintenance					
Aim and focus point	To develop staff capacity on comprehensive knowledge on road maintenance. ・ Professional knowledge related dispute on road maintenance and management ・ Professional knowledge on administration of road maintenance and management					
Targeted staff	Staff from MLIT, Local government, independent administrative institutions, etc. , and at the same time who conduct on tasks related road maintenance and at the same time, ・ Assistant manager or staff on the position equivalent ・ Person with equivalent capacity as above					
Maximum participant	MLIT	Other ministry	Regional agencies	Independent agency	others	total
	27	2	13	6	2	50
Training duration	67.0 hours / 12days			3rd June – 14st June 2011		
Curriculum	1.Lectures (44.5 h) ・ Category A (5.0 h): Current issues, road asset management, road occupancy etc. ・ Category B (7.0 h): Warranty, act related to illegal behavior, court etc. ・ Category C (14.0 h): Act on administration, road act, etc. ・ Category D (6.0 h): Traffic police, noise and vibration etc. ・ Category E (6.0 h) : Risk management, PR ・ Category F (6.0 h) : Road maintenance					
	2.Mock practice on court cases (13.0 hours)					
	3.Map exercise (7.0 hours)					
	4.Others (3.0 hours): Orientation, graduation, guidance, etc.					

Source: Annual Training Plan 2013, College of land, Infrastructure, Transport and Tourism

ii) Training Courses for Road Structure

Training course on road structure is 2 weeks residential course divided into further three (3) courses according to manager and assistant manager level. Subjects are covered in design, construction and maintenance, so that comprehensive knowledge is enhanced.

Table 9.2.23 Training Course for Road Structure-1 (Manager)

Name of course	Road Structure <Manager level >					
Aim and focus point	To develop capacity of management levels staff on comprehensive professional knowledge on road facility management and apply to make proper judgment required. ・ Professional knowledge on road structure planning, design and construction ・ Professional knowledge on road structure inspection, diagnoses and maintenance ・ Reinforcement of capacity on proper judgment at various occasions					
Targeted staff	Professionals from MLIT and at the same time who conduct on tasks related road facility ・ Manager or staff on the position equivalent ・ Person with equivalent capacity as above					
Maximum participant	MLIT	Other ministry	Regional agencies	Independent agency	others	total
	29	1				30
Training duration	33.5 hours / 5days			7th Oct – 11th Oct 2011		
Curriculum	1.Lecture (26.0 hours) ・ Category A (4.0 hours) : Current issues on Road administration etc. ・ Category B (16.0 hours) : Steel Bridge, Concrete Bridge, Lower structures, Accessories, Anti earthquakes, Case studies ・ Category C (6.0 hours) : Road engineering, Pavement, and Tunnels.					
	2.Research (5.0 hours): validity of technical standards					
	3.Others (2.5 hours): Orientation, graduation, guidance, etc.					

Source: Annual Training Plan 2013, College of land, Infrastructure, Transport and Tourism

Table 9.2.24 Training Course for Road Structure-2 (Assistant manager- design & construction)

Name of course	Road Structure <Assistant Manager- Design and Construction>					
Aim and focus point	To develop capacity of management levels staff on comprehensive professional knowledge on road facility and apply to make proper judgment required. ・ Professional knowledge on road structure planning, design and construction ・ Practical skill on design of road bridge					
Targeted staff	Professionals from MLIT, Local government, independent administrative institutions, etc., and at the same time who conduct on tasks related road facility ・ Assistant manager or staff on the position equivalent ・ Person with equivalent capacity as above					
Maximum participant	MLIT	Other ministry	Regional agencies	Independent agency	others	total
	20	1	20	3	1	45
Training duration	69.5.0 hours / 12days			1st July – 12th July 2011		
Curriculum	1. Lecture (47.5 hours) ・ Category A (4.5 hours): Current issues on road administration etc. ・ Category B (22.0 hours) :Outline on bridge, steel and concrete bridge, lower structures, accessories, Anti earthquakes ・ Category C (14.0hours):Bridge planning & survey, constriction/quality of steel/concrete bridge ・ Category D (7.0 hours): Road engineering, pavement, and tunnels.					
	2. Research (12.0 hours)					
	3. Site Visit (7.0 hours)					
	4. Others (3 hours): Orientation, graduation, guidance, etc.					

Source: Annual Training Plan 2013, College of land, Infrastructure, Transport and Tourism

Table 9.2.25 Training course for Road Structure-3 (Assistant manager- maintenance)

Name of course	Road Structure <Assistant Manager- maintenance>					
Aim and focus point	To develop capacity of management levels staff on comprehensive professional knowledge on road structures, especially on inspection, survey, diagnoses and repair works. ・ Professional knowledge on inspection, survey, diagnoses and repair works of road structure. ・ Practical skill on road bridge inspection					
Targeted staff	Professionals from MLIT, Local government, independent administrative institutions, etc. , and at the same time who conduct on tasks related road facility ・ Assistant manager or staff on the position equivalent ・ Person with equivalent capacity as above					
Maximum participant	MLIT	Other ministry	Regional agencies	Independent agency	others	total
	20	1	20	3	1	45
Training duration	69.0 hours / 12days			18th Nov – 29th Nov 2011		
Curriculum	1.Lecture (42.0 hours) ・ Category A (10.0 hours):Current issues on road administration etc., durability of concrete ・ Category B (17.0 hours) :Outline on bridge, steel and concrete bridge, lower structures, accessories, Anti earthquakes ・ Category C (6.5hours):Outline of bridge inspection and practice, inspection of steel and concrete Bridge, Non-destructive training, ・ Category D (5.5hours):Bridge management, damages of steel and concrete ・ Category E (3.0 hours):Tunnel					
	2. On site practice (14.0 hours): Nondestructive survey, Inspection					
	3. Research (10.5 hours)					
	5.Others (2.5 hours): Orientation, graduation, guidance, etc.					

Source: Annual Training Plan 2013, College of land, Infrastructure, Transport and Tourism

f. Trainers

MLIT College does not have in-house trainers, instead, invites experts from the field including MLIT, academics, and associations so that various leading professional knowledge and skills are provided.

g. Training Style

Various method of lecture, research, practice are applied to trainings so that trainees can participate training actively. Also residential training encourages officials to learn various aspects of officials and unity.

h. Qualification

At the end of training, trainees who successfully attended sufficient number of classes, and scored sufficient result at assessment, receive certification of completion.

i. Training Fees

Training fee including trainer cost, maintenance of building, staff salary are funded by state funds. Trainee cost such as food, accommodations and materials are paid by trainee, which most of the case, covered by each organizations or units.

2) Regional Development Bureau (RDB)

a. Characteristics

- To provide technical training courses and workshops, to cover specialized field of RDBs and regional specific topics.
- To provide training opportunities not only to officials of RDBs but also to local government and agency, private companies under their region.

b. Objectives

Training aims to enhance professional and technical capacity of staff to execute works under the managing filed of RDBs.

c. Targeted Trainees

Training is offered to mainly officials under the management of RDB including national highway office, technical office, branches. Some of trainings, mostly workshops are offered to staff of local government, consultant and contractor. There is workshop specifically targeting public under their jurisdiction.

d. Training Programs

Training program has been developed to cover state administrative management and professional field managed under RDB. Training programs varies by RDBs but most RDBs offer comprehensive training courses and professional/ technical workshops. Some of RDBs

assigns technical offices to provide trainings to all staff under their subsidiaries. Below shows example of training provided at Kanto RDB.

i) Training Courses

Kanto RDB provides trainings according job ranks and professional fields (administration, general, professional). General and professional training are compulsory. Road maintenance and management training is covered under general training.

Table 9.2.26 Training Courses at Kanto RDB

Target	Administration	General	Technical professional
Manager	・ Negotiation skill	・ Training to be trainers ・ Public relations	・ Disaster assessment ・ Constriction auditor
Assistant Manager	・ Administrative law ・ Law and regulation	・ Professional skill ・ Health & safety on construction ・ Training for newly assigned assistant manager	・ Advanced engineering ・ Advanced machinery ・ Advanced electric & communication
Officers		・ Training for officers ・ Construction industry administration ・ Training at private company ・ Road maintenance & management	・ Intermediate engineering ・ Quantity survey
Newly employed	・ Administration ・ Construction Industry	・ Information security ・ Training for newly employed	・ Introduction to construction skill ・ Introduction to engineering

Source: Kanto RDB internal training program (http://www.ktr.mlit.go.jp/soshiki/soshiki00000003.html)

ii) Technical Workshop / Seminar

Kanto RDB also organizes mainly three (3) types of workshops, inviting experts in the field.

+ Skill up seminar
+ Technical workshops
+ Qualification workshop

Table 9.2.27 Workshops Organized at Kanto RDB

Type	Contents	Target	Qualification
Skill up seminar	organized once a year so that staff present their research topic	MLIT, Local government, and relevant organizations	Certificate
Technical workshops	Focused on particular topic which experts are invited to provide up to date information in the field	Professionals under RDB	Certificate
Qualification Workshop	To provide qualification training on road patrol, road maintenance and road facility management	consultant and contractors who assigned to projects on road maintenance	Certificate

3) Japan Construction Training Centre (JCTC)

a. Characteristic

- To provide training opportunities to staff of local government and agency as well as consultant and contractors on the managing field of MLIT

- To provide high-level training programs, inviting academics and experts actively involved in the field.
- To provide intensive training programs with accommodations

b. Background of Foundation

The Japan Construction Training Center (JCTC), a public foundation, was founded with financial support from National Governor's Association in 1962 with an objective of strengthening management capacity of local government officers in infrastructure construction, operation and maintenance. In 1983, JCTC strengthened its function, upon receiving request from Japan Association of City Mayor and National Association of Towns and Villages and now it expands its target to consultant and contractors, to supplement training MLIT. It has been 50 years since its establishment and about 180 thousand of people have participated in its training programs.

c. Objectives

To enhance capacity of local government staff and private company staff who are involved in infrastructure development.

d. Target Trainee

Trainings are targeting central and local government officials, ministerial agency/public corporation staff and consultant and contractors. Depends on training, stakeholders are limited to officials or open to all.

e. Training Programs

The Center offers following three (3) training programs on 12 subjects and provides in total of about 80 courses. **Table 9.2.28** shows training courses provided in 2013.

- Public official training: targeting national and local governments, foundations
- General training: targeting officials as well as private companies
- Special training: training target are limited.

Besides, the Center is accredited to run following two (2) specific training and exam.

i) Qualification Exams

As the accredited training institution by MLIT, JCTC also runs following 4 type of qualification exam under Construction Industry Act and Land Readjustment Act, once a year at main regions.

+ Civil work construction management engineers
+ Piping construction management engineers
+ Landscape work construction management engineers, and
+ Land use and construction management engineer

ii) Training Stipulated for Project Supervisor

Construction industry Act [29] also stipulates that projects over certain size are to assign "Construction Supervisor", who has expertise knowledge and skills. The supervisor is to take training every 5 year under accredit training institutions. This condition is also applied to consultant and contractors who carry out road maintenance works. The Centre offers this stipulated training for "Construction Supervisor". Training is offered as 1 day (6 hours) training at main regions and issues certificate for completion.

Table 9.2.28 Training Courses in 2013

No.	Training field	Training Courses	Trainees		
			G	G & P	M
1	Business management	Public works tendering system	X		
		Comprehensive evaluation tendering	X		
		Prevention of legal conflict in construction	X		
		Asset management		X	
		PPP/PFI		X	
		Lessons learnt from Audit Board inspection		X	
		GIS		X	
		Presentation skill in construction		X	
2	Project supervision	Cost estimate for public works	X		
		Construction work supervisor	X		
		Construction work quality control and inspection	X		
		Exercise on construction work implementation plan		X	
		Construction work supervision		X	
		Concrete work supervision		X	
		Maintenance and repair of concrete structures		X	
		Construction technologies for young engineer (Basics)		X	
		Labor safety management during construction		X	
		Temporary works		X	
		Points of public works – Planning and design		X	
		Points of public works – Construction work, supervision and inspection		X	
3	Soil and geology	Geological survey		X	
		Geological design		X	
		Measures against soil pollution		X	
4	Disaster prevention	Disaster restoration	X		
		Countermeasures right after large disasters		X	
		Flood control		X	
		Earthquake resistant design		X	
		Slope protection		X	
		Measures against land slides		X	
5	Tunnel	NATM construction technology		X	
6	Roads	Road administration – General	X		
		Road administration – Recent policy		X	
		Road planning – Exercise		X	
		City/town/village roads		X	
		Traffic safety measures for city/town/village roads		X	
		Road pavement technologies		X	
		Road technologies – Special technologies			X
7	Bridges	Bridge design		X	
		Bridge design and construction technology		X	
		PC bridge technology		X	
		New technology and construction of PC bridges		X	

[29]Amended in20th December, 2008,(LawNo.114)

No.	Training field	Training Courses	Trainees		
			G	G & P	M
		Bridge maintenance repair		X	
8	Land and right-of-way	9 courses	X	X	
9	River and dam	10 courses	X	X	
10	Erosion control	2 courses		X	
11	Urban planning	13 courses	X	X	
12	Building facilities	15 courses	X	X	

(Note) G: Government staff, P: Private company staff, M: Membership

f. Training Courses for Road Maintenance

In total of seven (7) courses are offered on road sector as shown on below table.

Table 9.2.29 Training Plan for Road (State Management Training)

	Training course	Training type	Target stakeholders	No. trainees	Days	Cooperated body
1	Road management	O	Local officials	60	10	-
2	Road Comprehension	G	All	40	3	-
3	Rod planning	G	Central / Local officials, consultants	60	10	-
4	Regional and municipal road	G	Local officials, consultants	60	5	-
5	Traffic safety on regional & municipal road	G	Local officials, consultants	50	4	-
6	Pavement technology	G	Professionals from all	50	3	Japan Road Contractors Association
7	Road technologies	S	Professionals from all with certain experiences	50	5	Japan Road Contractors Association

Source: JCTC 2015 Training Implementation schedule, G: General, O: Official, S: Special

g. Trainers

Trainers are invited from RDBs, MLIT, academics and institutes. In case of specialized subjects, trainings are implemented in cooperation with expertise bodies in fields.

h. Training Fees

Trainees have to pay training fee to JCTC including training, venue, accommodation and meals. Local officials can apply subsides from Municipal Development Corporation.

4) The Center for Infrastructure Asset Management Technology and Research (CIAM)

This section presents an example of a joint training program on infrastructure maintenance and management developed by a local government and academic institution.

Gifu University in collaboration with and Gifu Prefecture, offers training program called "Maintenance Expert Training Program[30]". This intensive training course offers general and advanced knowledge of infrastructure maintenance targeting engineers under regional authorities and regional construction industries.

[30] "Challenges For More Efficient And Effective Asset Management And Governance For Infrastructure: Maintenance Expert Training Program In Gifu", Kazuhide SAWADA, et al

a. Objectives

This program aims at cultivating human resources for the prefectural construction industries, which enable to ensure high levels of safety and security and regional activation. Followings shows objectives set for each target trainees.

- Prefectural staff: settling a long-/medium-/short-term maintenance and management plan of infrastructure at prefectural office or at Construction Research Center of Gifu Prefecture.
- Engineers in regional industries: playing a main role in disaster prevention or infrastructure maintenance works at his/her origin company, JV, or consortium, and endeavoring to guarantee the quality of the work of regional construction companies and to deliver a technical proposal of good quality

b. Responsible agency

The training program is run by Center for Infrastructure Asset Management Technology and Research (CIAM) which has been established specifically for this program under Gifu University. Besides this training, the center also runs consultant service.

c. Target trainee

- Engineers from local authorities with over 2 years of experience on infrastructure maintenance
- Engineers from regional construction industries with over 3 years of experience on inspection, design, construction, infrastructure maintenance.

d. Training courses

"Maintenance Expert Training Program" is composed from three (3) courses of asset management, applied infrastructure design and practical trainings, and runs twice a year for 20 days covering 80 lessons.

