

**MINISTRY OF ROAD AND TRANSPORT, MONGOLIA  
ROAD DEPARTMENT, ULAANBAATAR CITY**

**PROJECT  
FOR  
CAPACITY DEVELOPMENT  
ON  
BRIDGE MAINTENANCE AND MANAGEMENT  
IN  
MONGOLIA**

**PROJECT COMPLETION REPORT**

**NOVEMBER 2015**

**JAPAN INTERNATIONAL COOPERATION AGENCY  
(JICA)**

**CTI ENGINEERING INTERNATIONAL CO., LTD.  
CENTRAL NIPPON EXPRESSWAY COMPANY LIMITED  
ORIENTAL CONSULTANTS GLOBAL CO., LTD.**

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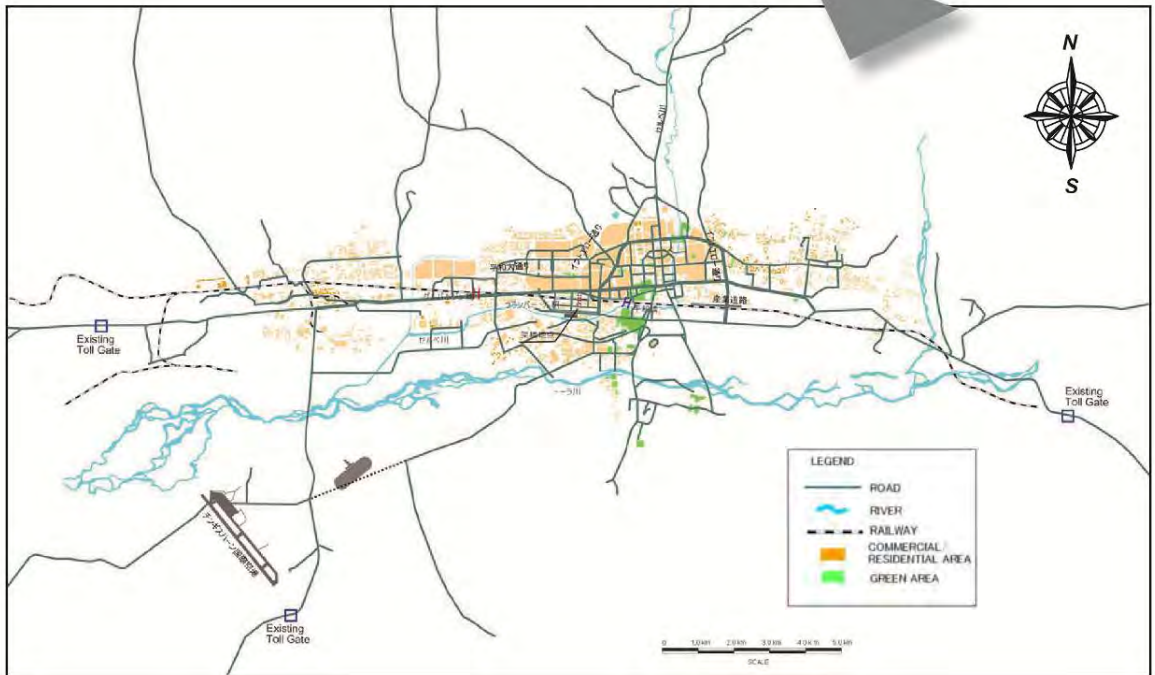
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Project Location Map (Nationwide)



Project Location Map (Ulaanbaatar City)



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## Abbreviations

### **A. Ministries and Organizations**

ADB	Asian Development Bank
ROD	UBC Road Department
JICA	Japan International Cooperation Agency
MED	Ministry of Economic Development
MRT	Ministry of Road and Transport
RTDC	Roads and Transportation Development Center
UBC	Ulaanbaatar City Government
WB	World Bank

### **B. Others**

AH	Asian Highway
CD	Capacity Development
C/P	Counterpart
CFRP	Carbon Fiber Reinforced Plastic
DB	Database
JCC	Joint Coordination Committee
JTG	Joint Technical Group
MNT	Mongolian Tugrik
MT	Master Trainer
OJT	On the Job Training
PC	Pre-stressed Concrete
PIU	Project Implementation Unit
RC	Reinforced Concrete
R/D	Record of Discussions
WS	Workshop
MT/IE	Master Trainer of Bridge Inspection and Evaluation
MT/RR	Master Trainer of Rehabilitation and Retrofitting
MT/DB	Master Trainer of Data Base System
CP/MP	Counter Part in charge of the Long-Mid Term Bridge Maintenance and Management Program

# **1. GENERAL**

## **1.1 Background of the Project**

Mongolia is a landlocked country surrounded by China and Russia with the national land area of 1.56 million km<sup>2</sup> or four times as large as Japan. The road network is more than 49,000 km, and there are 433 bridges along the national and international roads. Transportation by road in Mongolia accounts for 98.5% of passenger traffic. Next to railway, road transportation accounted for 42.5% of freight transport in 2009. The importance of roads to the economy of Mongolia has drastically increased in this way.

Ulaanbaatar City, the capital of Mongolia has over 40% of the national population. The city has 645km of road network with 67 bridges. Consistent with the economic growth, particularly, in Ulaanbaatar City, passenger and freight transport, as well as traffic volume have drastically increased and these are further expected to increase in the future.

On the other hand, a considerable number of the bridges in Mongolia were constructed under the former Soviet Union and China in the 1960's and these have significantly deteriorated. Thus, they need to be updated, rehabilitated and/or retrofitted to accommodate the increasing traffic. However, adequate road maintenance activities have not been carried out since democratization in 1990 due to budgetary constraint and lack of engineering capacity in Mongolia. In addition, maintenance of roads and bridges has been implemented by contract to maintenance companies; however, these are limited to only minor repair and/or urgent rehabilitation, and systematic bridge maintenance management aiming at the Preventive Maintenance has not been carried out in line with the policy and/or plans based on their inspection and evaluation.

The Road and Transportation Policy and Coordination Department of the Ministry of Road and Transport (hereinafter referred to as MRT) and the Operation and Maintenance Division of the Road Department in Ulaanbaatar City Government (hereinafter referred to as UBC) are responsible for the maintenance of bridges nationwide and in Ulaanbaatar City respectively. Since most of the staff members in these departments have limited knowledge in advanced technology on systematic bridge maintenance, it is an urgent issue to develop the capacity of these staff members in bridge maintenance such as inspection, evaluation and rehabilitation, as well as maintenance management database.

In addition, Japan International Cooperation Agency (hereinafter referred to as JICA) had conducted the "Project for Construction of Railway Flyover in Ulaanbaatar City (Japan's Grant Aid Project 2009-2012)" with the construction of "Naryn Bridge." JICA also undertook the "Preparatory Survey for the Construction of Ajilchin Flyover Project (2012-2013)" for the construction of bridge by means of Yen Loan in accordance with the "Infrastructure Development for Economic Activities" stipulated as priority sector in the Country Assistance Policies for Mongolia. Accordingly, this

project was highly expected to play an important role in the maintenance of bridges constructed or to be constructed under Japan's ODA.

In view of the above situation, the Government of Mongolia (GOM) had requested the Government of Japan (GOJ) to implement the technical assistance project to develop the capacity in bridge maintenance. In response to the request, JICA had a series of discussions with MRT and UBC and other authorities concerned to formulate the capacity development project. Through the series of discussion among JICA and the authorities concerned in Mongolia, the Minutes of Meetings was signed in April 2013, which led both parties to conclude the Record of Discussions (R/D) in May 2015. Thus the Project for Capacity Development on Bridge Maintenance and Management in Mongolia (herein referred to as "the Project") was to implement a technical cooperation project with MRT and UBC as counterparts (C/P) based on the R/D.

## 1.2 Outline of the Project

The outline of the Project is given below. The Project was extended up to October 2015 to provide assistance in the pilot bridge rehabilitation work borne by UBC through planning of rehabilitation, supervising the construction and introducing advanced technology in rehabilitation and retrofitting.

### Project Overview

- |                    |   |
|--------------------|---|
| 1. Overall Goal    | : Maintenance status of bridges is improved in Mongolia.  |
| 2. Project Purpose | : MRT's and UBC's capacity for planning skills of bridge maintenance is improved.   |
| 3. Outputs         | 1) Output 1:<br>Concept of "Bridge Management Cycle" is widely understood, and guidelines and/or manuals regarding inspection, evaluation, priority assessment and selection of measures are developed.<br><br><Activities><br>1-1. To draft, review and finalize a bridge inspection manual.<br>1-2. To draft, review and finalize an evaluation manual for condition/deterioration of bridges.<br>1-3. To draft, review and finalize a guideline for selection of bridge rehabilitation/retrofitting measures.<br>1-4. To conduct trainings/seminars on the concept of "Bridge management cycle".<br><br>2) Output 2:<br>Database system to record information of bridges is developed nationwide and in UBC.<br><br><Activities><br>2-1. To collect information and/or documents related to existing bridges.<br>2-2. To collect information on the condition of existing bridges through site survey and to develop existing bridges' inventory.<br>2-3. To inspect existing bridges.<br>2-4. To evaluate condition/deterioration of existing bridges.<br>2-5. To propose rehabilitation/retrofitting measures of existing bridges.<br>2-6. To develop bridge database systems including inventory, design report/drawings, results and history of inspection etc. of existing bridges. |

2-7. To establish the procedure and to develop manuals for input, reporting and update of bridge database system.

3) Output 3:

National policy on maintenance and management are developed.