Table 9.2.30 Training Courses for ME

Courses	Subject covered
Theory on asset management	Introduction to asset management
	Data collection of asset management
	Theory of risk management
	Verification of risk management
	Financial theory
	Asset management
Applied design of infrastructure	Introduction to infrastructure design
	Design practice
	Infrastructure inspection/maintenance/reinforcement design
	Quality management practice
Practice on inspection, maintenance and reinforcement	Maintenance and repair theory
	Inspection and management practice
	Inspection, maintenance and reinforcement method practice
	Construction management theory

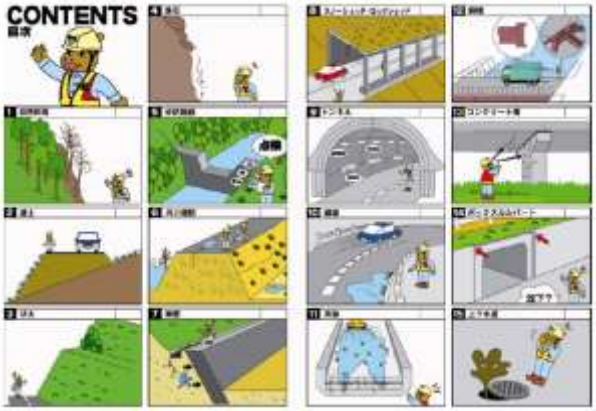
Source : "Challenges For More Efficient And Effective Asset Management And Governance For Infrastructure: Maintenance Expert Training Program In Gifu", Kazuhide SAWAD,et al

e. Trainers

Trainers are invited from teachers and professors from the university as well as Gifu prefecture, infrastructure research Centre, NPOs.

f. Textbook and Material

Textbook is developed by ME Unit. It includes many graphics to make user friendly as well as visually understandable on the importance of maintenance and management. The textbook is also widely available for public at bookshops, etc.



Source: ME Unit, CIAM

Figure 9.2.1 Example of Textbook

g. Qualification

Engineers, who successfully pass the final examination and submit sufficient reports, are granted a title of "Maintenance Expert (ME)" of regional (Prefecture) level.

9.2.4 Main Findings on current status of road maintenance training in Vietnam

- In Vietnam, training on civil servant and public official are stipulated in details. Trainings on professional knowledge and skill on professional field is delegated to each ministry. However, training program and training implementation institution are yet to be established in road maintenance sector. Thus regular comprehensive training as well as technical training is not provided.
- DOP of DRVN is responsible for human capacity development and training for road maintenance, however, lacks in staff, experience and responsibility to manage human capacity development for nationwide staff, and need review of their responsibility and strengthen their function as a whole.
- Goal and target for human capacity in road maintenance sector is absent, and training program for road maintenance is not formulated for all level of staff involved in road maintenance. Thus sufficient trainings are not offered considering staff experience, specialization and tasks assigned.

- Dedicated training implementing organization is absent not only for civil servant, but for all level of stakeholders. Although competent institution with professional knowledge and technology exists, but not well utilized for providing trainings.
- Training implementation procedure is facilitated at some degree for civil servant training but not established as training cycle for the other type of trainings. Needs assessment is not contributing to develop effective and efficient training program, and monitoring evaluation on training have not been implemented.
- Limitation on available training resources such as facility, equipment, materials, trainers and funds is considered one of the main causes for limiting sufficient delivery of training in road maintenance sector, especially for Non Business Unit and enterprise. Also due to not grasps an entire picture of required trainings, training funds are not secured.

9.3 RECOMMENDATION FOR TRAINING OF PROJECT OUTPUTS

DRVN as state management for National Road delegated by MOT is expected to play a leading role for human capacity development on road maintenance. Recommendations are formulated for training of project outputs focusing on following points.

- Enhance training cycle
- Develop training program
- Strengthen training implementation system
- Strengthen technical support

9.3.1 Principle Approach

- Regular trainings are delivered to all stakeholders involved in road maintenance activity related to the project outputs.
- Trainings program for road maintenance is developed integrating reinforcement of road maintenance activities and institutional reform through the project, at the same time sustainable manner in Vietnam.
- Training are delivered utilize existing training system where possible.
- Focus of reinforcement lies on development of DRVN organization capacity to deliver trainings to stakeholders, and to influence institution to enable sufficient delivery of trainings.

9.3.2 Strengthen Training Implementing Procedure

DRVN is recommended to review existing procedure and establish “sustainable training cycle”. The cycle contains 1) Goal and Human capacity development strategy, 2) Needs assessment, 3) Training program development, 4) Implementation, and 5) Monitoring and Evaluation, as shown on the below figure, and allows delivering trainings continuously, at the same time to

enhance the training quality by implementation through reviewing for next trainings toward the Goal of human resource in road maintenance.

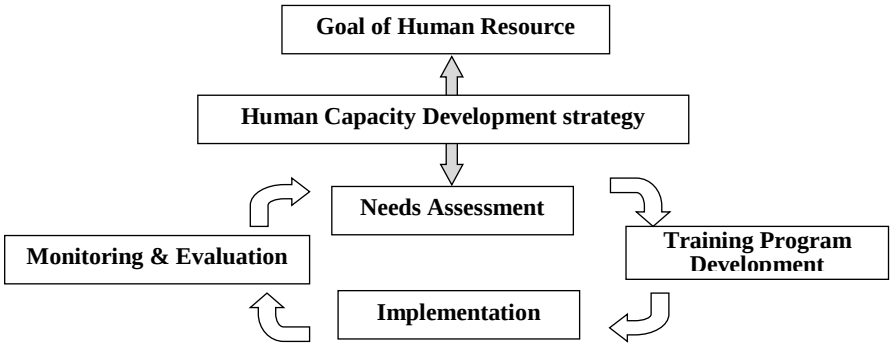


Figure 9.3.1. Sustainable Training Cycle

1) Goal and Strategy of Human Capacity Development

DRVN is advised to set the Goal of future expected capacity of individuals and agencies to promote project outputs in Vietnam, so that the gap of existing and future needs of human resource capacity is clarified. Human capacity development strategy is formulated to set detail approaches to fill the gap achieving the Goal, and shared among relevant agencies.

2) Needs Assessment

DRVN is advised to coordinate with relevant road maintenance agencies to accumulate training needs and demand.

3) Training Program Development

Based on the above assessment, training programs is developed or revised, and annual training plan on road maintenance is formulated. It is advised that annul training plan is to provide sufficient details of training courses for a year ahead, so that staff and agency to can plan ahead.

4) Implementation

DRVN is advised to clarify role and responsibility of department and agency for implementation of trainings and establish training system to ensure regular implementation of trainings.

5) Monitoring and Evaluation

Monitoring and evaluation of training is a key to provide effective trainings as well as opportunity to gather future trainings needs. Based on results, training program, training contents, material, training implementation system are reviewed for trainings in the future.

9.3.3 Develop Training Program

In order to ensure delivery of sufficient information and technology on road maintenance activities enhanced by the Project to right stakeholders, development of training program for "During the project" and "After the project "are recommended. It is essential to get approval

from agencies and units responsible for road maintenance, on developed training programs prior to develop training plan and implement trainings.

In order to formulate effective training program, it is advised to apply following step process from the identification of training requirements (Step 1 to Step 4), to training program planning (Step 5). Recommended training program are detailed in Section 9.4.

1) Step 1: Identification of Required Output for the Project activities

Required outputs for each project activity and responsible body are identified for "During and After the Project".

2) Step 2: Identification of Targeted Stakeholders

Stakeholders are examined through work assignments to deliver above identified outputs. For "During the Project", stakeholders are limited in the project counterparts of DRVN, RRMB I[31], RTC Central, RTC 1 and SBs under RRMB I jurisdiction, which is broadened to nationwide at training for "After the Project".

3) Step 3: Clarification of Stakeholder Task Assignment against Required Output

Stakeholders identified are further clarified for their assigned tasks and performance expected against required outputs. Task allocation of "During and After the Project" is shown tentatively in Table 9.3.1. Prior to the implementation of trainings, DRVN is advised to review the table under the Activity 4, and also to take in account of project progress as well as any renovation or reform occurred after the project term.

4) Step 4: Identification of Required Information and Technologies

Information and technology, as well as their depth to be provided are carefully considered according to assigned tasks of stakeholders. To provide right information to right stakeholders, the above Step 3 task allocation and grasp existing and expected staff capacity for tasks becomes crucial.

5) Step 5: Planning of Training Program

Based on the above identified training requirements, training programs are planned further details for the most efficient, effective and economical manner to be delivered in consideration with below listed.

a. Responsible Organizations for Training Implementation

Each training program needs to identify responsible organization for implementation, and trainers. Details are further recommend under following training implementation system.

[31] RRMU II is replaced to RRMB I, and RTC 1I is replaced to RTC 1, and RRMCs is replaced to SBs, in this chapter hereafter.

b. Training Implementation Style

Training style is selected from such as workshop, seminar, classroom training, OJT as appropriate to training contents and target stakeholder. Especially for technical training requiring building in-depth knowledge and skill, a combination of knowledge building training and OJT is recommended. Continuous cycle of knowledge building and its application to the real setting is considered to enhance further understanding through supplementing each other.

c. Frequency and Duration

In order to enhance human capacity, it is crucial that trainings are provided regularly for sufficient duration. Especially technical subjects require regular trainings to make sure development of sufficient stable capacity of stakeholders, as well as transfer and update the latest technologies. In case of trainings for SBs where staff have quick turnover require sufficient frequency in a year so that newly assigned staff has opportunity to receive training.

d. Material, Equipment and Facility Required

Output of project activities such as system, guidelines, manuals, standards and software are utilized as primary training materials. Supplement materials are also advised to be prepared as required. Also equipment and facility, permission required, funding source also arranged for required training implementation.

Table 9.3.1 Tasks Required for Proposed Road Maintenance Activities under the Project

Project Activity	OUTPUT = Training Material	Tasks required for deployment	Central Level			Regional level			Others
			MOT	DRVN	RTC Central	RRMBs / PDOTs	RTCs	SBs / PRRMCs	
Activity 1 Road information management									
Activity 1.1:Prepare road database system & confirm requirements for the system Activity 1.2: Develop Road Database input format and Software Activity 1.3: Validate Database and Monitor Data input	・ Database operation software ・ Operation Manual	System Maintenance and Management		○	○		○		
		Database Management		○					
		Operation of system		S		○			
		Data verification				○			
		Data inputting				S		○	
		Technical Support			○		○		
Activity 2 Road Maintenance Planning									
Activity 2.1: Conduct Pavement Condition Survey	・ Vehicle ・ System for pavement condition survey ・ Operation Manual	System Maintenance and Management		○					
		Database Management		○					
		Operation of system			○		○		
		Site Survey Management				○			
		Data verification			○	S	○		
		Survey & Data inputting			○		○		
Activity 2.2 a PMS / PMoS Dataset Conversion Software Development	・ PMS Dataset ・ Operation Manual	System Maintenance and Management		○	○		○		
		Database Management		○					
		Operation of system (Data conversion)				○			
		Data Verification				○			
		Data importing				○			
		Technical Support			○		○		
Activity 2.2 b Formulate road maintenance plan	・ VPMS system (Planning software) ・ Operation Manual	System Maintenance and Management		○	○		○		
		Pavement Maintenance & Budget plan		○		○			
		Data analysis		○		○			
		Operation of system		○		○			
		Site Survey & Data Inputting				S		○	
		Data importing		○		○			
		Technical Support			○		○		
Activity 3 Road maintenance Technology									
Activity 3.1 Improve Road Maintenance Technology on Road inspection, Diagnosis, Repair work selection	・ Technical Standards covering road inspection, Diagnosis, Repair work selection	Site management		○		○			
		Repair and maintenance work				S		○	
		Data Collection				S		○	
		Patrolling / Inspection				S		○	
Activity 3.2 Improve Technical Standards on Road Routine Maintenance 2003	・ Revised Routine maintenance standards	Update and management of Standard		○					
		Selection of repair and maintenance work				○			
		Appraisal & verification of maintenance work				○			
		Evaluation of road inspection result				○			
Activity 3.3 Develop Pavement monitoring system	・ Pavement Monitoring System ・ Operation Manual	System Maintenance and Management		○	○		○		
		Database Management		○					
		Operation of system		S		○			
		Data Verification		S		○			
		Data importing		S		○			
		Technical Support			○		○		
Activity 4 Road maintenance institution									
Reinforce DRVN management system on Capacity Development	・ Road maintenance implementation procedure ・ Recommendation on road maintenance institutions	Review of Road maintenance Institution	S	○					
		Review of Road maintenance procedure	S	○	○	○	○	○	○

LEGEND S : Supporting body ○ : Implementing Body / User

9.3.4 Reinforce Training Implementation System for Road Maintenance Sector

(1) Reinforce Training Implementation System

Strengthen and establish training implementation system for road maintenance sector is crucial to deliver training programs developed for continuous deployment of project outputs utilizing existing and potential capacity of agencies on expertise knowledge and trainings. Please be noted that the recommendation is subject to the proposal of Activity 4.

Through the development of training program at Section 9.4, training implementation systems for" During and After the project" were analyzed and recommended to be developed in phases. "During the project" trainings are implemented in cooperation with DRVN and JICA Project Team aiming to enhance DRVN capacity not only in planning and management, but also in implementation of trainings and workshops, and develop trainers. Then for training "After the project", trainings are deployed nationwide with lead of DRVN preferably in cooperation with RTC Central and institutes. RTC Central is recommended to reinforce capacity to implement technical aspects of training. With regards to highly technical subjects, it is advised to cooperate with experts in the field such as science and academic institutions under MOT, so that those subjects are sufficiently addressed with up to date information and technologies compatible to the world standard.

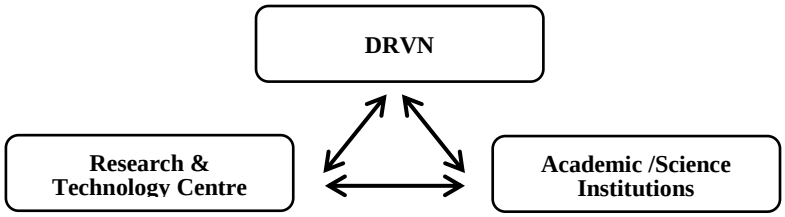


Figure 9.3.2 Cooperation for Training Implementation "After the project"

(2) Strengthen of DOP of DRVN

In order to implement necessary trainings for road maintenance activities recommended in the project completion, in addition to delegate training implementation to external professional training organization, DRVN is recommended to strengthen its inner training function by setting up a dedicated unit under DOP of DRVN.

The unit is to be responsible for the professional capacity enhancement of staff involved in the DRVN managing field. It is expected to play a key role to disseminate information and technology through regular trainings and workshops under DRVN, not only focusing on general topic on administration and management, but also to provide technical trainings as required.

Tasks involves are development, coordination, implementation, management and monitoring and evaluation of training program, and also coordinates with responsible agencies for project outputs, as well as RTCs and research and academic institutions for implementation.

9.3.5 Technical Support System in Cooperation with UTC

On capacity enhancement of highly technical activities, it is crucial that professional and technical staff receive not only regular trainings but also technical support in order to maintain the system running by resolving any technical issues arise in everyday work. DRVN is recommended to establish technical support system in corporation with experts who have leading knowledge and skill in the field, such as UTC who have been supporting this Project for developing database system and software.

9.4 FORMULATION OF TRAINING PROGRAM

This section presents the training program developed for Project Outputs, Phase1: During the Project and Phase 2; After the Project.

9.4.1 Training Demand Analysis

Prior to develop training program, training demands were analyzed focusing on stakeholders, training program, and training implementation body, against road maintenance activities enhanced through the Project.

(1) Stakeholder Analysis

Stakeholders for training of "During and After the Project" are summarized in below **Table 9.4.1**.

- Staff is divided in to three (3) categories of management staff, professional and technical staff, and site workers, and involves nationwide Vietnam.
- "During the Project" is limited to the project counterparts under the jurisdiction of RRMB I, which is broaden to nationwide stakeholder at "After the Project".
- Currently renovation plan for road maintenance is on progress. Training "After the Project" needs to take into account those expected changes.

Table 9.4.1 Targeted Stakeholder and Organization Analysis

	Category	Targeted Organizations		Targeted Stakeholders
		During the Project	After the Project	
Central Government	Central Agency	DRVN	MOT, DRVN	Management staff
				Professional staff
		RTC Central	RTC Central	Management staff
				Professional & Technical staff
	Regional Agency	RRMB I	RRMBs	Management staff

				Professional & Technical staff
		RTC Central / RTC 1	RTCs	Management staff
				Professional & Technical staff
		SBs	SBs	Management staff
				Professional & technical staff
Private companies	Consultant/contracted companies)		PRRMCs, VEC, BOT/BT companies	Professional & Technical staff
				Site workers

(2) Training Program Analysis

Table 9.4.2 shows demand analysis on training subject for identified stakeholders. Training previously or currently offered is highlighted. Followings are some points observed.

- A great deal of information and technology is yet to be provided so that stakeholders carry out their assigned tasks sufficiently.
- Type and depth of information and technology to be covered varies depends on stakeholders. Professional and technical staff requires comprehensive and in depth practical information and technology, whereas management staff requires administration and management, and site workers need practical skill on site.

Table 9.4.2 Training Program Analysis

Project Activity	Training subject	Central Level			Regional level		
		MOT	DRVN	RTC Central	RRMBs	RTCs	SBs
Activity 1 Road information management							
Activity 1 Road information management	System Maintenance & Management		○	○	○	○	
	Database Management		○	○	○	○	
	Operation of system		○	○	○	○	
	Data verification		○	○	○	○	
	Data inputting		○	○	○	○	
Activity 2 Road Maintenance Planning							
Activity 2.1: Pavement Condition Survey	System Maintenance & Management		○	○	○	○	
	Database Management		○	○	○	○	
	Operation of system		○	○	○	○	
	Site Survey Management		○	○	○	○	
	Data verification		○	○	○	○	
	Survey & Data inputting		○	○	○	○	
Activity 2.2 a PMS / PMoS Dataset Conversion Software Development	System Maintenance & Management		○	○	○	○	
	Database Management		○	○	○	○	
	Operation of system		○	○	○	○	
	Data Verification		○	○	○	○	
	Data importing		○	○	○	○	
Activity 2.2 b Road maintenance planning	System Maintenance & Management		○	○	○	○	
	Pavement Maintenance & Budget		○	○	○	○	
	Data analysis		○	○	○	○	
	Operation of system		○	○	○	○	
	Site Survey & Data Inputting		○	○	○	○	
	Data importing		○	○	○	○	
Activity 3 Road maintenance Technology							
Activity 3.1: Road inspection, diagnosis, repair work selection	Site management		○	○	○	○	○
	Repair and maintenance work		○	○	○	○	○
	Data Collection		○	○	○	○	○
	Patrolling / Inspection		○	○	○	○	○

Project Activity	Training subject	Central Level			Regional level		
		MOT	DRVN	RTC Central	RRMBs	RTCs	SBs
Activity 3.2 Technical standards on road routine maintenance 2003	Update and management of Standard		○	○	○	○	
	Selection of repair maintenance work		○	○	○	○	
	Appraisal of maintenance work		○	○	○	○	
	Evaluation of road inspection result		○	○	○	○	
Activity 3.3 Pavement monitoring system	System Maintenance & Management		○	○	○	○	
	Database Management		○	○	○	○	
	Operation of system		○	○	○	○	
	Data Verification		○	○	○	○	
	Data importing		○	○	○	○	
Activity 4 Road maintenance institution							
Activity 4 Road maintenance institution	Review Road maintenance Institution	○	○	○	○	○	
	Review Road maintenance procedure	○	○	○	○	○	○

(3) Training Implementation Body Analysis

Potential agencies and organizations to implement trainings are examined in **Table 9.4.3**. Highlighted are existing training provided by training implementing bodies.

- A great need of capacity enhancement in human capacity development is required for DRVN and RTC Central to manage and organize trainings implementations.
- To deliver required training programs for road maintenance, support from existing domestic institution under DRVN and MOT, such as ITST and UTT/UTC are required.

Table 9.4.3 Training Implementation Body Analysis

Project Activity	Training subject	Road maintenance agency			Institute under MOT/DRVN			
		DRVN	RRMB	RTC Central	ITAMC	ITST	UTT/ UTC	NTSS
Activity 1 Road information management	System Maintenance & Management	○		○		○	○	
	Database Management	○		○		○	○	
	Operation of system	○		○		○	○	
	Data verification	○		○		○	○	
	Data inputting	○		○		○	○	
Activity 2.1: Pavement Condition Survey	System Maintenance & Management			○			○	
	Database Management			○			○	
	Operation of system			○			○	
	Site Survey Management			○			○	
	Data verification			○			○	
	Survey & Data inputting			○			○	
Activity 2.2 a PMS / PMoS Dataset Conversion Software Development	System Maintenance & Management	○		○			○	
	Database Management	○		○			○	
	Operation of system	○		○			○	
	Data Verification	○		○			○	
	Data importing	○		○			○	
Activity 2.2 b Road maintenance planning	System Maintenance & Management	○		○			○	
	Pavement maintenance & budget	○		○			○	
	Data analysis	○		○			○	
	Operation of system	○		○			○	
	Site Survey & Data Inputting	○		○			○	
	Data importing	○		○			○	
Activity 3.1: Road inspection,	Project / Site management	○		○		○	○	
	Repair and maintenance work	○		○			○	

Project Activity	Training subject	Road maintenance agency			Institute under MOT/DRVN			
		DRVN	RRMB	RTC Central	ITAMC	ITST	UTT/ UTC	NTSS
diagnosis, repair work selection	Data Collection	○		○			○	○
	Patrolling / Inspection	○		○			○	○
Activity 3.2 Technical standards on road routine maintenance 2003	Update and management of Standard	○				○	○	
	Selection of repair maintenance work	○				○	○	
	Appraisal of maintenance work	○				○	○	
	Evaluation of road inspection result	○				○	○	
Activity 3.3 Pavement monitoring system	System Maintenance & Management	○		○			○	
	Database Management	○		○			○	
	Operation of system	○		○			○	
	Data Verification	○		○			○	
	Data importing	○		○			○	
Activity 4 Road maintenance institution	Review Road maintenance Institution	○					○	
	Review Road maintenance procedure	○					○	

Note. ITAMC: Institute for Transport Administration and Management Cadres

9.4.2 Training Program for "During the Project"

Developed training program for "During the Project" is presented in **Table 9.4.6**.

1) Objectives

- Deliver information and technologies of the project output to the project counterparts, so that their understanding on project activities and outputs are deepen to enhance efficiency on project activities, as well as their capacities is improved sufficiently to operate project outputs.
- Develop trainers so that trainings are continuously delivered to disseminate project outputs nationwide after the project completion.

2) Principle

- Trainings are implemented in cooperation with JICA Project Team and DRVN
- Target trainees are limited to project counterparts
- Implementation is subject to the progress of activities

3) Responsible Agency

Basically WGs and project experts were responsible for the development of project outputs, training details and materials, whereas PMU TA and WG-5 have been responsible for administration, coordination and management of training.

Table 9.4.4 Responsible Agencies for Training "During the Project"

Responsibility	Tasks	Assigned agencies
Administration & management of Training	・ Manage trainings ・ Coordinate with road maintenance agencies and Units ・ Arrangement for implementation of trainings	・ PMU TA ・ WG-5

	・ Monitor and evaluate trainings	
Implementation of Training	・ Develop training contents and materials ・ Implement trainings ・ Evaluate trainings	・ JICA Experts ・ WGs responsible for the development of project outputs

4) Target Trainees

Training target has been limited to the project counterparts of DRVN, RRMB I, RTC Central, and RTC 1 and SBs.

5) Training Implementing System

Figure 9.4.1shows recommended training implementation system. To deliver training in cooperation of JICA Project Team and DRVN (WGs), this was considered the most efficient and effective for training quality, dissemination speed, and development of trainee capacity. Trainers are JICA Project Experts, JICA Project Assistant and members of WGs.

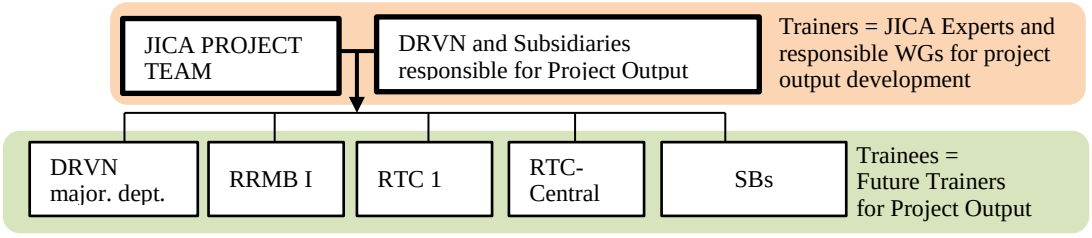


Figure 9.4.1 Training Implementation System for "During the Project"

6) Training Style

Mainly two styles have been employed, which are 1) Workshop, and 2) Technical training courses including OJT, Classroom teaching, Workshop, depends on training subject and trainees.

Workshop was hold to address wider range of stakeholders to disseminate project activities and outputs, whereas technical training courses were offered further in-depth technical and practical knowledge and skills on project outputs for professional and technical staff so that they can apply the outputs to the actual situation.

7) Timing, Frequency and Duration

Technical training courses and Workshop have been provided as appropriate to the progress of project outputs and as many times as possible.

8) Training Materials

Outputs of each activity have been used as main training materials, and sub materials have been also prepared as required for training by trainers.

Table 9.4.5 Trainings Materials Developed by the Project

Training courses		Project Act.	Training materials
Road Information Management		Act-1	・ Road Database System ・ Road database user manual
Pavement Condition Survey		Act-2.1	・ Pavement Condition Survey Manual
PMS / PMoS Dataset Conversion Software Development		Act-2.2a	・ PMS/PMoS Dataset Conversion software ・ Operation Manual
Road Maintenance Planning		Act-2.2b	・ Road Maintenance Planning software ・ Operation Manual
Road Inspection and Maintenance Technology	Road Inspection Technology	Act -3.1	・ Inspection Guideline
	Road Maintenance Technology	Act-3.2	・ Routine Road Maintenance Manual
	Pavement Monitoring Technology	Act-3.3	・ Pavement Monitoring System ・ Operation Manual

9) Qualification and Certificate

Training and workshop implemented during the project term, have not issued any qualification nor certificate.

Table 9.4.6 Recommended Training Program for "During the Project"

Training Program Requirements for "During the Project"					Training program planning for "During the Project"				
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Trainer / Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
Activity 1 Enhancement of Road Information Management	Road Asset Database System	・ Road Maintenance & Management Dept. .[32] ・ DRVN-IC (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Road Maintenance & Management Dept. ・ Technical & Construction Management Dept. (RRMB I)	DRVN Major Dep. (Management staff of Central State Agency)	・ General Guidance on Database System ・ Database Management ・ Operation of system	・ Road Maintenance & Management Dept. ・ DRVN-IC (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Technical & Construction Management Dept. (RRMB I)	・ JICA Project Expert ・ Road Maintenance & Management Dept. ・ DRVN-IC - RTC Central ・ University (UTC)	・ Workshop ・ Technical training (Classroom)	1day (1/ yr)	・ Database system ・ software ・ Operation Manual
			Traffic Safety Dept. / Information Centre (System / Database Manager of State Agency)	・ General Guidance on Database System ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting				1day (1/ yr)	
			RRMB I (Professional Staff of Regional Agency)	・ General Guidance on Database System ・ Operation of system ・ Data verification ・ Data inputting				1day (1/ yr)	
			RTC 1/ RTC Central (System maintenance /Technical Support)	・ General Guidance on Database System ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting				1day (1/ yr)	
			SBs (Site worker)	・ General Guidance on Database System ・ Data inputting				1day (2/ yr)	
Activity 2 Enhancement of Planning Capacity for Road Maintenance	Activity 2 .1 Pavement Condition Survey	・ Planning & Investment Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	DRVN Major Dep. (Management staff: of Central State Agency)	・ General Guidance on Pavement Condition Survey	・ Planning & Investment Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	・ JICA Project Expert ・ Planning & Investment Dept. ・ RTC Central	・ Workshop ・ Technical training(OJT/Classroom)	1day (1/ yr)	・ Vehicle ・ System for pavement condition survey ・ Operation Manual
			Planning & Investment Dept. (Professional Staff: Database Manager /System Manager)	・ General Guidance on Pavement Condition Survey ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting				1day (1/ yr)	
			RRMB I (Professional Staff/:End User)	・ General Guidance on Pavement Condition Survey ・ Operation of system ・ Site Survey Management				1day (1/ yr)	

[32] Road Infrastructure & Traffic Safety Department has been restructured under the Decision No.60/2009/QD-TTg, 21st October 2013, and Act 1 Road Information Management is moved to responsibility of Road Maintenance & Management Dept.

Training Program Requirements for "During the Project"					Training program planning for "During the Project"				
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Trainer / Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
			RTCs (Professional Staff: End User)	・ General Guidance on Pavement Condition Survey ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting				1day (1/ yr)	
			SBs (Site worker)	・ General Guidance on Pavement Condition Survey ・ Data inputting				1day (2/ yr)	
	Activity 2 .2.a PMS /PMoS Dataset CS Development	・ Planning & Investment Dept. ・ Information Centre (In cooperation with) ・ Science, technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	DRVN Major Department (Management staff: of Central State Agency)	・ General Guidance on Database System ・ Operation of system	・ Planning & Investment Dept. ・ Information Centre (In cooperation with) ・ Science, technology and International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic and Planning Dept. (RRMB I)	・ JICA Project Expert ・ Planning & Investment Dept. ・ Information Centre ・ RTC Central ・ University (UTC)	・ Seminar/Workshop ・ Technical training (OJT/Classroom)	1day (1/ yr)	・ PMS Dataset ・ Operation Manual User Manual
			Planning & Investment Dept. / Information Centre (Professional Staff: System / Database Manager)	・ General Guidance on Database System ・ System Maintenance & Management ・ Database Management ・ Operation of system ・ Data verification ・ Data import				1day (1/ yr)	
			RRMB I (Professional Staff: End User)	・ General Guidance on Database System ・ Operation of system ・ Data verification ・ Data import				1day (1/ yr)	
Activity 2 Enhancement of Planning Capacity for Road Maintenance			RTC 1/ RTC Central (System maintenance /Technical Support)	・ General Guidance on Database System ・ System Maintenance & Management ・ Database Management ・ Operation of system ・ Data verification ・ Data import				1day (1/ yr)	
			SBs						
	Activity 2 .2b VPMS	・ Planning and Investment Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	DRVN Major Department (Management staff: State Agency / End User)	・ General Guidance on VPMS System ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis	・ Planning and Investment Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept.	・ JICA Project Expert ・ Planning & Investment Dept. ・ DRVN-IC ・ RTC Central ・ University (UTC)	・ Workshop ・ Technical training (OJT/Classroom)	1day (1/ yr)	・ VPMS system ・ Operation Manual
			Planning & Investment Dept. / DRVN-IC (Professional Staff: System / Database Manager)	・ General Guidance on VPMS System ・ System Maintenance & Management ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis ・ Data importing ・ Data Inputting				1day (1/ yr)	

Training Program Requirements for "During the Project"					Training program planning for "During the Project"				
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Trainer / Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
			RRMB I (Professional Staff: End User)	・ General Guidance on VPMS System ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis ・ Data importing ・ Data Inputting	(RRMB I)			1day (1/ yr)	
			RTC 1/ RTC Central (Professional staff System maintenance /Technical Support)	・ General Guidance on VPMS System ・ System Maintenance & Management ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis ・ Data importing ・ Data Inputting				1day (1/ yr)	
			SBs (Site worker)	・ General Guidance on VPMS System ・ Data Inputting				1day (2/ yr)	
Activity 3 Improving Road Maintenance Technologies	Activity 3.1 Maintenance technology	・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. (In cooperation with) ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1 / RTC Central	DRVN Major Dep. (Management staff: State Agency)	・ General Guidance on Inspection	・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. (In cooperation with) ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1 /RTC Central	・ JICA Project Expert ・ Science, technology and International Cooperation Dept. ・ Road Maintenance & Management Dept.	・ Seminar/Workshop ・ Technical training (OJT/Classroom)	1day (1/ yr)	・ Technical Standards covering road inspection, Diagnosis, Repair work selection
			RRMB I (Professional Staff: Site Manager)	・ General Guidance on Inspection ・ Site management ・ Repair and maintenance work ・ Data Collection ・ Patrolling / Inspection				1day (1/ yr)	
			RTC 1/ RTC Central (Professional Staff)	・ General Guidance on Inspection ・ Site management ・ Repair and maintenance work ・ Data Collection ・ Patrolling / Inspection				1day (1/ yr)	
			SBs (Site Worker)	・ General Guidance on Inspection ・ Repair maintenance work ・ Data Collection ・ Patrolling / Inspection				1day (2/ yr)	
Activity 3 Improving Road Maintenance Technologies	Activity 3.2 Revised Routine Maintenance Standard	・ Road Maintenance & Management Dept. ・ Economic & Planning Dept. (RRMB I) (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ RTC 1 / RTC Central	DRVN Major Dep. (Management staff: State Agency)	・ Guideline of revised standard	・ Road Maintenance & Management Dept. ・ Economic & Planning Dept. (RRMB I) (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ RTC 1/ RTC Central	・ Road Maintenance & Management Dept. ・ Economic and Planning Dept. (RRMB I)	・ Workshop ・ Technical training (Classroom)	1day (1/ yr)	Revised Routine Maintenance Standard
			RRMB I (Professional Staff: End User)	・ General Guidance on Revised Routing Maintenance Standard ・ Appraisal & verification of maintenance work ・ Selection of repair & maintenance work ・ Evaluation of road inspection result				1day (1/ yr)	
			RTC 1/ RTC Central (Professional Staff: End User)					1day (1/ yr)	
			SBs (End User)					1day (2/ yr)	
	Activity 3.3 Pavement Monitoring	・ Road Maintenance & Management Dept. ・ Information Centre	DRVN Major Dep.(Management staff: State Agency/ End User)	・ General Guidance on PMoS System, ・ Operation of System,	・ Road Maintenance & Management Dept.	・ JICA Project Expert ・ Road Maintenance &	・ Workshop ・ Technical training (OJT/Classroom)	1day (1/ yr)	・ Pavement Monitoring System ・ Operation