<Activities>

- 3-1. To collect information and data on the existing bridge management system, budget, laws/regulations, policy and standard.
- 3-2. To draft a bridge maintenance and management policy.
- 3-3. To select necessary bridge maintenance works in accordance with the draft bridge maintenance and management policy.
- 3-4. To prioritize the selected bridge maintenance works.
- 3-5. To confirm total bridge maintenance work of the nation and to evaluate overall condition of existing bridges.
- 3-6. To develop an implementation schedule and to estimate a cost necessary for the bridge maintenance including the discussion with relevant organizations/agencies.
- 3-7. To develop a bridge maintenance and management program (long term and/or middle term).
- 3-8. To decide a bridge maintenance and management level and/or performance requirements.
- 3-9. To propose necessary bridge maintenance and management structure (organization, personnel etc.).

4) Output 4:

Staff members related to bridge/structure maintenance and management in MRT and UBC are trained, and trainings are conducted by Mongolian side.

<Activities>

- 4-1. To conduct surveys to confirm the capacity of organizations/officers in MRT and UBC related to bridge/structure maintenance and management.
- 4-2. To develop a training program for bridge/structure engineers.
- 4-3. To prepare training manuals and materials for capacity development of bridge engineers.
- 4-4. To conduct on-the-job-trainings, seminars and/or trainings for the bridge maintenance and management technologies including inspection, condition/deterioration evaluation and rehabilitation/retrofitting measures.
- 4-5. To propose the training system and plan for capacity development of officers related to bridge maintenance and management by Mongolian side.
- 4-6. To implement the training for officers related to bridge maintenance and management by Mongolian side.
- 4-7. To assist preparation, coordination and implementation of actual bridge rehabilitation works to be done by Mongolian side at its own budget.

4. Project Site : 68 bridges along international highway or national highway and all bridges in Ulaanbaatar City
5. Implementation Agency : Ministry of Roads and Transportation (MRT)  
Ulaanbaatar City Government (UBC)
6. Duration : August 2013 - October 2015 (27 months in Mongolia)

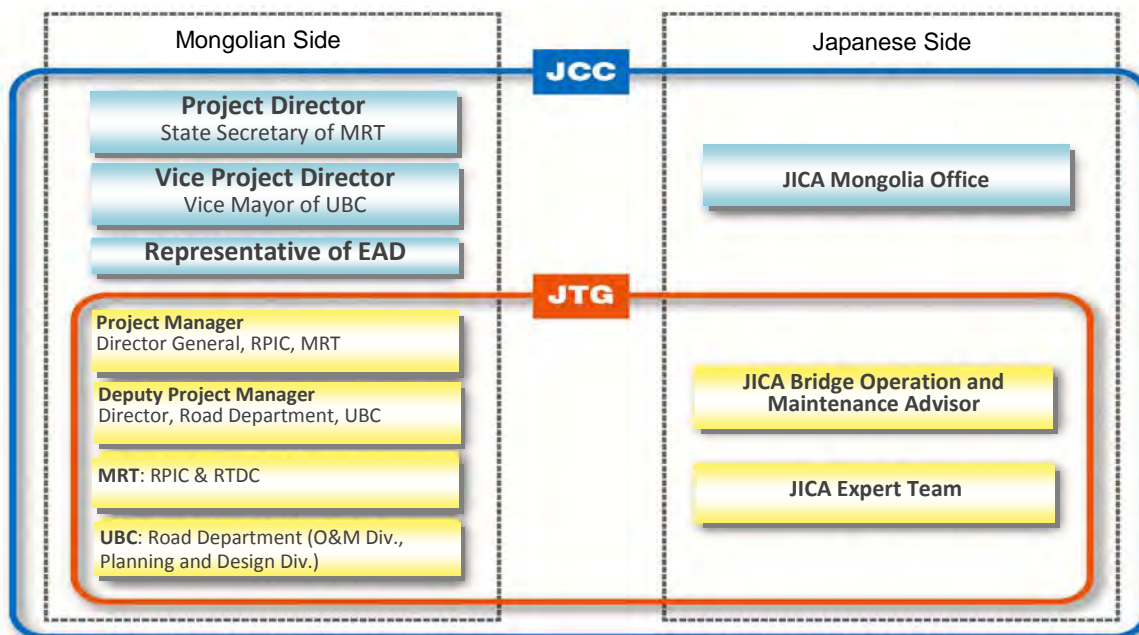
### 1.3 Objective of the Project

The objective of the Project was to develop the capacity in systematic bridge maintenance planning through activities such as dissemination of "Bridge Management Cycle", development of bridge maintenance manuals, development of Bridge Database System, and training of related staff in MRT and UBC.

### 1.4 Project Implementation Structure

The C/Ps and engineers from MRT and UBC were assigned to organize the Joint Technical Group (JTG) for the Project. In close coordination with JTG, the JICA Expert Team implemented the Project through periodic discussion and/or confirmation for achievement of outputs under the Project.

The Joint Coordinating Committee (JCC) was organized by MRT, UBC, MED from the Mongolian side and the JICA Mongolia Office, the Bridge Operation and Maintenance Advisor from JICA and the JICA Expert Team from the Japanese side in order to achieve the outputs of the Project and coordinate with related agencies in Mongolia.



JCC: Joint Coordination Committee; JTG: Joint Technical Group  
RPIC: Road Transport Policy Implementation and Coordination Department, RTDC: Roads and Transport Development Center  
Source: JICA Expert Team<sup>1</sup>

**Figure 1.4.1 Project Implementation Structure**

<sup>1</sup> All of figures and tables without indication of the source shall be deemed as products in the Project.

## 1.5 List of Members of the JICA Expert Team

Position	Name
Team Leader/ Bridge Expert/Capacity Development	Mr. OKAZAKI Akio
Bridge Expert (2)	Mr. MAMIYA Kei
Bridge Inspection	Dr. AOYAMA Minobu
Bridge Inspection (2)	Mr. WATANABE Yasufumi
Bridge Rehabilitation	Mr. MUKOUYAMA Tatsuo
Construction for Bridge Rehabilitation (1)	Mr. SHIDA Yasuhiro
Construction for Bridge Rehabilitation (2)	Mr. HASEGAWA Yusuke
Bridge Database System (1)	Mr. KUNIKATA Keigo
Bridge Database System (2)	Mr. Gantumur Burneebaatar
Cost Estimator	Mr. NISHI Shuichi
Bridge Retrofitting	Mr. IDE Yuji
Coordinator/Capacity Assessment	Ms. KATO Minami

## 1.6 List of Counterpart of Mongolian Side

Position in the Project	Name	Office	Title
Project Director	Mr. BATZAYA Baasandorj (Resigned)	MRT	State Secretary
	Mr. BAT-ERDENE Jalavsuren	MRT	State Secretary
Vice Project Director	Mr. MUNKHBAATAR Begzjav	UBC	Vice Mayor, UBC
Project Manager	Mr. ONON Rentsendorj (Resigned)	MRT	Director General, Road Policy Implementation and Coordination Department
	Ms. DORJIHAND Dashdorj	MRT	Director General, Road Transport Policy Implementation and Coordination Department (RPIC)
Deputy Project Manager	Mr. NANZADDORJ Dookhuu	UBC	Director, Road Department, UBC
C/P	Mr. B. Mandat (Resigned)	MRT	Director, O&M Division
	Mr. .Sugarjav (MT/RR, MT/DB, CP/MP)	MRT	Senior Specialist, Central Area, RPIC
	Mr. A.Gantulga (MT/IE, MT/RR) (Resigned)	MRT	Specialist, North Area, RPIC
	Mr. C.Munkhbat (MT/IE, MT/RR)	MRT	Specialist, West Area, RPIC
	Mr. J. Bayarsaikhan (MT/RR, CP/MP)	MRT	Specialist, Capital repair, reconstruction, , RPIC
	Mr. Kh. Oyumbileg	MRT	Specialist, Capital Repair, Reconstruction
	Mr. B. Darkhandariya (CP/MP)	MRT	Specialist, East Area, RPIC
Ms. Ts. Khosgerel (MT/DB)	MRT	Specialist, Local Road, RPIC	

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Position in the Project	Name	Office	Title
	Ms. B. Giiviishinen	MRT	Specialist, RPIC
	Mr. L. Bayanzul	MRT	Engineer, Capacity Development on Sustainable Bridge Maintenance and Management Project
	Mr. Kh. Khurelsukh (Resigned)	MRT	Director, Road Supervision and Research Center
	Mr. E. Bat-Orshikh (MT/DB)	MRT/RTDC	Specialist, O&M Division
	Mr. N. Enkhtulga (MT/IE)	MRT/RTDC	Specialist, O&M Division
	Kh. Bayartogtokh	MRT/RTDC	Senior Expert, Road Network Management, Construction, Inspection Division
	Mr. D. Turbileg	UBC	Director, ROD, Operation and Maintenance Division
	Mr. B. Enkhmandakh (MT/IE, MT/RR)	UBC	ROD, Operation and Maintenance Division, Control Specialist
	Mr. B. Tserensodnom (MT/IE)	UBC	ROD, Operation and Maintenance Division, Control Specialist
	Mr. Ya. Unurtuvshin	UBC	ROD, Operation and Maintenance Division, Control Senior Specialist
	Mr. B. Jargalduuren	UBC	ROD, Operation and Maintenance Division, Control Specialist
	Mr. L. Mendbayar	UBC	ROD, Material Research Laboratory
	Mr. B. Lkhaasuren	UBC	ROD, Material Research Laboratory
	Mr. B. Ankhbayar (MT/RR, CP/MP)	UBC	ROD, Planning and Research Division, Chief Engineer
	Mr. B. Olzbayar (MT/DB)	UBC	Specialist, ROD, Planning and Research Division
	Mr. E. Monkhbileg	UBC	Planning Specialist, ROD, Planning and Research Division
	Ms. B. Khishigjargal (MT/DB)	UBC	Specialist, ROD, Planning and Research Division
	Mr. B. Enkhsaikhan (MT/DB)	UBC	Expert, ROD, Planning and Research Division
	Mr. D. Dawaabayar	UBC	Bridge Planning Engineer, ROD, Planning and Research Division
	Mr. B. Ganbagana	UBC	Road Planning Specialist, ROD, Planning and Research Division
	Mr. B. Uranzaya	UBC	Specialist, ROD, Construction Supervision Division
	Mr. Battsolmon (CP/MP)	UBC	ROD, Planning and Research Division
	Mr. G. Khasbaatar	UBC	Project Manager, Head of Office

MRT: Ministry of Road and Transportation  
 UBC: Ulaanbaatar City Government  
 ROD: UBC Road Department  
 RTDC: Roads and Transportation Development Center

MT/IE: Master Trainer of Bridge Inspection and Evaluation  
 MT/RR: Master Trainer of Rehabilitation and Retrofitting  
 MT/DB: Master Trainer of Data Base System  
 CP/MP: Counter Part in charge of Long-Mid Term Bridge Maintenance and Management Program



## 1.7 Policy on Capacity Development

The efficient capacity development system where master trainers (MTs) are trained by JICA Expert Team to spread the technology to other staff members of their organization was introduced in the Project. Selected MTs were classified into engineering staff who would be in charge of inspection, evaluation and rehabilitation plan, and administration staff who would be in charge of Database operation. Selected MTs were trained by the JICA Expert Team aiming to have them in a responsible position for bridge maintenance work with capability of proper instruction and advice.

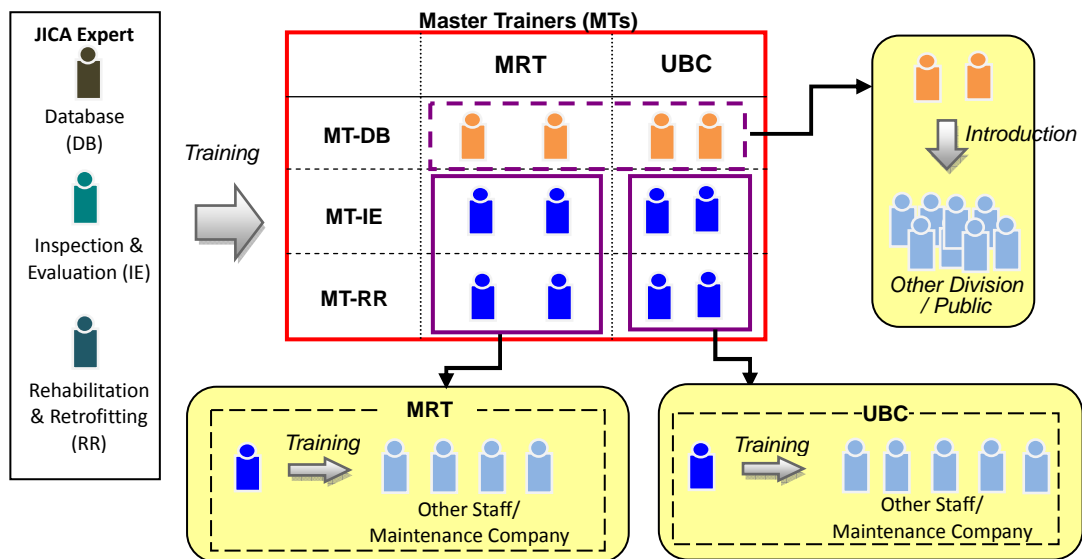


Figure 1.7.1 Training System of the Project through MT

The training of MTs by the JICA Expert Team was carried out focusing on the following training items to achieve the outputs stipulated in the Project Design Matrix (PDM).

Table 1.7.1 Training Items of the Project

Item	Detail	Description	Outputs of the Training
Development of Bridge Maintenance Database	DB System	System Configuration / System Development	<ul style="list-style-type: none"> <li>• Bridge Database System</li> <li>• Database Operation Manual</li> <li>• Database Administration Manual</li> </ul>
	DB Input	Data Input, updating, revision	
	DB Operation	Operation towards Maintenance Planning	
Bridge Inspection/Evaluation	Inspection	Periodic Inspection, Operation of Inspection Equipment	<ul style="list-style-type: none"> <li>• Manual for Bridge Inspection</li> <li>• Manual for Bridge Soundness Evaluation</li> </ul>
	Soundness Evaluation	Type of damage/degree of damage/evaluation criteria	
Bridge Rehabilitation/Retrofitting	Type of Repair Work	Outline of Rehabilitation and Retrofitting	<ul style="list-style-type: none"> <li>• Manual for Selection of Bridge Rehabilitation and Retrofitting Measures</li> </ul>
	Selection of Repair Work	Selection of repair work based on type of damage	
Mid-Long Term Maintenance Planning	Maintenance Level	Definition of Maintenance Level	<ul style="list-style-type: none"> <li>• The Mid-Long Term Bridge Maintenance and Management Program</li> </ul>
	Cost Estimate	Cost estimate for budgeting	
	Maintenance Planning	Objective of Mid-Long Term Bridge Maintenance Plan / Priority of repair work / Allocation of Yearly Budget	

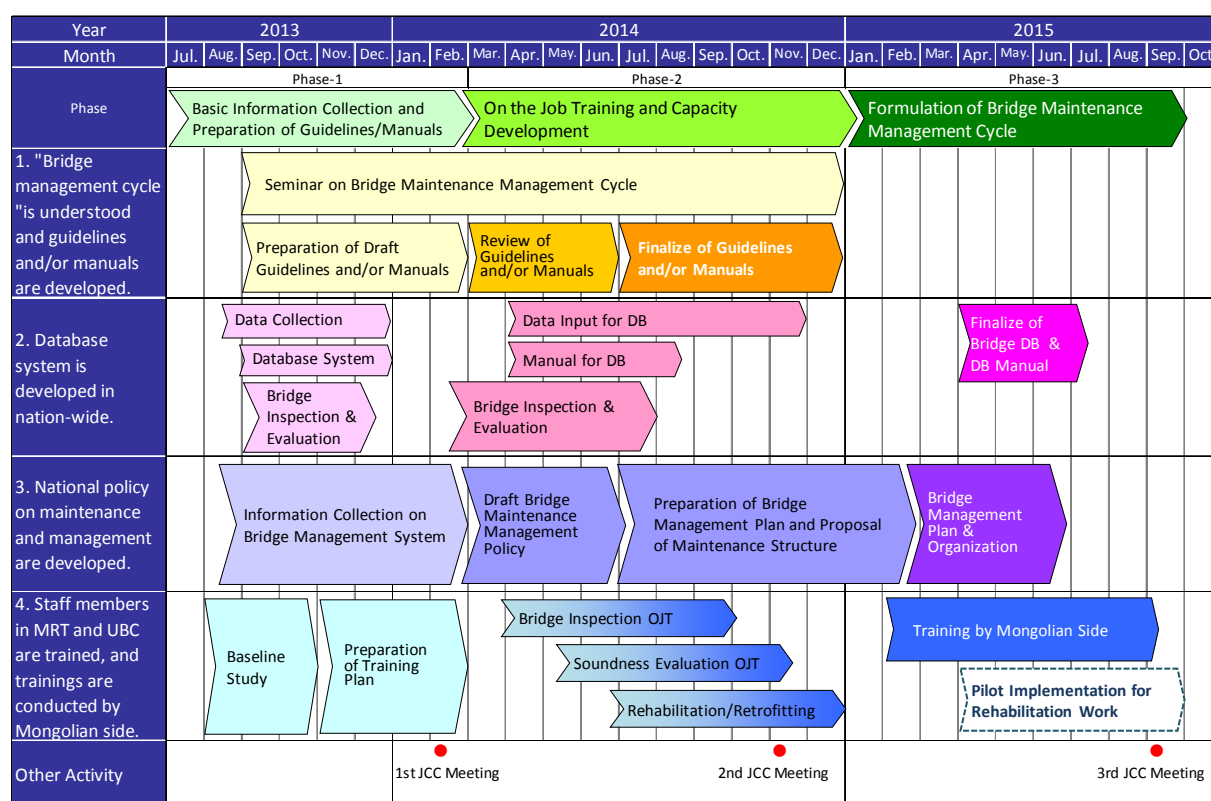
## 1.8 Implementation Schedule

Activities of the Project were implemented from August 2013 to September 2015. The Project was divided into three (3) phases to clarify the activities and its objectives as shown below.

**Table 1.8.1 Phases and Objectives of the Project**

	Duration	Objectives	Remarks
Phase-1	August 2013 -February 2014	Data Collection and Manual Development	
Phase-2	March 2014 - December 2014	OJT and Capacity Development	OJT by Manuals / Formulation of Development of Mid-Long Term Bridge Maintenance and Management Program
Phase-3	January 2015 - September 2015	Establishment of Bridge Maintenance Management Cycle	Training by Mongolian Side

JCC Meetings were held at the end of each Phase to confirm achievements of the Project and to review the Work Plan with the JCC members.



**Figure 1.8.1 Implementation Schedule of the Project**

## 1.9 Record of Activities

Major conferences and seminars held during the Project are listed below. Details of workshops and seminars are given in the succeeding chapter.