Training Program Requirements for "During the Project"					Training program planning for "During the Project"				
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Trainer / Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
	System	(In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1/ RTC Central	Road Maintenance & Management Dept./ DRVN-IC (Professional Staff: System / Database Manager)	・ General Guidance on PMoS System, ・ System Maintenance & management ・ Database management ・ Operation of System ・ System Guidance ・ Operation of System ・ Data Verification ・ Data importing	・ DRVN-IC (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1/ RTC Central	Management Dept. ・ DRVN-IC		1day (1/ yr)	Manual
			RRMB I (Professional Staff: End User)	・ General Guidance on PMoS System, ・ Operation of System ・ Data Verification ・ Data importing				1day (1/ yr)	
			RTC 1/ RTC Central (Professional staff System maintenance /Technical Support)	・ General Guidance on PMoS System, ・ System Maintenance & management ・ Database management ・ Operation of System ・ Data Verification ・ Data importing				1day (1/ yr)	
			SBs						
Activity 4 Strengthen Road Maintenance institution	Road maintenance Procedure	・ Road Maintenance & Management Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Organization & Personnel Dept. ・ Transport & Legislation Dept. ・ Traffic Management Dep. ・ RTC Central	MOT/DRVN Major Department (Management staff: State Authority/State Agency)	・ General Guidance on Road Maintenance institution ・ Road Maintenance institution & Procedure	・ Road Maintenance & Management Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Organization & Personnel Dept. ・ Transport & Legislation Dept. ・ Traffic Management Dep. ・ RTC Central	・ JICA Project Expert ・ Road Maintenance & Management Dept.	・ Workshop ・ Technical training (workshop/Classroom)	1day (1/ yr)	・ Road maintenance implementation procedure ・ Recommendation on road
			RRMB I (Management staff:/Professional Staff: End User)					1day (1/ yr)	
			RTC 1/ RTC Central (Professional Staff: End User)					1day (1/ yr)	
			SBs (End User)					1day (2/ yr)	

9.4.3 Training Program for "After the Project"

Recommended training program for "After the Project" is presented on **Table 9.4.10**.

(1) Objectives

Trainings offered "During the Project" is continuously implemented by the project counterparts with supporting organizations, so that project outputs are disseminated to all stakeholders of nationwide.

(2) Principle

- Regular trainings implemented to nationwide stakeholders for provision of information and technologies on outputs of the project activities.
- Training is implemented by lead of DRVN with cooperation of existing agency and institutions with expertise knowledge and skills
- Integrate proposed institutional and administrative reform into training program

(3) Responsible Agency

DRVN major departments responsible for the project outputs continue to be responsible for training details and materials, whereas Department of Organization and Personnel of DRVN is advised to set up dedicated unit for human capacity development and training, and take over entire responsibility for administrative management of training.

Table 9.4.7 Responsible Agencies for Training "After the Project"

Responsibility	Tasks	Assigned agencies
Administration & management of training	・ Manage trainings ・ Coordinate with road maintenance agencies and Units ・ Monitor and evaluate trainings	・ Department of Organization and Personnel of DRVN
Implementation of training	・ Develop training contents and materials ・ Implement trainings ・ Evaluate trainings	・ DRVN departments responsible for the outputs ・ RTC Central ・ Academic and science intuitions

(4) Target Trainees

Target trainees are broaden to nationwide management and professional /technical staff involved in road maintenance.

(5) Training Implementing System

1) Alternatives

Three (3) alternatives for training implementing system are developed as shown on **Table 9.4.8** and Figure 9.4.2. Result of analysis shows that Option A training by DRVN and RTC Central which divides management level training by DRVN and professional/technical level training by

RTC Central with cooperation of existing academic /science institutions is the most preferable training implementing system for training "After the Project".

- Option A implements training in two phases of Management training by DRVN and Professional training by RTC Central in cooperation with academic and science institute.
- Option B implements trainings by DRVN only to all stakeholders at one phase.
- Option C implements trainings in two phases to cascade down from central to regional agencies.

Table 9.4.8 Concept of Options on Training Implementing System for "After the Project"

Options	Concept	Phases	Implementing body	Staff level	Target stakeholder
Option A	Two Phased	Phase 1	DRVN	Management	DRVN, RRMBs, RTC Central
		Phase 2	RTC Central+ Academic /Science Institute	Professional/Technical	DRVN, RRMBs, RTCs, SBs
Option B	All Inclusive	Phase 1	DRVN	Management/Professional/technical	DRVN, RRMBs, RTCs, SBs
Option C	Three Phased	Phase 1	DRVN	Management /Professional/	DRVN, RRMBs, RTC Central
		Phase 2	Phase 1Trained trainees	Professional/Technical	RRMBs, RTCs, SBs

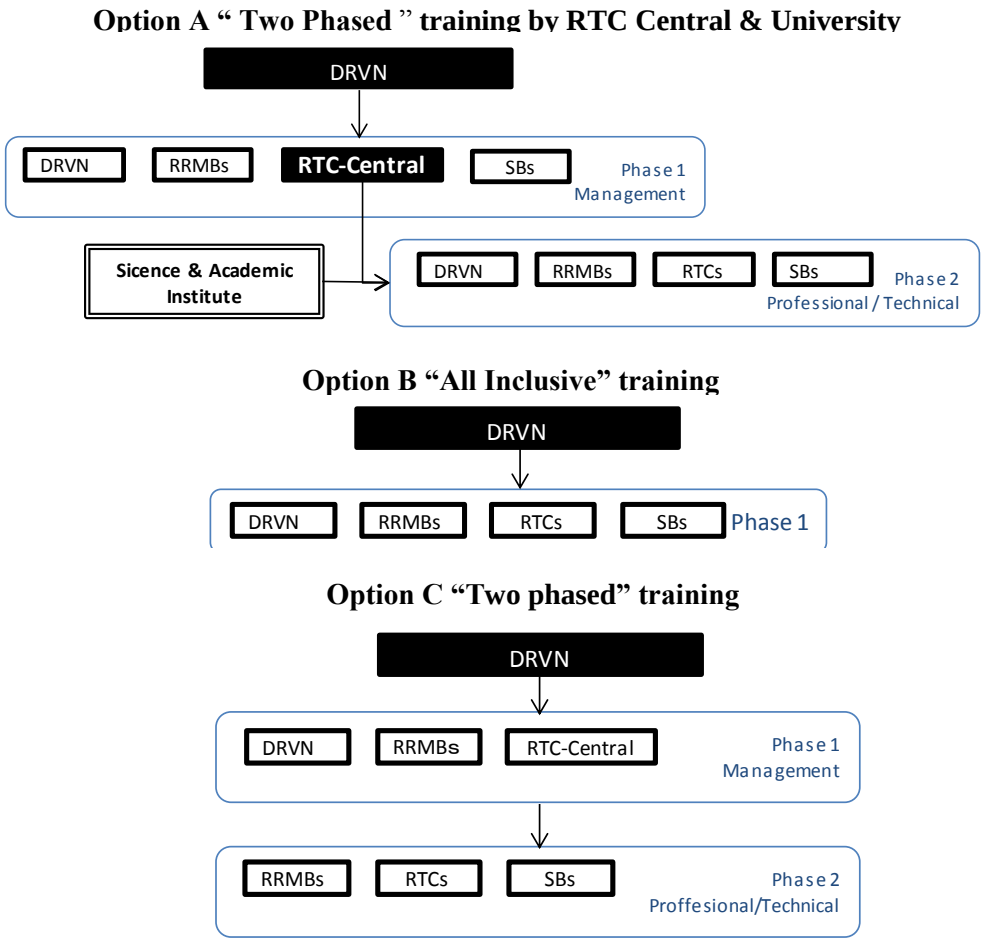


Figure 9.4.2 Options on Training Implementing System for "After the Project"

Table 9.4.9 Comparison of Alternative on Training Institution "After the Project"

Evaluation Index		Option A DRVN/RTC	Option B All inclusive	Option C 2 Phases
Training Quality	Direct training from experts	○	Δ	×
	Depth of knowledge and skill provided	○	×	Δ
	Training needs and demands covered by tasks	○	×	Δ
	Enhancement of stakeholder capacity	○	×	Δ
Efficiency	Minimum number of trainings to be implemented	Δ	○	×
	Fast dissemination of information	Δ	○	Δ
	Saving cost on Facility and equipment	○	Δ	Δ
Overall		A	C	B

Legend: ○ Advantage, ⊿Fair, ×Disadvantage

2) Training Implementing Body

a. DRVN

DRVN, as Central state agency managing national roads, is advised to strengthen its capacity on training implementation as mentioned earlier, addressing wider stakeholders and lead to provide comprehensive management trainings.

i) Targeted Stakeholders

DRVN is recommended to provide training mainly to management staff of Central government agencies of MOT and other ministries, DRVN, RTC Central, RRMBs, RTCs, and SBs.

ii) Consideration for Training Implementation

+ Develop trainers within DRVN and invite experts.
+ Unit under DOP of DRVN is established.
+ Accumulate knowledge and resources relevant to road maintenance including training materials, so that they can be utilized for other future training.

b. Road Technical Centers (RTCs)

RTCs, responsible for research and technology, are recommended to enhance their capacity on technical training focusing on OJTs and technical workshops and technical support, utilizing their expertise knowledge and skill to road maintenance sector. Especially RTC Central under DRVN is expected to be a leading body for technical training and coordinates with other potential training implementing bodies for specialized technical subject.

i) Targeted Stakeholders

RTC Central is recommended to deliver trainings to professional and technical staff and site workers of Central government agencies (DRVN, RTC Central, RRMBs), whereas RTCs under RRMBs are proposed to target professional and technical staff as well as consultant and contractors under their jurisdiction of RRMBs.

ii) Consideration for Training Implementation

+ Develop trainers under each RTC to provide regular trainings and technical supports in regions.
+ Review responsibility and financial incentive for RTCs to enable sufficient delivery of trainings to wider stakeholders sustainably.
+ Organize sufficient facility and equipment for provision of trainings and workshops.

c. Institute of Transport Science and Technology (ITST)

The Centre for Training and Information of ITST, as the technology and research body of MOT, has expertise knowledge and skill on advanced technology of transport and experience in running training courses for managing field of MOT under MOT direction. The Centre currently runs traffic safety trainings under ODA, and also has developed a training program for road maintenance targeting inspectors and workers under the contract with DRVN, which have not been implemented so far. Considering this background, ITST is capable to support DRVN and RTCs for development and implementation of training program.

d. University of Transport and Technology (UTT) and University of Transport and Communication (UTC)

Academic institution carry out academic research on asset management and road maintenance planning etc, as well as carry out new technology related road maintenance. Especially University of Transport and Communication (UTC) has been running research on road asset management database system in cooperation with University of Kyoto, and staffs are considered to have advanced knowledge and skill in the field. UTT also currently receives JICA Technical Assistance for capacity enhancement. Considering this background, cooperation with academic institutions will support sustainable implementation of training especially on topic required advance technologies.

(6) Training Style, Frequency and Duration

Following 1) Seminar and Workshop, and 2) Training courses, are recommended to be delivered regularly.

1) Seminar/Workshop

- Comprehensive Seminar/Workshop: information on overall project outputs on road maintenance is disseminated to the nationwide stakeholders of central and regional government agencies as well as consultant and contractors. Half to one day session is offered minimum of once a year.
- Technical Seminar / Workshop: Specific technical subject of project outputs is offered to nationwide professional and technical staff of central, regional government agencies as well as consultant and contractors, for 1-2 days in regular and demand basis.

2) Training courses

- Management training courses: training course is offered through lectures, class room based training focuses on administrative and management staff on regular basis for 1-2 days.
- Technical training courses: Intensive practical training courses are offered to professional and technical staff through OJTs and class room based utilizing computers, actual equipment and machinery to maximize applicability of training to the actual road maintenance tasks. The course is provided sufficient frequency to meet high turnover of staff. Duration is up to 5 days sufficient to cover in-depth contents.

(7) Training Materials

Training contents and materials provided at the training "During the Project" are revised by road maintenance agencies and assigned training trainers and organizations, based on feedback, progress of activities, and needs of staff and administrative management, so that training materials are utilized for after the project. Additional materials are also to be prepared for training as required.

Table 9.4.10 Recommended Training Programs for "After the Project"

Training Program Requirements for "After the Project"					Training program planning for "After the Project"					
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Phase**	**Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
Activity 1 Enhancement of Road Information Management	Road Asset Database System	・ Road Maintenance & Management Dept. ・ Information Centre (DRVN-IC) (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Technical & Construction Management Dept. (RRMB I)	DRVN Major Dep. (State Agency)	・ General Guidance on Database System ・ Database Management ・ Operation of system	・ Road Maintenance & Management Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Technical & Construction Management Dept. (RRMB I)	P-1	・ Road management & maintenance Dep. ・ DRVN-IC	・ Seminar/ Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ Database system software ・ Operation Manual
			Traffic Safety Dept. / DRVN-IC (System / Database Manager)	・ General Guidance on Database System ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting					1day (1/ yr)	
			RRMBs / SBs (Regional agency)	・ General Guidance on Database System ・ Operation of system ・ Data verification ・ Data inputting		P-1	・ Road management & maintenance Dep.DRVN-IC		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			RTCs (System management / Technical Support)	・ General Guidance on Database System ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting		P-1	・ Road management & maintenance Dep. ・ DRVN-IC		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution (UTC)		1day (2/ yr)	
			Consultant and Contractors (Data Input)	・ General Guidance on Database System ・ Data inputting		P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
Activity 2 Enhancement of Planning Capacity for Road Maintenance	Activity 2 .1 Pavement Condition Survey	・ Planning & Investment Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	DRVN Major Dep. (State Agency)	・ General Guidance on Pavement Condition Survey	・ Planning & Investment Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	P-1	・ Planning & Investment Dept.	・ Seminar/ Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ Vehicle ・ System for pavement condition survey ・ Operation Manual
			Planning & Investment Dept. (Database Manager /System Manager)	・ General Guidance on Pavement Condition Survey ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting		P-1	・ Planning & Investment Dept.		1day (1/ yr)	
			RRMBs/SBs (Regional agency)	・ General Guidance on Pavement Condition Survey ・ Operation of system ・ Site Survey Management		P-1	・ Planning & Investment Dept.		1day (1/ yr)	
						P-2	・ RTC Central(UTC)		1day (2/ yr)	
			RTCs (System management / Technical Support)	・ General Guidance on Pavement Condition Survey ・ Database Management ・ System Maintenance & Management ・ Operation of system ・ Data verification ・ Data inputting		P-1	・ Planning & Investment Dept.		1day (1/ yr)	
						P-2	・ RTC Central(UTC)		1day (2/ yr)	
			Consultant and Contractors	・ General Guidance on Pavement Condition Survey ・ Data inputting		P-2	・ RTC Central(UTC)		1day (2/ yr)	
	Activity 2 .2.a PMS/ PMoS Dataset Conversion Software Developmen	・ Planning & Investment Dept. ・ Information Centre (In cooperation with) ・ Science, Technology &	DRVN Major Department (State Agency)	・ General Guidance on Database System ・ Operation of system	・ Planning & Investment Dept. ・ Information Centre (In cooperation with) ・ Science, Technology	P-1	・ Planning & Investment Dept. ・ Information Centre	・ Seminar/ Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ PMS Dataset ・ Operation Manual User Manual
			Planning & Investment Dept. / Information Centre	・ General Guidance on Database System ・ System Maintenance & Management ・ Database Management		P-1	・ Planning & Investment Dept. ・ Information Centre		1day (1/ yr)	