**Table 1.9.1 Major Conferences and Seminars during the Project**

Phase	Title of Meeting	Data	Description
Phase-1	MRT Kick-Off Meeting	9 September 2013	Project orientation of C/P of MRT
	UBC Kick-Off Meeting	10 September 2013	Project orientation of C/P of UBC
	1st JTG Meeting	20 September 2013	Approval of Work Plan
	Bridge Maintenance Management Cycle Seminar	18 and 19 November 2013	Introduction of Bridge Maintenance Management Cycle based on practices in Japan.
	1st JCC Meeting	28 February, 2014	Approval of 1st Progress Report
Phase-2	2nd JTG Meeting	18 June 2014	Confirmation of Progress and Achievement of the Project.
	3rd JTG Meeting	10 September 2014	Confirmation of Mid-Long Term Bridge Maintenance Management Plan
	1st C/P Training in Japan	11-25 September 2014	Site visit to learn the bridge maintenance system in Japan and Local Government.
	Science and Technology Committee Meeting (MRT)	10 November 2014	Approval of Bridge Maintenance Manuals
	2nd JCC Meeting	25 November 2014	Approval of 2nd Progress Report
Phase-3	4th JTG Meeting	30 June 2015	Confirmation of Progress and Achievement of the Project.
	In-house Training	12 March 2015; 7 May 2015	Training of staff members of MRT/UBC by MTs of their respective offices.
	Engineer Seminar	14 May 2015	Seminar for engineers of private company and/or road maintenance company presented by MRT and UBC (Number of Attendees: 50 persons)
	2nd C/P Training in Japan	14 -25th July 2015	Site visit to learn bridge rehabilitation work
	Site Seminar	28 August 2015; 4 September 2015	Introduction of technology on bridge rehabilitation and retrofiting under the Pilot Implementation Project.
	Public Seminar	10 September 2015	Introduction of the bridge maintenance management cycle to the public by MTs of MRT/UBC.
	3rd JCC Meeting	16 September 2015	Approval of 3rd Progress Report, Certification of MTs and wrap-up of the Project.



## 2. PROJECT ACTIVITIES

### 2.1 Dissemination of Concept of the Bridge Management Cycle (Output-1)

For the dissemination of bridge maintenance in Mongolia, the significance of bridge maintenance and the concept of the Bridge Management Cycle have been introduced through the workshops and seminars conducted in the Project. An image of the Bridge Management Cycle that was explained in the Project is shown in Figure 2.1.1 below.

Bridge Maintenance Manuals consist of the “Manual for Bridge Inspection”, “Manual for Bridge Soundness Evaluation” and “Manual for Selection of Bridge Rehabilitation and Retrofitting Measures” were prepared during Phase-1 of the Project and it was finalized in July 2014 after adding new knowledge obtained in Phase-2. These manuals were officially distributed to engineers in Mongolia in accordance with the Minister’s Decree, through approval of the Science and Technology Committee that was organized in November 2014 by MRT.

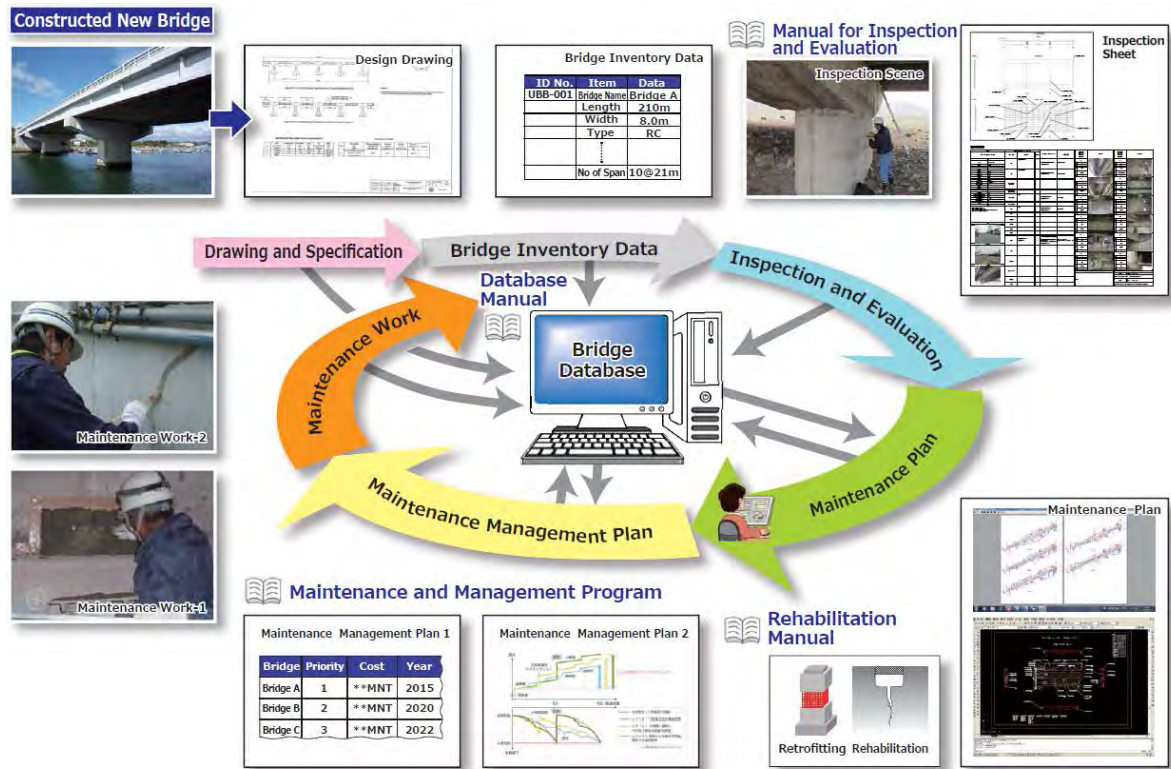


Figure 2.1.1 Concept of the Bridge Management Cycle

### **2.1.1 Manual for Bridge Inspection**

The Manual for Bridge Inspection was developed in consideration of the following items for easier understanding of the checkpoints and procedures of bridge inspection for the less<sup>1</sup> experienced engineers in Mongolia.

#### **(1) Basic Instruction on Bridge Structures**

The Section on “Bridge Structure” was incorporated in the beginning part of the Manual to introduce the various bridge types, name of elements, etc., with visual explanations and interpretation for easier understanding by junior engineers.

#### **(2) Explanation of Bridge Deterioration Mechanism**

In order to elucidate the checkpoints of bridge inspection, a section on “Bridge Deterioration Mechanism”, together with theoretical explanations, was incorporated in the Manual.

#### **(3) Consideration of Bridge Situation in Mongolia**

Not only the common deterioration mechanism, but also practical examples of deterioration with its mechanism in Mongolia were introduced to the Manual. Particularly, the concrete T-shape girder bridges (based on standards of former Soviet Union), which have been constructed the most in Mongolia have been similarly damaged, thus the methodology of bridge inspection was developed to ensure the recording of said damages. Moreover, since water in river channels get frosted in winter and the inspectors could access the intermediate piers inaccessible in summer, implementation of winter inspection has been recommended to confirm the condition of substructures after trial inspection as demonstrated by the JICA Expert Team in February 2014.

#### **(4) Simplified Inspection Sheet**

The Inspection Sheet was simplified as much as possible to ensure the sustainability of proper and secure implementation of inspection.

#### **(5) Schematic View**

Schematic views such as the variety of girders, expansion joints and bearings, as well as typical conditions as references of evaluation, were added in the Manual to help the site engineers understanding of the items to be inspected.

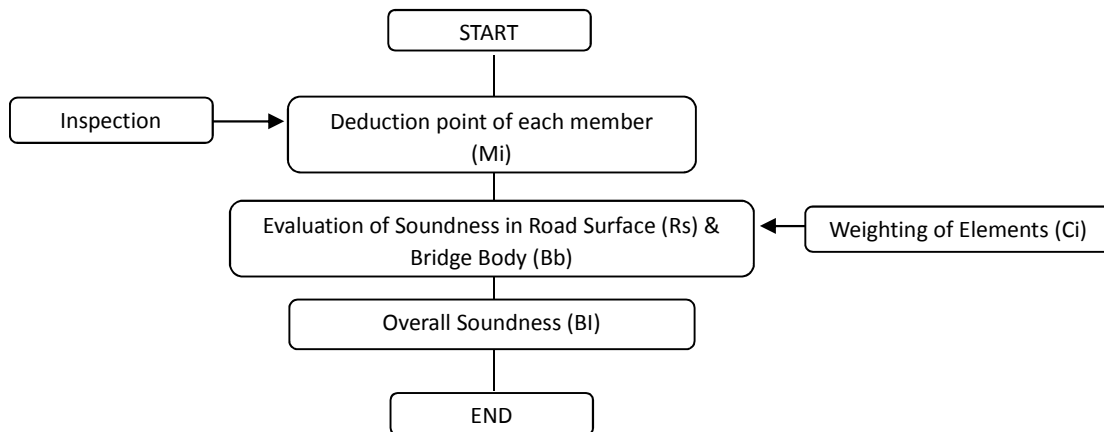
### **2.1.2 Manual for Bridge Soundness Evaluation**

#### **(1) Outline of the Manual**

The Manual for Bridge Soundness Evaluation developed in the Project stipulates that the soundness of bridge is to be quantitatively evaluated based on bridge inspection conducted in accordance with the following flowchart in reference to the manuals which has been used in municipalities in Japan, taking into account the scarcity of well experienced engineers in Mongolia (see Figure 2.1.2).

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<sup>1</sup> Total number of the bridge engineer registered to the Road Association in Mongolia is forty (40), and the number of bridge engineer who have been in active service is only twenty-six (26) as of 2015.



**Figure 2.1.2 Flowchart of Bridge Soundness Evaluation**

Soundness score of evaluation of major elements is calculated by the summation of deduction points of each bridge member based on the type and extent of defects of each members. Overall Soundness (BI) is estimated on the basis of soundness score of road surface (Rs) and bridge body (Bb) composed of soundness score of major elements considering the weight factor of each element. The reason that soundness of road surface was considered in the whole bridge soundness score is, that certain priority should be given to the rehabilitation of bridge surface in some cases because a lot of damage in the bridge surface hampering traffic flow have been recognized in Mongolia.

**(2) Methodology of Bridge Soundness Evaluation**

The bridge soundness shall be quantitatively evaluated based on bridge inspection data, and the soundness score shall be computed for bridge body and road surface respectively to evaluate the overall bridge soundness.

Evaluation score of each component is calculated by subtracting the total deduction points based on defect type and quantity of each member from 100 points. “Basic deduction point” and its evaluation unit have been defined as shown in Table 2.1.1. Total deduction points for each member ( $M_i$ ) shall be estimated by the summation of each deduction point as shown in Formula (1) below.

$$\text{Total Deduction Point for Each Member: } M_i = \sum (\text{Deduction Point}) \dots\dots\dots(1)$$

Evaluation Point for Road Surface (Rs) and Evaluation Point for Bridge Body (Bb) shall be computed by subtracting the Total Deduction Point ( $M_i$ ) multiplied by weight factor ( $C_i$ ) from 100 points as shown in Formulae (2) and (3) below.

$$\text{Evaluation Point for Road Surface: } R_s = 100 - \sum (M_i \times C_i) \dots\dots\dots(2)$$

$$\text{Evaluation Point for Bridge Body: } B_b = 100 - \sum (M_i \times C_i) \dots\dots\dots(3)$$

Overall Soundness of Bridge (BI) was computed by the addition of respective evaluation points for Road Surface and Bridge Body multiplied by the weight factor ( $C_r=0.33$  and  $C_b=0.67$ ) as shown in Formula (4) below.

$$\text{Overall Soundness: } B_I = R_s \times C_r + B_b \times C_b \dots\dots\dots(4)$$

**Table 2.1.1 Basic Deduction Point for each Defect Type and its Evaluation Unit**

Component	Member	Type of Defect		Evaluation Unit	
		Type of Defect	Basic Deduction Point		
Road Surface	Curb, Side Wall, Hand Railing	Curb	10	Span	
		Sidewall, Hand Railing	23	Span	
	Expansion Joint	Elevation Gap	15	No.	
		Hole, Damage on Surrounding Concrete	15	No.	
		Damage on Filling Material	3	No.	
	Pavement	Pot Hole	15	Span	
		Large Crack	10	Span	
		Medium Crack	3	Span	
		Wearing	5	Span	
	Approach Slab	Slant	10	No.	
		Crack	10	No.	
		Structural failure on Wing, Parapet	10	No.	
		Narrow Width	3	No.	
	Drainage System	No Drainage	33	Span	
		Function Failure	10	Span	
Bridge Body (Concrete Bridge)	Main Girder	Shear, Horizontal Crack	9	Span	
		Large Crack by Bending	6	Span	
		Defect on concrete nearby bearing	A,B	10	Span
			C	2	Span
		Scale	3	Span	
	Free Lime	3	Span		
	Deck Slab	Hole perforate	15	Span	
		Scale	5	Span	
		Crack	10	Span	
		Free Lime	3	Span	
	Abutment, Pier	Crack, Wearing, Rebar exposure	13	No.	
		Subsidence / Slant	20	No.	
		Critical Wearing, Less Cross Section of Pier	5	No.	
Bridge Structure (Steel Bridge)	Main Girder	Fatigue Crack	12	Span	
		Severe Degradation of Painting	12	Span	
		Defect nearby bearing	A, B		Span
			C	2	Span
	Others	3	Span		
	Deck Slab	Hole perforation	15	Panel	
		Panel Evaluation "A"	9	Panel	
		Panel Evaluation "B"	6	Panel	
		Panel Evaluation "C"	3	Panel	
	Abutment, Pier	Crack, Wearing, Rebar exposure	13	No.	
		Subsidence / Tilting	20	No.	
Critical Wearing, Too Slender Pier		5	No.		

### 2.1.3 Manual for Selection of Bridge Rehabilitation and Retrofitting Measures

The Manual for Selection of Bridge Rehabilitation and Retrofitting Measures was designed to be practical, easy to use and compatible with the present situation in Mongolia. Therefore, opinions in the meetings with the C/Ps and in the WSs were incorporated into the Manual. The following information was also incorporated to make the Manual adequate for Mongolia.



**(1) Fact-finding on the present situation of existing bridges in Mongolia**

It was essential to understand the structural characteristics and damage of existing bridges for the development of a manual beneficial to Mongolia. Since many of the RC-T beams constructed from the 1960's under Russian standards have suffered a great deal of damage and deterioration, considerations were given to analyze the characteristics and causes of damage on the type of bridge.

**(2) Information collection from contractors and material manufacturers**

Information about the condition (damage), maintenance, history of rehabilitation, method of rehabilitation of existing bridges and the procurement condition of rehabilitation materials were collected from contractors and material manufacturers. Information on new bridges such as type of bridge, material, cost and construction method was also collected for input in the manual to be developed.

**(3) Collection of examples of rehabilitation and retrofitting in Mongolia**

Examples of rehabilitation and retrofitting works for bridges in Mongolia were collected to check the skill level of bridge maintenance work in Mongolia and to incorporate the major methods of rehabilitation in Mongolia in the manual.

**2.1.4 Seminar/Workshop on the Concept of Bridge Management Cycle**

**(1) Phase-1**

1st Bridge Management Seminar was conducted for MRT and UBC by the JICA Expert Team on November 18 and 19, 2013 respectively. Following contents were explained by the JICA Expert Team in the seminar.

a) Significance of Systematic Bridge Maintenance

- i) If insufficient bridge maintenance is made, a fatal situation such as impassable or collapse could be expected, which would cause a negative impact to the social economy or larger expense for recovery.
- ii) In advanced countries such as the USA and Japan, bridge maintenance cost is increasing due to the increasing dilapidation of bridges.
- iii) It is essential to transform the approach to bridge management from "Corrective Maintenance" to "Preventive Maintenance" in consideration of the Life Cycle Cost (LCC) to save on bridge maintenance cost which is expected to increase in the future.

b) Introduction of Bridge Management practiced in the USA and Japan

- i) Bridge management organizations and the frequency of maintenance in the USA and Japan were introduced.
- ii) The Bridge Management Cycle composed of maintenance activities such as bridge inspection, evaluation and rehabilitation in both countries were explained.

c) Issues on Bridge Management in Mongolia

- i) No maintenance plan from the long term viewpoint, progress in the aging of bridges, increasing of traffic and effect of overloaded vehicles were pointed out as issues on bridge maintenance in Mongolia.
- ii) Concept of Mid-Long Term Bridge Maintenance Program to be developed in the Project was introduced.



**Photo 2.1.1 Bridge Management Seminar in MRT**



**Photo 2.1.2 Bridge Management Seminar in UBC**

**Table 2.1.2 Participants of the Bridge Management Seminars**

First Bridge Management Seminar in MRT: November 18, 2013			
No.	Name	Department	Position
1	N. Sugarjav	MRT	Senior Expert, Road Operation and Maintenance Division
2	Kh. Khurelsukh	RTDC	Departmental Director
3	J. Bayarsaikhan	MRT	Expert, Road Operation and Maintenance Division
4	Ts. Khosgerel	MRT	Expert, Road Operation and Maintenance Division
5	E Bat-Orshikh	RTDC	Road, Bridge Account Informative Technology Respond Specialist
6	Toshiyuki Oka	JICA Expert Team	Bridge Maintenance Engineer
First Bridge Management Seminar in UBC: November 11, 2013			
No.	Name	Department	Position
1	G. Khasbaatar	UBC	Project Coordinator
2	B. Enkhmandakh	UBC	Expert, Road Operation and Maintenance Division
3	Toshiyuki Oka	JICA Expert Team	Bridge Maintenance Engineer

**(2) Phase 2**

Technology transfer was carried out through the WS and/or OJT on bridge inspection, soundness evaluation, database development and rehabilitation plan which are elements of the Bridge Maintenance Cycle. Knowledge gained through the WSs and trainings was shared with the C/Ps through the JTG meetings to facilitate understanding of the Bridge Management Cycle.

**(3) Phase 3**

The Bridge Management Cycle was disseminated by the MTs to engineers and the public during Phase-3, through the following training and seminars.

a) Implementation of In-house Training

“In-house Training” was implemented by the MTs of MRT and UBC for the staff members related to road administration to disseminate the concept of the Bridge Management Cycle in their own organizations between March and May in 2015.

b) Holding of Engineer’s Seminar

“Engineer’s Seminar” was held by MTs in May 2015 to share the knowledge on and technology of the Bridge Management Cycle transferred by the JICA Expert Team with the engineers of road maintenance companies, construction companies and consultants.

c) Holding of Public Seminar

“Public Seminar” was held in September 2015 by the MTs for academic experts, students and mass media to promote nationwide understanding of the Bridge Management Cycle and the significance of bridge maintenance.

d) Presentation at Road Expo

The JICA Expert Team was invited to “the Road Expo” organized by the Road Association in Mongolia in March 2015 to present the outputs of the Project. The JICA Expert Team made a presentation of the Bridge Management Cycle to many engineers belonging to construction firms in Mongolia through this opportunity.

e) Introduction of the Project by the Engineering Magazine

An overview of the Project and outputs have been published in the academic journal of the Road Association in Mongolia to disseminate the Bridge Management Cycle and the activities of the Project. The contents were widely read by many road/construction engineers belonging to the Road Association in Mongolia.