Training Program Requirements for "After the Project"					Training program planning for "After the Project"					
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Phase**	**Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
	t	International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	(System / Database Manager)	・ Operation of system ・ Data verification ・ Data import	&International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			RRMBs/ SBs (Regional agency)	・ General Guidance on Database System ・ Operation of system ・ Data verification ・ Data import		P-1	・ Planning & Investment Dept. ・ Information Centre		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			RTCs (System management / Technical Support)	・ General Guidance on Database System ・ System Maintenance & Management ・ Database Management ・ Operation of system ・ Data verification ・ Data import		P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			Consultant and Contractors							
	Activity 2 .2b VPMS	・ Planning and Investment Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	DRVN Major Department /(State Agency / End User)	・ General Guidance on VPMS System ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis	・ Planning and Investment Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept. ・ Finance Dept. ・ Economic & Planning Dept. (RRMB I)	P-1	・ Planning & Investment Dept. ・ Information Centre	・ Seminar/ Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ VPMS system ・ Operation Manual
			Planning & Investment Dept. / Information Centre (System / Database Manager)	・ General Guidance on VPMS System ・ System Maintenance & Management ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis ・ Data importing ・ Data Inputting		P-1	・ Planning & Investment Dept. ・ Information Centre		1day (1/ yr)	
			RRMBs / SBs (Regional agency)	・ General Guidance on VPMS System ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis ・ Data importing ・ Data Inputting		P-1	・ Planning & Investment Dept. ・ Information Centre		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			RTCs (System management / Technical Support)	・ General Guidance on VPMS System ・ System Maintenance & Management ・ Operation of system ・ Maintenance & Budget planning ・ Data analysis ・ Data importing ・ Data Inputting		P-1	・ Planning & Investment Dept. ・ Information Centre		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			Consultant and Contractors							
Activity 3 Improving Road Maintenance Technologies	Activity 3.1 Maintenance technology	・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept.	DRVN Major Dep. (State Agency)	・ General Guidance on Inspection	・ Science, Technology & International Cooperation Dept. ・ Road Maintenance & Management Dept.	P-1	・ Science, technology and International Cooperation Dept. ・ Road Maintenance & Management Dept.	・ Seminar/ Workshop ・ Training courses (Management	1day (1/ yr)	・ Technical Standards covering road inspection,

Training Program Requirements for "After the Project"					Training program planning for "After the Project"					
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Phase**	**Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
		(In cooperation with) ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1 / RTC Central	RRMBs/SBs (Site Manager)	・ General Guidance on Inspection ・ Site management ・ Repair and maintenance work ・ Data Collection ・ Patrolling / Inspection	(In cooperation with) ・ Planning and Investment Dept. ・ Economic and Planning Dept. (RRMB I) ・ RTC 1/ RTC Central	P-1	・ Science, technology and International Cooperation Dept. ・ Road Maintenance & Management Dept.	/ Technical)	1day (1/ yr)	Diagnosis, Repair work selection
						P-2	・ RTC Central		1day (2/ yr)	
			RTCs	・ General Guidance on Inspection ・ Site management ・ Repair and maintenance work ・ Data Collection ・ Patrolling / Inspection		P-1	・ Science, technology and International Cooperation Dept. ・ Road Maintenance & Management Dept.		1day (1/ yr)	
						P-2	・ RTC Central		1day (2/ yr)	
			Consultant and Contractors (Site Worker)	・ General Guidance on Inspection ・ Repair maintenance work ・ Data Collection ・ Patrolling / Inspection		P-2	・ RTC Central		1day (2/ yr)	
	Activity 3.2 Revised Routine Maintenance Standard	・ Road Maintenance & Management Dept. ・ Economic & Planning Dept. (RRMB I) (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ RTC 1 / RTC Central	DRVN Major Dep. (State Agency)	・ Guideline of revised standard	・ Road Maintenance & Management Dept. ・ Economic & Planning Dept. (RRMB I) (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ RTC 1 / RTC Central	P-1	・ Road Maintenance & Management Dept. ・ Economic and Planning Dept. (RRMB I)	・ Seminar/ Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ Revised Routine Maintenance Standard
			RRMBs/SBs (End User)	・ General Guidance on Revised Routing Maintenance Standard ・ Appraisal & verification of maintenance work ・ Selection of repair & maintenance work ・ Evaluation of road inspection result		P-1	・ Road Maintenance & Management Dept. ・ Economic and Planning Dept. (RRMB I)		1day (1/ yr)	
						P-2	・ RTC Central		1day (2/ yr)	
			RTCs (End User)			P-1	・ Road Maintenance & Management Dept. ・ Economic and Planning Dept. (RRMB I)		1day (1/ yr)	
						P-2	・ RTC Central		1day (2/ yr)	
			Consultant and Contractors (End User)			P-2	・ RTC Central		1day (2/ yr)	
	Activity 3.3 Pavement Monitoring System	・ Road Maintenance & Management Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1/ RTC Central	DRVN Major Dep .(State Agency/ End User)	・ General Guidance on PMoS System, ・ Operation of System,	・ Road Maintenance & Management Dept. ・ Information Centre (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Economic & Planning Dept. (RRMB I) ・ RTC 1/ RTC Central	P-1	・ Road Maintenance & Management Dept. ・ Information Centre ・ University (UTC)	・ Seminar /Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ Pavement Monitoring System ・ Operation Manual
			Road Maintenance & Management Dept./ Information Centre (System / Database Manager)	・ General Guidance on PMoS System, ・ System Maintenance & management ・ Database management ・ Data analysis ・ Operation of System ・ Data Verification ・ Data importing		P-1	・ Road Maintenance & Management Dept. ・ Information Centre ・ University (UTC)		1day (1/ yr)	

Training Program Requirements for "After the Project"					Training program planning for "After the Project"					
Activity	**Output**	**Responsible Agency for development of Project Output**	**Target Stakeholder**	**Required information**	**Responsible Agency for Training Implementation**	**Phase**	**Assigned training implementation organization**	**Training Style**	**Duration Frequency**	**Training Material**
			RRMBs/SBs (Regional agency)	・ General Guidance on PMoS System, ・ Operation of System ・ Data Verification ・ Data importing		P-1	・ Road Maintenance & Management Dept. ・ Information Centre ・ University (UTC)		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			RTCs (System management / Technical Support)	・ General Guidance on PMoS System, ・ System Maintenance & management ・ Database management ・ Operation of System ・ Data Verification ・ Data importing		P-1	・ Road Maintenance & Management Dept. ・ Information Centre		1day (1/ yr)	
						P-2	・ RTC Central ・ Academic Institution(UTC)		1day (2/ yr)	
			Consultant and Contractors				・			
Activity 4 Strengthen Road Maintenance institution	Road maintenance Procedure	・ Road Maintenance & Management Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Organization & Personnel Dept. ・ Transport & Legislation Dept. ・ Traffic Management Dep. ・ RTC Central	MOT/DRVN Major Department/ (State Authority/State Agency)	・ General Guidance on Road Maintenance institution ・ Road Maintenance institution & Procedure	・ Road Maintenance & Management Dept. (In cooperation with) ・ Science, Technology & International Cooperation Dept. ・ Planning & Investment Dept. ・ Organization & Personnel Dept. ・ Transport & Legislation Dept. ・ Traffic Management Dep.	P-1	・ Road Maintenance & Management Dept.	・ Seminar/ Workshop ・ Training courses (Management / Technical)	1day (1/ yr)	・ Road maintenance implementation procedure ・ Recommendation on road
			RRMBs/ SBs (Regional agency)	・ General Guidance on Road Maintenance institution ・ Road Maintenance institution and Procedure		P-1	・ Road Maintenance & Management Dept.		1day (1/ yr)	
						P-2	・ Road Maintenance & Management Dept. ・ Traffic Safety Dept.		1day (2/ yr)	
			RTCs (End User)	・ General Guidance on Road Maintenance institution ・ Road Maintenance institution & Procedure		P-1	・ Road Maintenance & Management Dept.		1day (1/ yr)	
						P-2	・ Road Maintenance & Management Dept.		1day (2/ yr)	
			Consultant and Contractors (End User)	・ General Guidance on Road Maintenance institution ・ Road Maintenance institution & Procedure		P-2	・ Road Maintenance & Management Dept.		1day (2/ yr)	

9.5 TRAINING PROGRAM DELIVERED FOR "DURING THE PROJECT"

"During the project", 13 training of 7 courses combining technical training 2013 and intensive technical training 2014, and 7 workshops were implemented In total about 775 people have participated from MOT, DRVN, RRMBs, RTCs, and science and academic institutions, associations, private companies. Summary of Trainings and workshops offered are shown in Summary chapter.

9.5.1 Training Plan

Based on training program developed for "During the Project", training plans were developed at the beginning of each year of 2013 and 2014 and discussed with DRVN for approval. The plan shows overview of trainings course and workshop to be implemented at the year, and upon the approval, further details were developed under each working group such as schedule, target trainees and training contents to meet the progress of activities.

In 2013, due to the progress of project activities, there were some changes in the original training plan. Some of trainings were postponed to the year 2014, such as training on "Pavement Condition Survey" and workshop. In 2014, intensive training and workshop were planned aiming for the final technical transfer and dissemination of project outputs.

9.5.2 Workshops

Workshop was hold seven (7) during the project term, on project activities, pavement repair technology, road maintenance institution and procedure, and road asset management.

Table 9.5.1 List of workshops implemented during the project term

	Title of Workshop	Date
1	Workshop on Project for Capacity Enhancement in Road Maintenance	26th September 2012
2	Workshop on Pavement Repair Technology (Activity 3.2b)	15th May 2013
3	Workshop on Pavement Repair Technology (Activity 3.2b)	11th October 2013
4	Workshop on Road Maintenance Institution and Procedure (Activity 4)	28th June 2013
5	Workshop on Road Maintenance Institution and Procedure (Activity 4)	8th October 2013
6	Workshop on Pavement Management System	20th June 2012
7	Workshop on Project for Capacity Enhancement in Road Maintenance	7th March 2014

(1) Workshop on Project for Capacity Enhancement in Road Maintenance

1) 1st Workshop

- Date : 26th September 2012, Wednesday
- Venue: Hanoi Hotel
- Aim and Objectives

+ Introduce framework and report progress of the project
+ Introduce fundamental issues and practices on road maintenance in Japan
+ Discuss issues related to the project implementation

- Responsible Agency: DRVN and JICA Project Team
- Participants: 100 participants from DRVN, RRMB I and subsidiaries and concerned parties in the field. (Participant list to be referred to Appendix A4)
- Program: as shown in below.
- Evaluation result: refer to Appendix A4.

Table 9.5.2 the 1st Workshop Program

Time Table	Presentation	Speaker
From 8:00	Registration	
8:20 - 8:30	Welcome and Opening Remarks from DRVN	Mr. Nguyen Ngoc Dong (Vice Minister of MOT CUM General Director of DRVN)
8:30 - 8:50	Overall Framework of the JICA Project	Mr.Tsuneo KATO (JICA Project Team Leader)
8:50 - 9:20	Kyoto Model Pavement Management System	Prof. Kiyoshi Kobayashi (Kyoto University)
9:20 - 9:50	Introduction of Road Maintenance of National Highway in Japan	Mr. Hideyuki Kanoshima (JICA Long term Expert)
9:50 – 10:10	Tea Break	
10:10 - 10:35	Activity 1 Enhancement of Road Information Management	Dr. Bhoj Raj PANTHA (JICA Expert)
10:35 - 11:00	Activity 2 Enhancement of Road Maintenance Planning	Mr. Toshiya MATSUDA (JICA Expert)
11:00 - 12:00	Open Discussion	Dr. Nguyen Trong Phu
12:00 -13:30	Lunch	
13:30 - 13:55	Activity 3 Improvement of Road Maintenance Technology	Mr. Yasushi AOKI (JICA Expert、Deputy Team Leader)
13:55 - 14:20	Activity 4 Strengthening of Road Maintenance Institution	Mr.Tsuneo KATO (JICA Project Team Leader)
14:20 - 15:45	Open Discussion	Dr. Nguyen Trong Phu
15:45 - 15:50	Conclusion	Mr.Tsuneo KATO
15:50	End of workshop	

2) 2nd Workshop

- Date : 7th March 2014, Friday
- Venue: DRVN
- Aim and Objectives
  + Promote understanding on outputs of project activities
  + Exchange opinion on the project outputs and deployment
  + Disseminate project output to nationwide
- Responsible Agency: DRVN and JICA Project Team

- Participants: 120 participants from MOT and other ministries, DRVN, RRMBs, RTCs, SBs and concerned parties in the field. (Participant list to be referred to **Appendix A4**)
- Program: as shown in below.
- Evaluation result: refer to **Appendix A4**.

Table 9.5.3 the 2nd Workshop Program

Time Table	Min.	Presentation	Speaker
8:00	30	Registration	
8:30 – 8:40	10	Opening Remarks	Leader of DRVN
8:40 – 9:00	20	Road Asset Management in Japan	Mr Hideyuki Kanoshima (MLIT/ JICA Project Team)
9:00 – 9:10	10	Current Status and Comprehensive Innovation Concept of Road maintenance of MOT	Mr. Le Hong Diep (Deputy DG of Dep.Road Management & Maintenance)
9:10 – 9:20	10	Framework of JICA Project for Capacity Enhancement in Road Maintenance	Dr. Nguyen Trong Phu (PMU TA,DRVN)
9:20 – 9:40	20	Tea Break	
9:40 –10:00	20	Enhancement of Road Information management	Dr. B. R Pantha (JICA Project Team)
10:00– 10:15	15	Pavement Condition Survey	Dr. Kazuya Aoki (Pasco)
10:15– 10:35	20	Enhancement of Road Maintenance Planning	Mr. Tuneo Kato (JICA Project Team)
10:35– 10:50	15	Enhancement of Road Inspection and Maintenance Technology	Dr. Tran Thi Kim Dang (JICA Project Team)
10:50– 11:10	20	Enhancement of Road Maintenance Institution	Mr.Tuneo Kato (JICA Project Team)
11:10– 11:30	20	Human Capacity Development for Road Maintenance and Management	Ms. Akiko Miyakawa (JICA Project Team)
11:30 – 11:50	20	Next Step for Road Maintenance in Vietnam	Mr. Pham Thanh Binh (DG of Dep. of Planning & Investment)
11:50– 12:20	30	Open Discussion	
12:20– 12:30	10	Closing Remark	Leader of DRVN
12:30– 14:00	90	Lunch	

(2) Workshop on Pavement Repair Technology (Activity 3.2b)

1) 1st Workshop on Pavement Repair Technology

- Date : 15th May 2013
- Venue: DRVN
- Aim: Introduce Japanese Pavement Maintenance Technology
- Responsible Agency: DRVN and JICA Project Team
- Participants: 21 participants from MOT, DRVN, RRMBs and subsidiaries and concerned parties in the field. (Participant list to be referred to **Appendix A4**)
- Program: as shown in below.

Table 9.5.4 Workshop Program (Act 3.2b)

Time	Presentation	Speaker
8:00-8:10	Registration	
8:10-8:15	Welcome and Opening Remarks from DRVN	DRVN (Mr. Cuong)
8:15-8:20	Speech from the JICA Project Team	Mr.Tsuneo KATO
8:20-8:50	Ready Mix Materials for Pavement Patching - Cold Technology	Mr. Motofumi TATSUSHITA
8:50-9:20	Pavement Crack Seal - Hot Technology	Mr. Motofumi TATSUSHITA
9:20-9:50	Pavement Bump Repair - Cold Technology	Mr. Motofumi TATSUSHITA
	Break Time	
10:00-10:30	Bridge deck Waterproofing Material and Method	Mr. Motofumi TATSUSHITA
10:30-11:00	Open Discussion	
11:00-11:10	Conclusion	Dr. Phu

2) 2nd Workshop on Pavement Repair Technology

- Date : 11th Oct 2013
- Venue: DRVN
- Aim: Introduce Japanese Pavement Maintenance Technology
- Responsible Agency: DRVN and JICA Project Team
- Participants: 15 participants from DRVN, RTCs, SBs and concerned parties in the field. (Participant list to be referred to **Appendix A4).**
- Program: as shown in below.