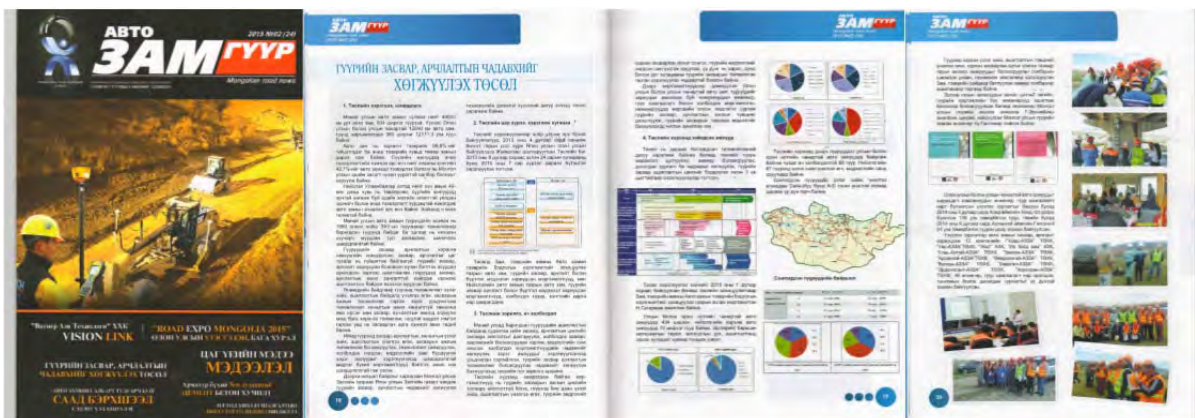


Figure 2.1.3 Publication of the Project by the Road Association in Mongolia

## **2.2 Development of Bridge Database System (Output-2)**

### **2.2.1 Data Collection of Existing Bridge**

#### **(1) Existing Bridges of MRT**

Inventory data of MRT bridges had been kept by the Roads and Transport Development Center (former Road Management and Research Center) as the database system developed in 2003. Prior to the start of nationwide bridge inspection under the Project, existing bridge data were collected by the JICA Expert Team to arrange basic information on the existing bridges such as type, length and construction year.

#### **(2) Existing Bridges of UBC**

Existing data for sixty-seven (67) bridges of UBC were collected under the “Preparatory Survey on Project for Construction of Ajilchin Flyover in Ulaanbaatar City” conducted by JICA in 2012, and detailed bridge information such as photos, inventories, conditions and construction drawings were compiled under the said survey. The JICA Expert Team collected these data including additional information on newly constructed and rehabilitated bridges. Data of seventy (70) bridges of UBC were arranged through additional data collection and updating of existing data during the Project.

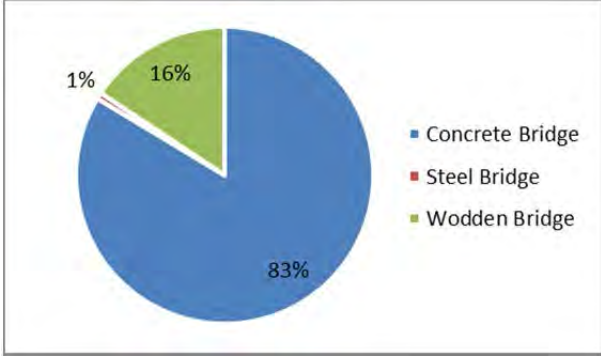
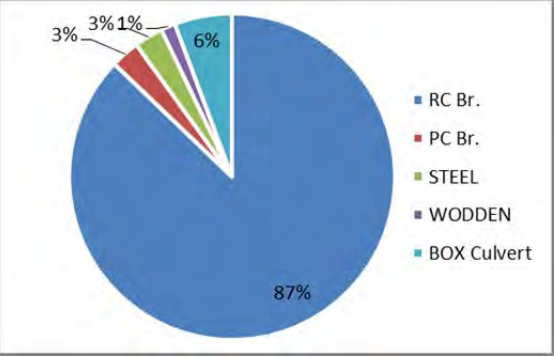
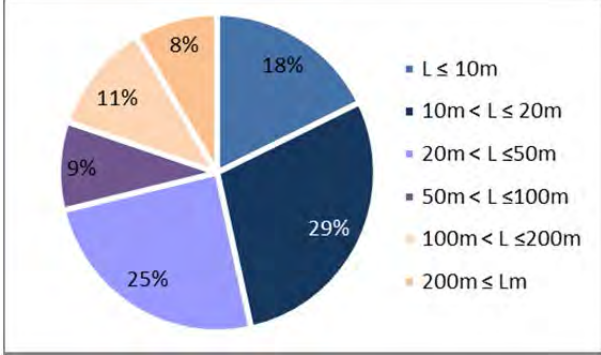
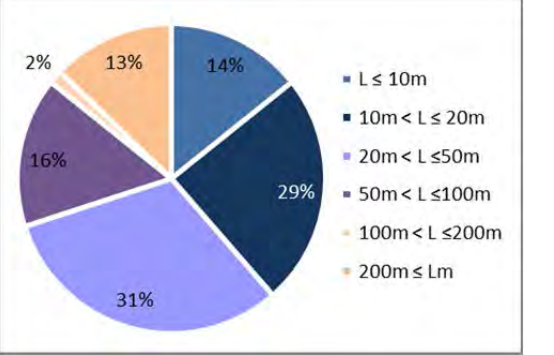
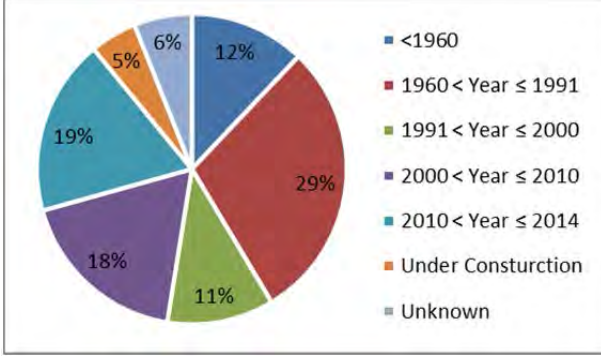
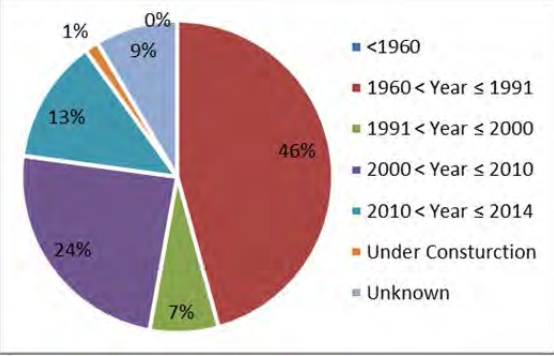
### **2.2.2 Bridge Inventory Data**

Inventory data of 68 MRT bridges selected for the Project were collected through the data collection of existing bridges and inspection survey carried out by the JICA Expert Team in cooperation with the MTs. The inventory data of 70 UBC bridges were collected by updating the original inventory data developed in 2012 under a JICA’s project. Naryn Bridge which was constructed in 2012 and two (2) of the new bridges constructed in 2013 were added to the original data.

### **2.2.3 Existing Bridge Inspection**

Bridge inspection data were developed for 68 MRT bridges and 70 UBC bridges through the inspection survey carried out under the Project. Summary of the data developed by the inspection is shown in following table.

**Table 2.2.1 Data of MRT and UBC Bridges**

Data of MRT Bridges	Data of UBC Bridges
 <p>Type of Bridge</p>	 <p>Type of Bridge</p>
 <p>Bridge Length</p>	 <p>Bridge Length</p>
 <p>Construction Year</p>	 <p>Construction Year</p>
<p>Total Number of Bridges 433 Bridge along National Road 404 Bridge along International Road 29</p>	<p>Total Number of Bridges: 70 (including 3 box culverts)</p>

Source: JICA Expert Team

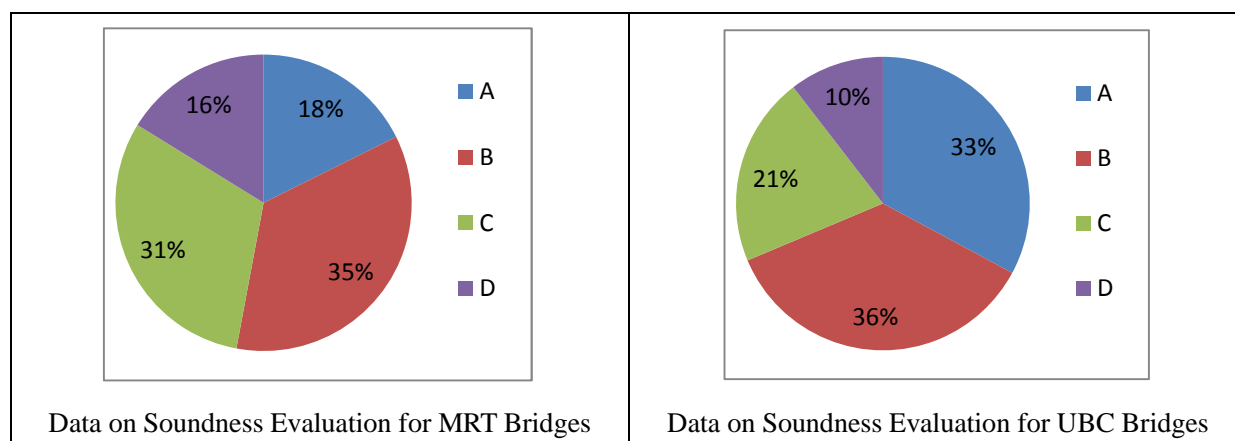
#### 2.2.4 Bridge Soundness Evaluation

The soundness evaluation for Sixty-eight (68) MRT bridges and Seventy (70) UBC bridges have been carried out by MTs and the JICA Expert Team during the Project. The inspections and evaluation were implemented based on the “Manual for Bridge Inspection” and the “Manual for

Bridge Soundness Evaluation” prepared under the Project. Summary of the inspection and evaluation results is shown below.

**Table 2.2.2 Summary of Bridge Inspection and Soundness Evaluation**

		MRT	UBC
Total number of bridge		433	67 (Except Box Culvert)
Inspected Bridge by the Project (%: ratio to total number of bridge)		68 bridges (15.7%)	67 bridges (100.0%)
Soundness (%: ratio to the number of Inspected by the Project)	A	12 bridges (18%)	22 bridges (33%)
	B	24 bridges (35%)	24 bridges (36%)
	C	21 bridges (31%)	14 bridges (21%)
	D	11 bridges (16%)	7 bridges (10%)



**Figure 2.2.1 Results of Soundness Evaluation of Bridges**

**Table 2.2.3 Required Measures corresponds to the Soundness**

Soundness	Condition of Bridge	Type of Measures			
		Monitoring	Rehabilitation	Retrofitting	Replacement
A	Minor defects that rehabilitation work is not required.	✓			
B	Few defects and damages to be repaired periodically.	✓	✓		
C	Many defects and/or damages to be rehabilitated or reinforced in few years.	✓	✓	✓	✓
D	Developed defects and/or damages to be urgently measured.	✓	✓	✓	✓

Source: JICA Expert Team

### Bridge Location Map of Mongolia

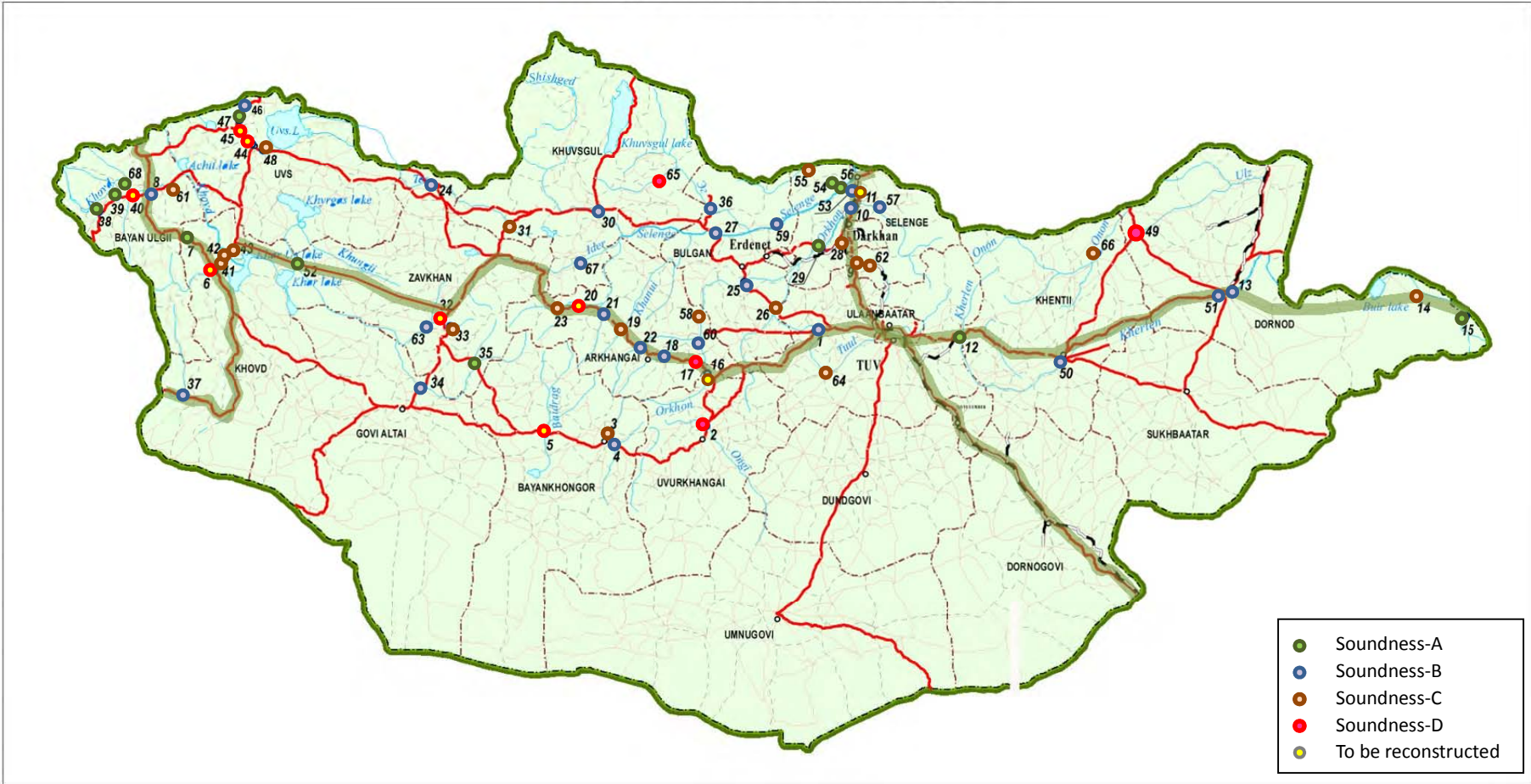


Figure 2.2.2 Location Map of MRT Bridges and Evaluation Results

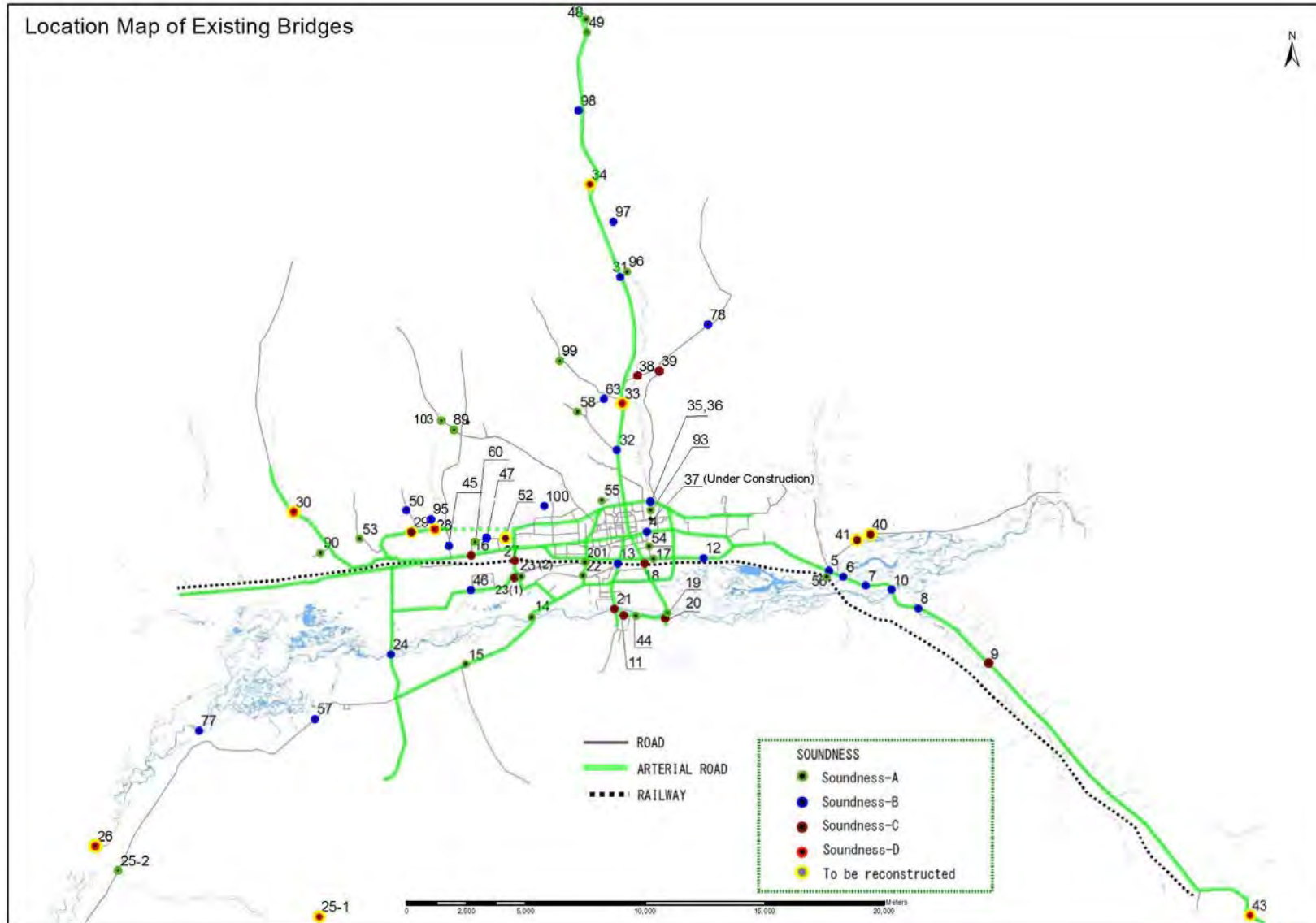


Figure 2.2.3 Location Map of UBC Bridges and Evaluation Results



### 2.2.5 Proposal for Rehabilitation and Retrofitting Measures

Adoptable Rehabilitation and Retrofitting Measures for Concrete and Steel Bridges have been proposed taking into account the experience with bridges repair work, conditions of procurement, and natural conditions in Mongolia. The flowcharts for the selection of bridge rehabilitation and retrofitting measures introduced in the “Manual for Selection of Bridge Rehabilitation and Retrofitting Measures” are shown below.