Table 9.5.5 Workshop Program (Act 3.2b)

Time	Program	Speaker
8:20 - 8:30	Registration	
8:30 -8:40	Welcome and Opening Remarks from DRVN	
8: 40-9:30	Topic 1: Asphalt Emulsion in Japan, followed by Q&A	Mr.Motofumi Tatsushita (NICHIREKI Co., LTD)
9: 30-9:40	Break	
9:40 -10:30	Topic 2:Presentation of samples presented in May 2013, followed by Q&A ・patching material ・repairing material for height difference ・crack seal ・water proof material for bridge surface	Mr.Motofumi Tatsushita, (NICHIREKI Co., LTD)
10:30-11:20	Open Discussion	
11:20-11:30	Closing remark	

(3) Workshop on Road Maintenance Institution and Procedure (Activity 4)

1) 1st Workshop

- Date : 28th June 2013

- Venue: DRVN
- Aim: to introduce the application of pavement management system to road maintenance in Japan and to clarify how our project's outputs are adapted to road maintenance in Vietnam.
- Responsible Agency: DRVN and JICA Project Team
- Participants: 45 participants from MOT, DRVN, RRMBs, and concerned parties in the field. (Participant list to be referred to Appendix 5.2).
- Program: as shown in below.

Table 9.5.6 Workshop Program (Act 4)

Time	Presentation/	Speaker
8:30-8:40	Registration	
8:40-8:45	Opening Remarks	DRVN
8:45-9:05	Case Study of Application Pavement Asset Management in Japan's Local Government (1) Nagasaki Prefecture	Mr. Kanoshima
9:05-9:25	Case Study of Application Pavement Asset Management in Japan's Local Government (2) Kumamoto Prefecture	Mr. Kanoshima
9:25-9:45	Case Study of Application of Pavement Asset Management in Japan's Central Government	Mr. Kanoshima
9:45-10:00	Discussion	
10:00-10:20	Break Time	
10:20-10:40	Points to be discussed for Application of PMS in Vietnamese Context	Mr. Kanoshima
10:40-10:55	Discussion	
10:55-11:00	Conclusion	

2) 2nd Workshop

- Date : 8th Oct 2013
- Venue: DRVN
- Aim: to realize the importance of technology management, development and transfer on road engineering to create a favorable condition for effective and efficient usage of technologies, and then to summarize focal points on the technology issues on road engineering in Vietnam.
- Responsible Agency: DRVN and JICA Project Team
- Participants: 29 participants from MOT, DRVN, RRMBs, RTC, SBs and concerned parties in the field. (Participant list to be referred to **Appendix A4**).
- Program: as shown in below.

Table 9.5.7 Workshop Program (Act 4)

Time	Presentation	Speaker
9:00-9:10	Registration	
9:10-9:15	Opening Remarks	DRVN
9:15-9:30	Brief Introduction of Workshop	Mr. Kanoshima
9:30-9:55	Case Studies in Japan on Technology Management and Technology Development	Mr. Kanoshima
9:55-10:20	Case Studies in Japan on Technology Transfer by Central Government to Local Governments	Mr. Kanoshima
10:20-10:45	Key Issues on Technology Management, Technology Development and Technology Transfer and	Mr. Kanoshima
10:45-10:50	Conclusion	

(4) Workshop on Pavement Management System

1) 1st Workshop

- Date : 20th June 2012
- Venue: DRVN
- Responsible Agency: DRVN and JICA Project Team
- Participants: 45 participants from MOT, DRVN, RRMBs, and concerned parties in the field.
- Program: as shown in below.

Table 9.5.8 Workshop Program

Time	Presentation	Speaker
07:30-08:00	Registration	
08:00-08:10	Opening Remarks	DRVN leader
08:10-09:10	Introduction of Pavement Management System - Kyoto Model	Professor Kiyoshi KOBAYASHI (Kyoto University)
09:10-09:25	Discussion	
09:25–10:05	Deterioration Forecasting and LCC Evaluation	Professor Kiyoyuki KAITO (Osaka University)
10:05-10:15	break	
10:15-10:55	System operation and Demonstration	Dr. Kazuya AOKI (PASCO Incorporation)
10:55-11:30	Discussion	
11:30-11:40	closing remarks	

9.5.3 Training Courses

(1) Technical Trainings in 2013

In 2013, trainings are provided as technical transfer of project outputs according to the progress of project activities. Outline of each training courses are listed in below.

1) Aim

- Transfer of technology developed through Project activities
- Develop trainers for dissemination of the Project outputs to the nationwide.

2) Training Implementing System

In general JICA Project Experts have developed training curriculum and training material and implemented and evaluated trainings. PMU TA and DOP of DRVN have coordinated and manage trainings.

3) Training Courses

13 training from following 7 training courses were provided as technical training. Project outputs were utilized as training materials. Further details of each training course are to be referred to each activity section.

Table 9.5.9 List of Training Courses

	Training courses	Method	Frequency	Contents	Targeted trainee	Trainers	Training Materials
1	Road Database System (Act 1)	CBT	3 times	1st: Overall database system 2nd:Database operation & management 3rd:Database operation & management	・ DRVN ・ RRMB I ・ RTCs ・ SBs	・ JICA Project Experts ・ Project assistant ・ WG members	・ Road Database System ・ A quick guide for new data input ・ Road database user manual
2	Pavement Condition Survey (Act 2.1)	OJT CBT	1 times	Introduction of Pavement condition survey and analysis	・ RRMB I ・ RRMB II ・ RRMB III ・ RRMBIV ・ RTC 1 ・ RTC II ・ RTC III ・ RTC IV	・ PASCO	・ Pavement Condition Survey Manual ・ Collected Pavement Condition Survey Data
3	PMS/PMoS Dataset Conversion Software development (Act 2.2a)	CBT	1 times	PMS dataset & development of pivot type data, Conversion to dataset	・ DRVN ・ RRMB I ・ RTCs ・ SBs	・ JICA Project Expert ・ Project Assistant	・ PMS Dataset Conversion software ・ Operation Manual
4	Road Maintenance Planning (Act 2.2b)	CBT	2 times	Software for Road maintenance plans	・ DRVN ・ RRMB I ・ RTCs ・ SBs	・ JICA Project Expert ・ Project Assistant	・ Road Maintenance Planning software ・ Operation Manual
5	Inspection Method (Act 3.1)	OJT CR	2 times	1st:General Guidance on Inspection & Manual 2nd: Inspection on Facilities / Inspection Technique	・ DRVN ・ RRMB I ・ RTCs ・ SBs	・ JICA Project Expert ・ Project Assistant	・ Inspection Guideline
6	Revised Routine Maintenance Standard (Act 3.2a)	CR	2 times	1st: General on Routine Maintenance Standard and Japanese practices 2nd:New Routine Maintenance Standard on road maintenance	・ DRVN ・ RRMB I ・ RTCs ・ SBs	・ JICA Project Expert ・ Project Assistant	・ Routine Road Maintenance Manual

	Training courses	Method	Frequency	Contents	Targeted trainee	Trainers	Training Materials
8	Pavement Monitoring System (Act 3.3)	CBT	2 times	1st: PMoS system 2nd: PMoS system	・ DRVN ・ RRMB I ・ RTCs	・ JICA Project Expert	・ Pavement Monitoring System ・ Operation Manual

Note: CBT: Computer based training, OJT: On the Job Training, W: Workshop

(2) Technical Trainings in 2014

In 2014, intensive trainings were provided from 4th to 6th March 2014. Further details for each training courses are to be referred to each activities.

1) Aim

- Implement comprehensive technology transfer, incorporating all project outputs to the member of counterparts and relevant road maintenance agencies.
- Develop trainers assuredly for dissemination of the project outputs to nationwide after the project completion.

2) Training Implementing System

In general JICA Project Experts have developed training curriculum and training material and implemented and evaluated trainings. PMU TA and DOP of DRVN have coordinated and manage trainings.

3) Trainee

PMU TA and WG-5 was requested to be selected from participants of previous training and potential trainer for future trainings.

4) Training courses

Following tables shows training schedule and outline of courses provided as intensive training. Training materials developed during trainings implemented in 2013 were revised and utilized for trainings proposed in 2014.

Table 9.5.10 Trainings Schedule

Date	4th March (TUE)	5th March (WED)	6th March (THU)
8:00	REGISTRATION		
8:30 – 11:30	**SESSION I (8:30 – 9:00)** Introduction to JICA Project	**SESSION I: (8:30– 10:30)** Lecture and Computer practice on PMS and PMoS Dataset Conversion Software Development (Act2.2a)	**SESSION I:** Lecture on Inspection Technology (Act3.1)
	SESSION II (9:00 – 11:30) Lecture on Road Information Management (Act1)	**SESSION II (10:45– 11:30**) Lecture and Computer practice on PMoS System (Act3.3)	

12:30	REGISTRATION		
13:00 – 16:00	**SESSION III:** Computer Based Practice on Road Information Management (Act1)	**SESSION III:** Lecture and Computer practice on Road Maintenance Planning (Act2.2b)	**SESSION II:** Lecture on Road Maintenance Technology (Act3.2)

Table 9.5.11 Training Plan of Intensive Technical Training

Training	Date / Duration	Training Style	Objectives	Curriculum	Trainee	Trainers	Training Material and Equipment		
							Training Material	Equipment	Others
Introduction	4,th Mar 0.5 hour	Lecture	・ To develop understanding of JICA Project activities	**[Lecture]** ・ Framework of project activities	・ DRVN ・ RRMB I ・ RTC Central ・ RTC I ・ SBs ・ Others	Dr. Phu	・ PPT	・ Projector with screen	・ DRVN room ・ Interpreter
Road Information Management (Act.1)	4th Mar. 1 day	Classroom with Computer Practice	・ To enhance capacity of DRVN staff on road information management ・ To raise trainers	[Lecture] ・ Overview of Road Database System ・ Database Structure and Data Type ・ Road Database System Function and Operation ・ Database Operation and Management with Demonstration **[Computer Practice]**	・ DRVN ・ RRMB I ・ RTC Central ・ RTC 1 ・ SBs ・ Others	Dr. Pantha Mr. Doan	・ Road database system ・ Sample data (Inventory data) ・ Road database user manual ・ PPT	・ Projector with screen (2 set) ・ Computers (10 set)	・ DRVN room ・ Interpreter
PMS /PMoS Dataset CS Development (Act. 2.2a)	4th Mar. 0.3day	Classroom with Computer Practice	・ To enhance capacity of DRVN staff on PMS dataset development for ・ To raise trainers	**[Lecture]** ・ Outline of Conversion Software ・ Software Operation and Management with Demonstration **[Computer Practice]**	・ DRVN ・ RRMB I ・ RTC Central ・ RTC 1 ・ Others	Mr. Kato Mr. Do	・ PMS dataset conversion software ・ Sample data (PCSdata) ・ Conversion software ・ operation guideline ・ PPT	・ Projector with screen (2 set) ・ Computers (10 set)	・ DRVN room ・ Interpreter
Road Maintenance Planning (Act. 2.2a)	5th Mar. 0.5 day	Classroom with Computer Practice	・ To enhance capacity of DRVN staff on road maintenance planning ・ To raise trainers	**[Lecture]** ・ Outline of Pavement Condition Survey ・ Outline of Road Maintenance Planning ・ Software Operation and Management with Demonstration [**Computer** Practice]	・ DRVN ・ RRMB I ・ RTC Central ・ RTC 1 ・ Others	・ Mr. Mori ・ Mr. Do	・ Road Maintenance Planning software ・ Sample data ・ Operation Manual ・ PPT	・ Projector with screen (2 set) ・ Computers (10 set)	・ DRVN room ・ Interpreter

Training	Date / Duration	Training Style	Objectives	Curriculum	Trainee	Trainers	Training Material and Equipment		
							Training Material	Equipment	Others
Road Inspection Technology (Act. 3.1)	6th Mar. 0.5 day	Classroom	・ To enhance capacity of DRVN staff on road facility inspection ・ To raise trainers ・ To understand practices of inspection	**[Lecture]** ・ Objectives of Road Inspection ・ Current Framework of Road Inspection in Vietnam ・ Briefly Introduction of Japanese Practices on Road Inspection ・ Introduction of Framework of Guideline for Road Inspection in Vietnam developed by JICA Project Team ・ Bridge Inspection Case Study ・ Summary & Recommendation	・ DRVN ・ RRMB I ・ RTC Central ・ RTC 1 ・ SBs	Mr. Nguyen Dinh Thao	・ Inspection guideline ・ PPT	・ Projector with screen (1set)	・ DRVN room ・ Interpreter
Road Maintenance Technology (Act. 3.2)	6th Mar. 0.5 day	Classroom	・ To enhance capacity of DRVN staff on road maintenance standard ・ To raise trainers	**[Lecture]** ・ Current DRVN Standard ・ Framework of new Manual ・ Methodology of developing new Manual ・ Road Maintenance Technology	・ DRVN ・ RRMB I ・ RTC Central ・ RTC 1 ・ SBs ・ Others	Dr. Tran Thi Kim Dang	・ Routine Road Maintenance Manual ・ PPT	・ Projector with screen (1set)	・ DRVN room ・ Interpreter
Pavement Monitoring Technology (PMoS) (Act. 3.3)	5th Mar. 0.2 day	Classroom with Computer Practice	・ To enhance the capacity of road maintenance planning for DRVN staff ・ To raise trainers	**[Lecture]** ・ Outline of PMoS System ・ Software Operation and Management with Demonstration **[Computer Practice]**	・ DRVN ・ RRMB I ・ RTC Central ・ RTC 1 ・ SBs	Mr. Kunimasa Mr. Do	・ Pavement Monitoring System ・ Sample data ・ Guideline of PMoS ・ PPT	・ Projector with screen (2 set) ・ Computers (10 set)	・ DRVN room ・ Interpreter

9.5.4 Training Implementing Cycle

At each training and workshop, task sharing and procedure for implementation have been discussed and clarified between JICA Project Team and DRVN. Especially DOP of DRVN, have been advised to play a main role for implementation of training and workshops to enhance capacity and clarify training implementation procedure. Following procedure describes process adopted for training in 2013 and revised in 2014.

Table 9.5.12 Training implementation cycle for trainings 2013 and 2014

	Items	Cycle
1	Training Demand and Need analysis	Training Needs
2	Development of Training Program	Develop training program
3	Discussion and agreement on Training Program	
4	Development of draft training plan	Implement Trainings
5	Discussion and agreement on draft training plan	
6	Development of draft training detail and training materials	
7	Discussion and agreement on draft training detail, date, and materials	
8	Finalization of training detail, date, and materials	
9	Issuance of official letter on training and date	
10	Information sharing on training among DRVN and relevant agencies	
11	Clarification of role and responsibility on training management and implementation	
12	Preparation of cost estimate for training implementation	
13	Arrangement for trainees, venue etc. for training implementation	
14	Selection of Trainee, approval of trainee list, and Invitation	
15	Confirmation of attendance to trainee	
16	Setting up of Venue	
17	Printing and binding of training materials	
18	Implementation of trainings and workshop	
19	Preparation of attendance list	
20	Collection of evidence documents for training fees, and clearance of bills	
21	Monitoring and evaluation of trainings	Monitoring and evaluation
22	Review of implemented trainings	
23	Revise Training program, curriculum, materials	

(1) Training Implementation

1) Development of Training Details

Once training plan was agreed with DRVN and JICA Project Team, further details, schedule and materials were developed and finalized with WGs and JICA Project Experts. Then a formal letter was issued to DRVN to request necessary arrangement for implementation.

2) Selection of Participants

DRVN was requested to select appropriate trainees and inform the number and participants list to JICA Project Team prior to implementation. It was advised that trainees are selected based on

criteria and attend all session of each training course. Expected trainees were confirmed for their attendance prior to the implementation and attendances were monitored during trainings by recording attendant list.

3) Arrangement and Coordination for Trainee and Training Implementation

PMU TA and DOP of DRVN made necessary arrangement and coordination for trainee and training implementation. Expense was applied MOF regulation, and with regards to the items funded by JICA, DRVN prepared quote for approval as well as handled evidence documents for clearances of expense.

(2) Monitoring and Evaluation

At each training and workshop, training and trainees were monitored and evaluated to improve future training and workshop. For trainings and workshops "During the Project", JICA experts conducted questionnaire survey, and the results of survey have been discussed at the review meetings. DRVN has been also advised.to conduct monitoring and evaluation, however rarely observed. Result was reported and discussed among DRVN and JICA Project Team for further improvement of future trainings.

1) Review of Training 2013

At the end of 2013, questionnaire survey on trainings and workshop in 2012/2013 was carried out targeting WG leaders and members, and 34 members out of total 46 members, which are 74% of WG members, have responded, which lead to organize intensive training 2014. Questionnaire and survey results are attached in Appendix 5.3.

2) Review of Training 2014

At the end of intensive technical trainings in 2014, questionnaire survey on trainings and was carried out to participants. Majority of participants has evaluated the knowledge and skills gained through trainings are high. Questionnaire and survey results are attached in Appendix 5.3.

9.5.5 Training Materials

Training and workshop materials used are listed in a table below. Presentation materials, manuals and guidelines have been revised at each training, and final version of training materials are provided to DOP of DRVN for future trainings of project outputs.

Table 9.5.13 List of Training and Workshop Materials

	Training / workshop	Number of Trainings	Training date	Training Material
1	Road Database System (Act 1)	4 times	・ 6 Jun 2013 ・ 20 Jun 2013 ・ 28 Aug 2013 ・ 4 Mar 2014	・ Training Program ・ Presentation material ・ Road Database User's Manual
2	Pavement Condition survey (Act 2.1)	1 time	・ 25/26 Feb 2014	・ Training Program ・ Presentation material ・ Operation Manual
3	PMS / PMoS Dataset Conversion Software Development (Act 2.2a)	2 times	・ 27 Aug 2013 ・ 5 Mar 2014	・ Training Program ・ Presentation material ・ CS Operation Manual
4	Road Maintenance Planning (Act 2.2b)	2 times	・ 27 Aug 2013 ・ 5 Mar 2014	・ Training Program ・ Presentation material ・ A Quick Operation Manual ・ For Pavement Management System
5	Inspection Method (Act 3.1)	3 times	・ 18 Jul 2013 ・ 28/29 Nov 2013 ・ 6 Mar 2014	・ Training Program ・ Presentation material ・ Inspection Guideline
6	Revised Routine Maintenance Standard (Act 3.2a)	3 times	・ 24 Jul 2013 ・ 25 Sep 2013 ・ 6 Mar 2014	・ Training Program ・ Presentation material ・ Manual for Road Routine Maintenance
7	Pavement Monitoring System (Act 3.3)	3 times	・ 2 Aug 2013 ・ 18 Sep 2013 ・ 5 Mar 2014	・ Training Program ・ Presentation material ・ Pavement Monitoring System User's Manual
8	Workshop on New Technology (Act 3.2b)	2 times	・ 15 May 2013 ・ 11 Oct 2013	・ Training Program ・ Presentation material
9	Workshop on Road Maintenance Institution (Act 4)	2 times	・ 28 Jun 2013 ・ 8 Oct 2013	・ Training Program ・ Presentation material
10	Workshop on Pavement Management System	1 times	・ 20 Jun 2012	・ Training Program ・ Presentation material
11	Workshop for project for capacity enhancement in Road maintenance	2 times	・ 26 Sep 2012 ・ 7 Mar 2014	・ Workshop program ・ Presentation material

9.6 RECOMMENDATION FOR CAPACITY ENHANCEMENT OF HUMAN CAPACITY DEVELOPMENT ON FUTURE ROAD MAINTENANCE

This section presents recommendation on capacity enhancement of human capacity for the future road maintenance, after 3 to 5 years of project completion.

9.6.1 Strengthening of DRVN Human Capacity

It is well understood that capacity enhancement of human resource, budgets and management methods and technologies are important for a road administrator in order to raise the quality of road administration. With this, MLIT in Japan has been paying much attention on its staff training, regularly providing training opportunities at its own college, which was founded specialized for staff training. The college makes it possible to integrate training facilities, lecturers and materials to the college and to provide systematic and high quality training to the MLIT staff, which is fitted to MLIT infrastructure management. Currently, training opportunities are also given to regional government staff at this college.

With the Japanese practices in mind, the Project herein recommends some capacity enhancement plans for DRVN staff, as shown below.

(1) Rising Needs of Training Programs

Conditions surrounding road environment is changing so rapidly that need for the capacity enhancement of DRVN staff is also rising rapidly. The following are the basic needs of strengthening training functions of DRVN.

- To enhance social accountability for DRVN staff to the public
- To enhance management capacity including law conformity
- To enhance productivity in accomplishing responsibilities
- To cope with rapid growth of road construction and maintenance technologies.

(2) Training Requirements

Training programs need to be developed in order to meet the following requirements;

- For civil servants: General, wide, not in-depth, short time periods (One or two days)
- For public officials: Specialized fields consistent with responsibilities, narrow, intensive training (in-depth), longer time period (4 -5 days)

(3) Expected Training Programs and Participants

Besides training for dissemination of project outputs, the Project selected the following training programs which are deemed fundamental for national road administration. Training opportunities need to be given to DRVN departments, RRMBs, RTCs and SBs to meet the requirements consistent with their responsibilities.

Table 9.6.1 Training Programs and Participants (Draft Plan)

Field	Training Programs	DRVN	RRMBs	RTCs	SBs
Civil servant training	Political theory	X	Director	Director	
	Training on knowledge of state management	X			
Road administration	Road administration	X			
	Road regulations	X			
	Road Construction management	X			
	Road Maintenance management	X			
	Disaster prevention	X			
	PPP/PFI	X			
	Compliance	X			
Business procedures	Tendering and contract	X	X	X	X
	Cost estimate	X	X	X	X
	Budget proposal	X	X	X	X
	Information technologies (Road database)	X	X	X	X
Road construction management	Road planning (survey, F/S, designing)	XC			
	Road structure (Earthwork, pavement, tunnel)	XC			
	Construction work supervision	XC			
	Construction work quality management and acceptance	XC			
	Construction work performance evaluation	XC			
	Road disasters	XC			
Road maintenance and repair management	Maintenance and repair work planning	XM	X	X	X
	Road asset management	XM	X	X	X
	Maintenance and repair work technologies	XM	X	X	X
Traffic management	Traffic safety	X	X	X	X
	ITS	X		X	
Machine operation	Operation of maintenance machinery				X

(Note)
XC: Training programs for the departments in charge of construction
XM: Training programs for the department in charge of road maintenance and repair

(4) Expected Training Implementation Bodies (Draft plan)

There are four potential implementation bodies regarded as professional training organizations under MOT governance. Selection was made on the following criteria; whether training facilities and equipment are available, whether it has professional human resources for training (lectures), whether providing training course is a competence of the organization, and whether it has financial supports from MOT other than training fees to be collected from trainees.

Selection has clarified that University of Transport Technology (UTT) seems to be eligible enough to play a key training center and provide variety of training programs for national road administration, making best use of its resources. Also, ITST is deemed an organization capable of providing professional training programs, making best use of its research oriented resources.

Table 9.6.2 Training Program Implementation Bodies (Draft Plan)

Field	Training Courses	MOT Training Institute	UTT	ITST (UTC)	Northern College
Civil servant training	Political theory	X			
	Training on knowledge of state management	X			
Road administration	Road administration		X		
	Road regulations		X		
	Road construction management		X		
	Road maintenance management		X		
	Disaster prevention		X		
	PPP/PFI		X		
	Compliance		X		
Business procedures	Tendering and contract		X	X	
	Cost estimate		X	X	
	Budget proposal		X	X	
	Information technologies		X	X	
Road construction management	Road planning (survey, F/S, designing)			X	
	Road structure (Earthwork, pavement, tunnel			X	
	Construction work supervision			X	
	Construction work quality management and acceptance			X	
	Construction work performance evaluation			X	
	Road disasters			X	
Road maintenance and repair management	Maintenance and repair work planning		X		
	Road asset management		X		
	Maintenance and repair work technologies		X		
Traffic management	Traffic safety		X		
	ITS		X		
Machine operation	Operation of maintenance machinery				X

(Note) MOT Training Institute: MOT Institute for Transport Administration and Management Cadres

9.6.2 Strengthening of DOT Capacity Enhancement Plan

The Project has already made draft training programs for the following two cases, focusing on the dissemination of information on the outcomes of this Project.

- Training programs “During the Project “
- Training programs ” After the Project”

In addition to these training programs, the Project here in this report issues brief recommendation on the mid-term training programs specialized for Provincial-level People’s Committees.

Since the year 2000, the Vietnamese Government has accelerated the decentralization policy of some of the government functions from central ministries to the Provincial-level People’s Committees. With this policy, responsibilities given to the Provincial-level People’s Committees are gradually expanding in particularly in infrastructure development sector, so capacity enhancement of PPC staff is now becoming an important factor in the sector.

In addition, study on the capacity enhancement in national road maintenance is now underway through JICA Project for Capacity Enhancement in Road maintenance, regarding RRMB I road network as a pilot study for developing road maintenance and repair technologies. Upon completion of the Project, DRVN is encouraged to disseminate information on the Project products to other RRMBs and Provincial-level People's Committees currently in charge of national road maintenance and operation in the regions.

In the Japanese practices, two types of training programs are prepared for provincial-level government staff and private company staff as seen in Table 9.6.3. Practice (1) in the table is the training programs prepared by the college of MLIT for infrastructure management under MLIT supervision. Training opportunities are given not only to the MLIT staff, but also to the regional government staff including government agency staff. In addition, Practice (2) in the table shows training programs specialized for regional government staff, which is developed by Japan Construction Training Center, a public foundation approved by MLIT.

With these practices in mind, the Project formulated draft training plans as shown in **Table 9.6.3** as discussion topics with DRVN counterpart members. The plans in the table include four plans, beginning with one with narrow perspective to one with broad perspective as briefly shown below;.

- Plan-1:DRVN-level Plan (1); Training focused on the dissemination of project outcomes
- Plan-2:DRVN-level Plan (2); Training focused on national road administration
- Plan-3:MOT-level Plan; Training focused on road administration and management
- Plan-4:MOC-level Plan; Training focused on infrastructure construction and maintenance

The Project recommends the implementation of Plan-1 and Plan-2 as mid-term training plans for DOT staff in Provincial Peoples Committee which are now involved in the national road maintenance.

Table 9.6.3 Planning of Training Programs for Provincial-level People's Committees

Plans	Classification and Participants	Focuses of Training Programs	Main Topics	Training Implementation Body	Consensus and Finance
Practice in Japan (1)	Training on infrastructure construction, operation and maintenance MLIT staff, regional Government staff (Prefectures, cities, towns and villages) and ministerial agency staff.	・ Officer training (by Classes) - General ・ - Business procedures ・ Land and right-of-way acquisition ・ Urban planning ・ Housing ・ Disaster/Risk management ・ River management ・ Road management ・ GIS/Topographic survey ・ Information technologies ・ Railway management ・ Automobile ・ Port management ・ Civil aviation management ・ Transportation safety management	Training programs for infrastructure administration and management under the supervision of MLIT.	・ College of MLIT (One headquarters and one branch school)	・ Financial support from state (MLIT) budget ・ Participants should pay fees for textbooks.
Practice in Japan (2)	Training on infrastructure construction and maintenance Regional Government staff (Prefectures, cities/towns/ villages) and Private company staff	・ Business management ・ Project supervision ・ Soil and geology ・ Disaster prevention ・ Roads/Tunnel/Bridges ・ River and dam ・ Erosion control ・ Urban planning ・ Building facility ・ Land/ right-of-way acquisition	Training programs for infrastructure administration and management.	・ Japan Construction Training Center (Prefecture-level training are integrated into one center)	・ Based on consensus of prefecture governors ・ Financial support (Capital investment) from prefectures ・ Training fees from participants
Plan-1 DRVN-level plan	**Training on project products** for DOT staff in Provincial People's Committees who are managing national roads in the regions	・ Products of the JICA Project for Capacity Enhancement in Road Maintenance	・ Road inventory database ・ Road maintenance planning technology ・ Technical standards for road maintenance. ・ Pavement Monitoring	・ DRVN Personnel & Organization Department	・

Plans	Classification and Participants	Focuses of Training Programs	Main Topics	Training Implementation Body	Consensus and Finance
Plan-2 DRVN-level plan	**Training on national road maintenanc**e for DOT staff in Provincial People's Committees	・ National road management including products of the JICA Project for Capacity Enhancement in Road Maintenance	・ Business procedures ・ Road construction technologies ・ Road maintenance and repair technologies ・ Products of JICA Project	・ University of Transport technology (UTT, Hanoi, Vinh Yen City, Thai Nguyen City), or ・ Ho Chi Monh City University of Transport (UT-HCMC) , or ・ Institute of Transport Science and Technology (ITST, Hanoi, Da Nang, HCMC), or ・ Training centers (Transport sector, 42 centers nationwide)	・ Consensus of the Heads of PPCs ・ Training fees from participants
Plan-3 MOT-level plan	**Training on road construction and maintenance** for DOT staff in Provincial, District and Commune People's Committee	・ National road management ・ Provincial road management ・ District road management ・ Commune road management ・ Special road management	・ Business procedures ・ Road construction technologies ・ Road maintenance and repair technologies	・ University of Transport technology (UTT, Hanoi, Vinh Yen City, Thai Nguyen City), or ・ Ho Chi Monh City University of Transport (UT-HCMC), or ・ Institute of Transport Science and Technology (ITST, Hanoi, Da Nang, HCMC), or ・ Training centers (Transport sector, 42 centers nationwide)	・ Consensus of the Heads of PPCs ・ Training fees from participants
Plan-4 MOC-level plan	Training on infrastructure construction and maintenance for DOC/DOT/DOA/DOI staff in Provincial, District and Commune People's Committees, private companies.	・ Legal frame (Regulations) ・ Housing infra. Management ・ Transport infra. management ・ Irrigation infra. management ・ Industrial infra. management ・ Technical infra. management	・ General ・ Business procedures ・ Construction technologies ・ Maintenance and repair technologies	・ Foundation of integrated training center (Hanoi), or ・ Training centers (Housing/ Transportation/ Industry / Irrigation/ Urban infrastructure sector)	・ Consensus of the Heads of PPCs ・ Capital investment from PPCs for training facilities ・ Training fees from participants

(Note)

National Road management include; (1) Training for business procedures, (2) Training for construction technologies and (3) Training for maintenance and repair technologies

Training for business procedures include; Tendering and contracts, Cost estimate, Budget proposal and information technologies,

Training for construction technologies include; Road planning (Survey, F/S and designs), Road structures, Construction work supervision, Construction work quality assurance, construction work performance evaluation, road disasters and information management (Road inventory database, etc.).

Training for maintenance and repair work technologies include; Maintenance and repair work planning, Road asset management, Maintenance and repair work technologies and information management (Road maintenance database, etc.,).

Table 9.6.4 Training Center Approved by MOC (As of March 2013)

No.	Name	Management Unit	Building	Industrial	Infrastructure	Transport	Irrigation	Hydropower
1	Institute for Building Science and technology	MOC	X	X	X	X	X	X
2	Academy of managers for construction and cities	MOC	X	X	X	X	X	X
3	University of Architecture Ho Chi Minh City	MOC	X	X	X			
4	College of Construction No.3	MOC	X	X	X			
5	University of Architecture Ha Noi	MOC	X	X	X	X	X	X
6	Ha Noi Institute for research, education and training to official staff	Company	X	X	X	X	X	X
7	Institute for research, training and development management skill	Company	X	X	X	X	X	X
8	Apave Vietnam and Southeast Asian Ltd.		X	X	X			
9	University of Construction	MOET	X	X	X	X	X	X
10	University of Transport and Communication	MOET				X		
11	Ho Chi Minh City Open University	MOET	X	X	X	X	X	X
12	University of Technology - Ho Chi Minh City National University	NUHCM	X	X	X	X		
13	Lac Hong University	MOET	X	X	X			
14	Institute of Transport Science and technology	MOT				X		
15	Vietnam Center for Technology of Construction Quality Management – CQM	MOC	X	X	X	X	X	X
16	Management Consultant Development and Training JSC.	Company	X	X	X	X	X	X
17	Centre for applied information technology in construction - Vietnam federation of civil engineering association	Society	X	X	X	X	X	X
18	Institute for open training and research development - Binh Duong university	MOET	X	X	X			
19	Construction price JSC.	Company	X	X	X	X	X	X
20	Tender consultant training and business development JSC.	Company	X	X	X	X	X	X
21	Economic management training and research JSC.	Company	X	X	X	X	X	X
22	Institute for Southeast Asian Resource research and development JSC.	Company	X	X	X	X	X	X
23	Institute of construction economics sciences - Vietnam union of science and technology association	Society	X	X	X	X	X	X
24	Vietnam Institute of Architecture, Urban and Rural Planning	MOC	X	X	X	X	X	X
25	College of transport	MOT				X		
26	College of Construction and Industrial	MOI	X	X	X	X	X	X
27	Vietnam Education JSC.	Company	X	X	X	X	X	X
28	Centre for Science training and construction technology transfer -Vietnam federation of civil engineering association	Society	X	X	X	X	X	X
29	Vietnam Construction consultant association	Society	X	X	X	X	X	X
30	University of Transport Ho Chi Minh City	MOT	X	X	X	X		
31	Song Da Kinh Bac JSC.	Company	X	X	X	X	X	X

No.	Name	Management Unit	Building	Industrial	Infrastructure	Transport	Irrigation	Hydropower
32	Phuong Nam Training and Real estate assessment	Company	X	X	X	X	X	X
33	Management training and international cooperation JSC.	Company	X	X	X	X	X	X
34	University of Transport technology	MOT	X	X	X		X	X
35	Centre for Training and Information- Institute of Transport Science and technology	MOT	X	X	X		X	X
36	Centre for Science technology and Investment consultant -University of technology Da Nang	MOET	X	X	X	X	X	X
37	College of Construction Nam Dinh	MOC	X	X	X	X		
38	Business administration School - Vietnam National Coal - Mineral Industries Group	Society	X	X	X	X	X	X
39	Institute for Research and human resource management consultant - Human resource, talented person development technology association	Society	X	X	X	X	X	X
40	Institute for Direction and business administration technology - Ho Chi Minh City Business association	Society	X	X	X	X	X	X
41	Centre University of Construction	MOC	X	X	X	X	X	X
42	Water Resources University	MARD				X	X	X
43	College of Construction No.1	MOC	X	X	X			
44	Mien Tay Construction University	MOC	X	X	X	X		
45	Sub-Institute of Transport Science and technology in the southern Vietnam - Institute of Transport Science and technology	MOT				X		
46	Ha Noi Training and Investment Consultant JSC.	Company	X	X	X	X	X	X
47	College of Urban construction work	MOC	X	X	X	X	X	X
48	Institute for International Development - Vietnam Southeast Asian Science Studies Association	Society	X	X	X	X	X	X
49	Institute for training and management development - Branch of Davilaw intellectual property JSC.	Company	X	X	X	X	X	X
50	Centre for Research and Development Construction Technology - Au Lac Investment and Construction JSC.	Company	X	X	X	X	X	X
	Total					42		

(Source) MOC Homepage http://www/moc.gov.vn

CHAPTER 10 COUNTERPART TRAINING IN JAPAN, AND EQUIPMENT AND MACHINERY SUPPLY

10.1 COUNTERPART TRAINING IN JAPAN

Training courses in Japan will be held twice in total, once at each year in 2012 and 2013. The duration of each training course is two (2) weeks with thirteen (13) participants mainly from counterpart members.

10.1.1 Aim and Objective

The main aim of training in Japan is to provide knowledge and understanding on advanced institutional and organizational arrangement and technology on road maintenance in Japan.

10.1.2 First Training in Japan

First training in Japan was schedule for two (2) weeks from 2nd to 15th of December, 2012.

(1) Participants

Following five (5) trainees were selected from Project Counterparts as shown below.

Table 10.1.1 Participants for the 1st training in Japan

	Name	Position
1	Mr Nguyen Xuan Cuong	DRVN, Deputy General Director
2	Mr Quach Van Khoa	DRVN, Director of Road Infrastructure and Traffic Safety Department
3	Mr Thieu Duc Long	DRVN, Deputy Director of Science and Technology and International Cooperation Department
4	Mr Luong Van Minh	DRVN, Expert, Road Maintenance and Management Department
5	Ms Nguyen Thi Nhat	DRVN, Deputy Director of Organization and Personnel Department

(2) Trainers and Training Institution

Followings list shows the training implementing organizations for the program.

Table 10.1.2 Training Implementation Organization

	Training institution
1	Regional Development Bureau, MLIT
2	Public Works Research Institute, MLIT
3	Nippon Expressway Research Institute Co., Ltd
4	The Nippon Road Co., Ltd.
5	Metropolitan Expressway Co., Ltd.
6	Central Nippon Expressway Co., Ltd.
7	Katahira and Engineers International

(3) Training Program

Table 10.1.3 Training Program

Date	Time	Training Method	Training Contents	Training Institution
12/2 (Sun)			Arriving to Tokyo, Japan	
12/3 (Mon)	AM		Briefing	JICA Tokyo
	PM		Program Orientation	KEI Tokyo
		Lecture	Road administration in Japan	
12/4 (Tue)	AM	Lecture	History of road maintenance in Japan	KEI Tokyo
	PM	Lecture	Road maintenance and standard	
12/5 (Wed)	AM	Lecture	Road maintenance at MLIT	Tokyo National Road Office, KANTO Regional Development Bureau, MLIT
		Site Visit	Disaster Prevention Office	
	PM	Site Visit	Disaster Prevention Vehicle, Air Ventilation、road maintenance vehicle, Earthquake resistance work on Bridge	
12/6 (Thu)	AM	Lecture	Pavement Standard and procedure	Public Works Research Institute
	PM	Site Visit	Laboratory for Pavement standard	
12/7 (Fri)	PM	Lecture	Outline of Nippon Expressway Research Institute Co., Ltd	Nippon Expressway Research Institute Co. Ltd,
12/8 (Sat)				
12/9 (Sun)				
12/10 (Mon)	AM	Lecture	Advance technology and Method for Pavement maintenance and management, Site management and Quality Management	The Nippon Road Co. Ltd.
	PM	Site Visit	Research Centre, Work Plant	
12/11 (Tue)	AM	Site Visit	Pavement maintenance and management work	The Nippon Road Co. Ltd.
	PM	Lecture	Outline of Metropolitan Expressway, DVD on Road Maintenance and Rainbow Bridge	Metropolitan Expressway Co. Ltd.
		Site Visit	Rainbow Bridge	
12/12 (Wed)	AM	Site Visit	Communication Plaza Kawasaki, Traffic Control Centre Kawasaki	Central Nippon Expressway Co. Ltd.
		Lecture	Outline of NEXCO Central, Inspection and Maintenance for Highway	
	PM	Site Visit	Tomei Expressway, Shin- Tomei Expressway, Service areas	
12/13 (Thu)	AM	Site Visit	N2B Bridge Inspection Training Facility	Central Nippon Expressway Co. Ltd.
	PM	Lecture	Outline of Maintenance Centers	
		Site Visit	Toll Collection, Maintenance Vehicles, Weighbridges	
12/14 (Fri)	AM		Evaluation meeting, Question and Discussion	
12/15 (Sat)			Leaving Tokyo, Japan	

10.1.3 The Second Training in Japan

Second training in Japan was schedule for two (2) weeks from 4th to 16th of November, 2013.

(1) Participants

Following eight (8) trainees were selected from Project Counterparts as shown below.

Table 10.1.4 Participants for the second training in Japan

	Name	Position
1	Mr. Nguyen Phu Trong	DRVN, Director of PMU-TA
2	Mr. Nguyen Quoc Canh	DRVN, Deputy Director of Organization and Personnel Department
3	Mr. Nguyen Cong Chien	DRVN, Head of Evaluation 1 - Road Construction Management Bureau
4	Mr. Trinh Xuan Sinh	DRVN, Expert of Planning and Investment Department
5	Mr. Tran Ba Dat	DRVN, Deputy Director of Infrastructure and Road safety Department
6	Mr. Luu Quang Thin	MOT , Expert of Planning and Investment Department
7	Mr. Bui Le Dung	MOT, Expert of Traffic Infrastructure Department
8	Ms. Pham Thi Bich Lien	Writer of Lao Dong news paper

(2) Trainers and Training Institution

Following list shows the training implementing organizations for the program.

Table 10.1.5 Training Implementation Organization

	Training institution
1	Tokyo National Road Office, KANTO Regional Development Bureau, MLIT
2	Kanagawa Prefecture Government, Department of Road
3	Central Nippon Expressway Co. Ltd.
4	The Nippon Road Co. Ltd.
5	Nichireki Co.Ltd.
6	PASCO Corporation
7	Katahira and Engineers International

(3) Training Program

Table 10.1.6 Training Program

Date	Time	Training Method	Training Contents	Training Institution
11/4(Mon)			Arriving to Tokyo, Japan	
11/5(Tue)	AM		Briefing	JICA Tokyo
	PM		Program Orientation	KEI Tokyo
		Lecture	Road administration in Japan	
11/6(Wed)	AM	Lecture	Road Maintenance in MLIT	Tokyo National Road Office, KANTO Regional Development Bureau, MLIT
	PM	Site Visit	Emergency Management Office, Shinagawa Branch Office, Work Base for Clearance work, Bridge Repair Work at Estuary Arakawa River, National Highway 357	
11/7(Thu)	AM	Lecture	Outline of PASCO, Pavement Condition Survey in Japan	PASCO Corporation
	PM	Lecture	Current situation and Operation of Pavement Condition survey using Road Condition Survey Vehicle	
		Site Visit	Equipment for Pavement Condition survey	
11/8(Fri)	AM	Lecture	Road maintenance and management in Kanagawa Prefecture	Kanagawa Prefecture Government, Department of Road
	PM	Site Visit	Pedestrian Crossing Deck, Hakomine Doumon (Conccrete Structure for rock fall prevention), Disaster sites at Touno sawa, Owaku dani (Volcanic Valley)	
11/9(Sat)				
11/10(Sun)				

Date	Time	Training Method	Training Contents	Training Institution
11/11(Mon)	AM	Lecture	Outline of Nippon Road	The Nippon Road Co. Ltd.
		Site visit	Technical Research Centre	
	PM	Site Visit	Kawasaki Asphalt mixture Plant	
11/12(Tue)	AM	Lecture	Pavement Material, Research Centre	Nichireki Co. Ltd.
	PM	Site Visit	Asphalt Emulsion and Modified Asphalt Plant	
11/13(Wed)	AM	Site Visit	Tomei Expressway, Shin- Tomei Expressway, SURUGA NUMAZUWAN Service Area / Disaster Prevention Facility, Communication Plaza FUJI	Central Nippon Expressway Co. Ltd.
	PM	Site Visit	Communication Plaza Kawasaki, Traffic Control Centre Kawasaki	
		Lecture	Outline of NEXCO Central, Inspection and Maintenance for Highway	
11/14(Thu)	AM	Site Visit	N2B Bridge Inspection Training Facility	Central Nippon Expressway Co. Ltd.
	PM	Lecture	Outline of Maintenance Centers	
		Site Visit	Toll Collection, Maintenance Vehicles, Weighbridges	
11/15(Fri)	AM	Presentation	Evaluation meeting, Question and Discussion	
11/16(Sat)			Leaving from Tokyo, Japan	

10.2 EQUIPMENT AND MACHINERY SUPPLY

10.2.1 Items Procured and Purchased

JICA Project Team has procured and purchased the following equipment and machinery for the project activities.

a) Road Condition Survey Vehicle: 1 set

b) PMS Personal Computer(for data acquisition and analysis system): 2 sets

c) Personal Computers: 2 sets

d) Color Printer: 1 set

e) Projector: 1 set

f) Projector Screen: 1 set

10.2.2 Procurement of Survey Vehicle and Peripherals

(1) Supporting works for procurement of survey vehicle and peripherals

Following shows supporting works for procurement carried out by JICA Project.

- To investigate manufacturers of Survey Vehicle
- To research possibility of exporting a vehicle from Japan to Vietnam
- To make a draft specification for a tender of vehicle
- To make a draft form of "Request Form for Technical Cooperation (Equipment) by the Government of Japan" for procurement of Survey Vehicle.
- To make a preliminary cost estimate of Survey Vehicle and peripherals.

(2) Outline Process for procuring Survey Vehicle and peripherals

In accordance with Work Plan approved by JCC meeting held on January 11th, 2012, JICA Project Team purchased Road Condition Survey Vehicle (hereinafter referred to as "Survey Vehicle"), and relevant data acquisition and data analysis systems (hereinafter referred to as "peripherals).

JICA Project Team discussed with DRVN on draft specifications of Survey Vehicle, peripherals, and road database personal computers from August, 2012, and had the final confirmation by DRVN on May 2013. Following this confirmation, JICA headquarter made public announcement on July 10th 2013 for Survey Vehicle equipment and Peripherals by specifying equipment of PASCO Corporation. Main car body was procured by JICA Vietnam Office in Vietnam. As a result of tender on August 6th 2013, TOYOTA TSUSHO Corporation in cooperation with PASCO Corporation won a tender.

Following the technical transfer training in February and March 2014 using Survey Vehicle and peripherals, procured items were handed over to DRVN on 25th March 2014.

(3) Equipment of Survey Vehicle

Table 10.2 1 shows the equipment of Survey Vehicle and relevant systems.

Table 10.2.1 Equipment of Survey Vehicle and Relevant Systems

No.	Item
Vehicle for Road Condition Survey	
1	New Vehicle
2	Equipment of measuring longitudinal profile for IRI (Profile type)
3	IMU(Inertial Measurement Unit) for IRI
4	Laser Scanner of measuring Rutting depth
5	3CCD (Charge Coupled Device) Camera for recording the front view images of road
6	CCD (Charge Coupled Device) Camera for recording pavement surface images
7	GPS (Global Positioning System)
8	UPS (Uninterruptible Power Supply)
9	Equipment for checking, recording and saving data in the Vehicle
10	Equipment for rigging(inside/outside Vehicle)
Equipment for processing, analyzing, calculating and outputting data collected on the Road Condition Survey.	
1	Hardware and peripherals for data processing, analysis, calculation and outputting
2	Software for data processing, analysis, calculation and outputting

10.2.3 Procurement of PMS Personal Computer

(1) Outline Process for procuring PMS Personal Computer

In accordance with the above mentioned Work Plan, JICA Project Team discussed on specification of personal computer with DRVN. Upon agreement on the specification in November 2012, JICA Project Team purchased 2 set of personal computers for PMS in December 2012. Purchased computers were used at project office and handed over in March 2014, at the end of the Project.

(2) Specification of PMS Personal Computer

Following shows specification of PMS Personal computer purchased. Upon the handover, project outputs of PMS software was also installed into one of computer, and moved to DPI of DRVN.

Table 10.2.2 Schedule of Personal Computers for PMS

	Items	Detail
1	Desktop Computer 1 For PMS	CPU: DELL Vostro 470 (intel (R) Core i7 3770 RAM: 8GB OS: Windows 7 Professional Monitor: Dell U22312HM Monitor (23 inches) MS-Office: MS-Office 2010 Professional Visual Studio: 2012 Professional Antivirus Software: Norton Key Board: English UPS: SANTAK 1400W Other: Mouse, Cables
2	Desktop Computer 2 For PMS	CPU: DELL Vostro 470 (intel (R) Core i7 3770 RAM: 8GB OS: Windows 7 Professional Monitor: Dell U22312HM Monitor (23 inches) MS-Office: MS-Office 2010 Professional Visual Studio: 2012 Professional Antivirus Software: Norton Key Board: English UPS: SANTAK, 1400W Other: Mouse, Cables

10.2.4 Procurement of Other Equipment

Purchased items were located in the Project office during this Project, and handed over to DRVN at the end of March, 2014.

Table 10.2.3 Schedule of Other Equipment

	Items	Detail
1	Desktop Computer 1	CPU: HP Compaq Elite 8300 SFF (intel (R) Core i7 3770 RAM: 4GB OS: Windows 7 Monitor: HP W1972a Monitor (17 inches) MS-Office: MS-Office 2013 Professional Antivirus Software: Kaspersky Key Board: English UPS: SANTAK 1200W Others: Mouse, Cables
2	Desktop Computer 2	CPU: HP Compaq Elite 8300 SFF (intel (R) Core i7 3770 RAM: 4GB OS: Windows 7 Monitor: HP W1972a Monitor (17 inches) MS-Office: MS-Office 2013 Professional Anti-Virus Software: Kaspersky Key Board: English UPS: SANTAK 1200W Others: Mouse, Cables

3	Color Printer	Epson STYLUS PHOTO 1390 (model B321C)
4	Projector	Epson EB 905
5	Projector Screen	Tripod Model 84x 84 (Size 213 x 213 cm)