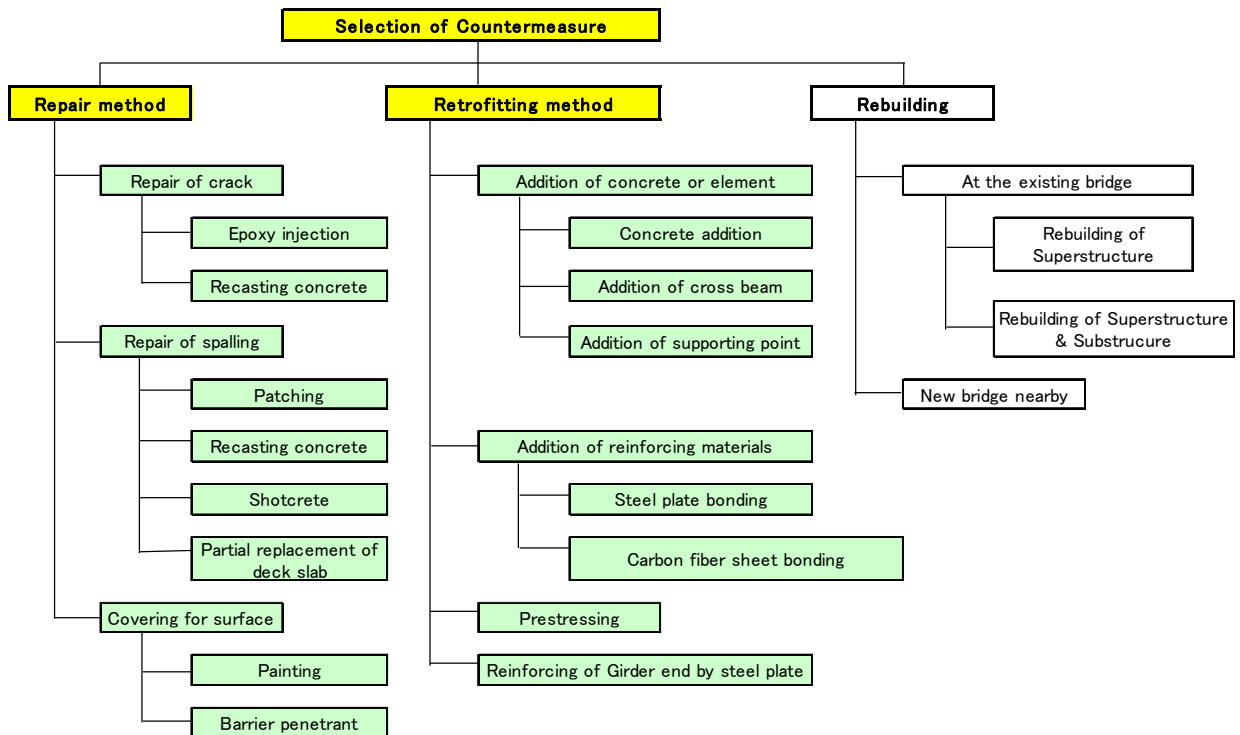


Figure 2.2.4 Rehabilitation and Retrofitting Measures for Concrete Bridges

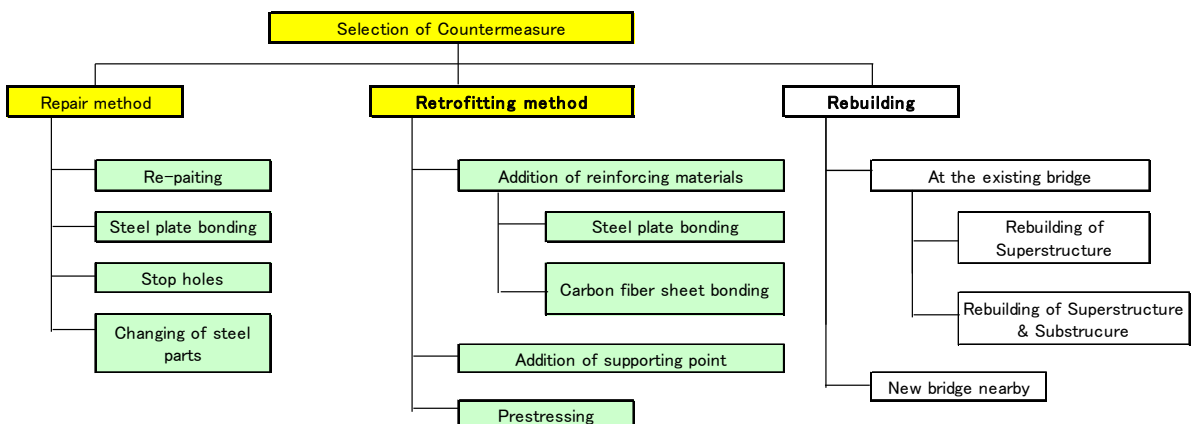


Figure 2.2.5 Rehabilitation and Retrofitting Measures for Steel Bridges

## 2.2.6 Development of Bridge Database System

### (1) Network of the Database System

#### a) MRT

A computer with LAN connection for the Database System has been installed at the Office of Road and Transport Policy Implementation and Coordination Department of MRT. As for the Roads and Transport Development Center, the Database was installed in the existing PC, and data of each bridge is going to be manually synchronized to share the same information. A part of information generated by the Bridge Database System in MRT is disclosed to the public at the website of MRT.

#### b) UBC

A computer for the Database System has been installed at the Design and Planning Division with LAN connection to input bridge inspection data from the Maintenance Division of the Road Department. The Design and Planning Division is to input data of the rehabilitation plan and maintenance program which shall be shared with the Maintenance Division.

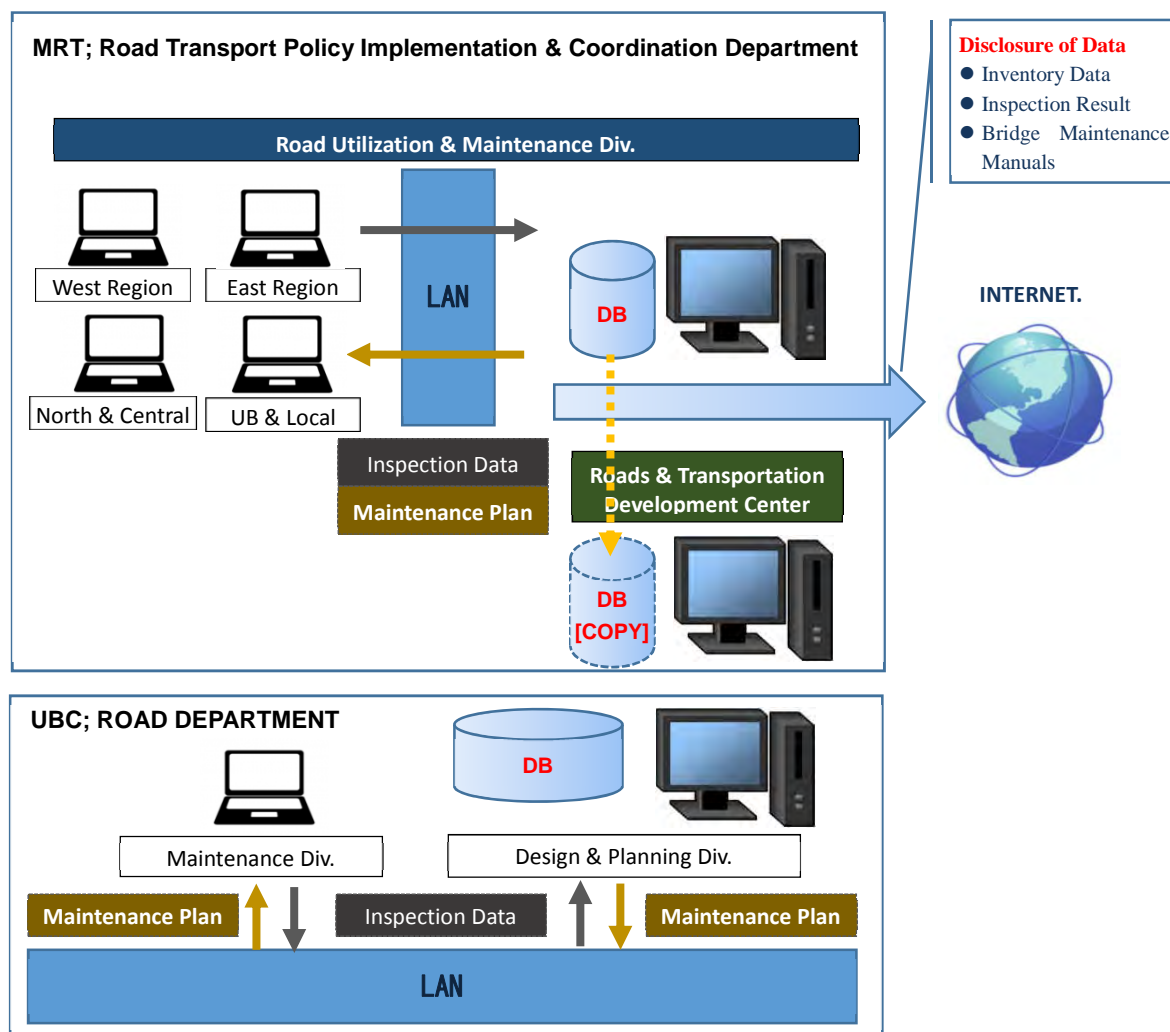


Figure 2.2.6 Network of the Bridge Database System

(2) Composition of the Bridge Database System

The Bridge Database System with the following functions has been developed in combination with versatile software to ensure the operational condition by MRT and UBC after completion of the Project.

Table 2.2.4 Configuration of Functions and Software of the Bridge Database System

Purpose	Type of Data	Software
To know the outline of bridge structure	Bridge Passport Data	MS Excel
To know the entire picture	Bridge General Photo	MS Excel
To know the location	Coordinate	Google Map
To know the soundness	Inspection Sheet	MS Excel
To know the maintenance program	Table of Maintenance Program	MS Excel
To know past maintenance work	Record of Maintenance Work	MS Excel
To know scale and material condition	Design Documents	PDF Format

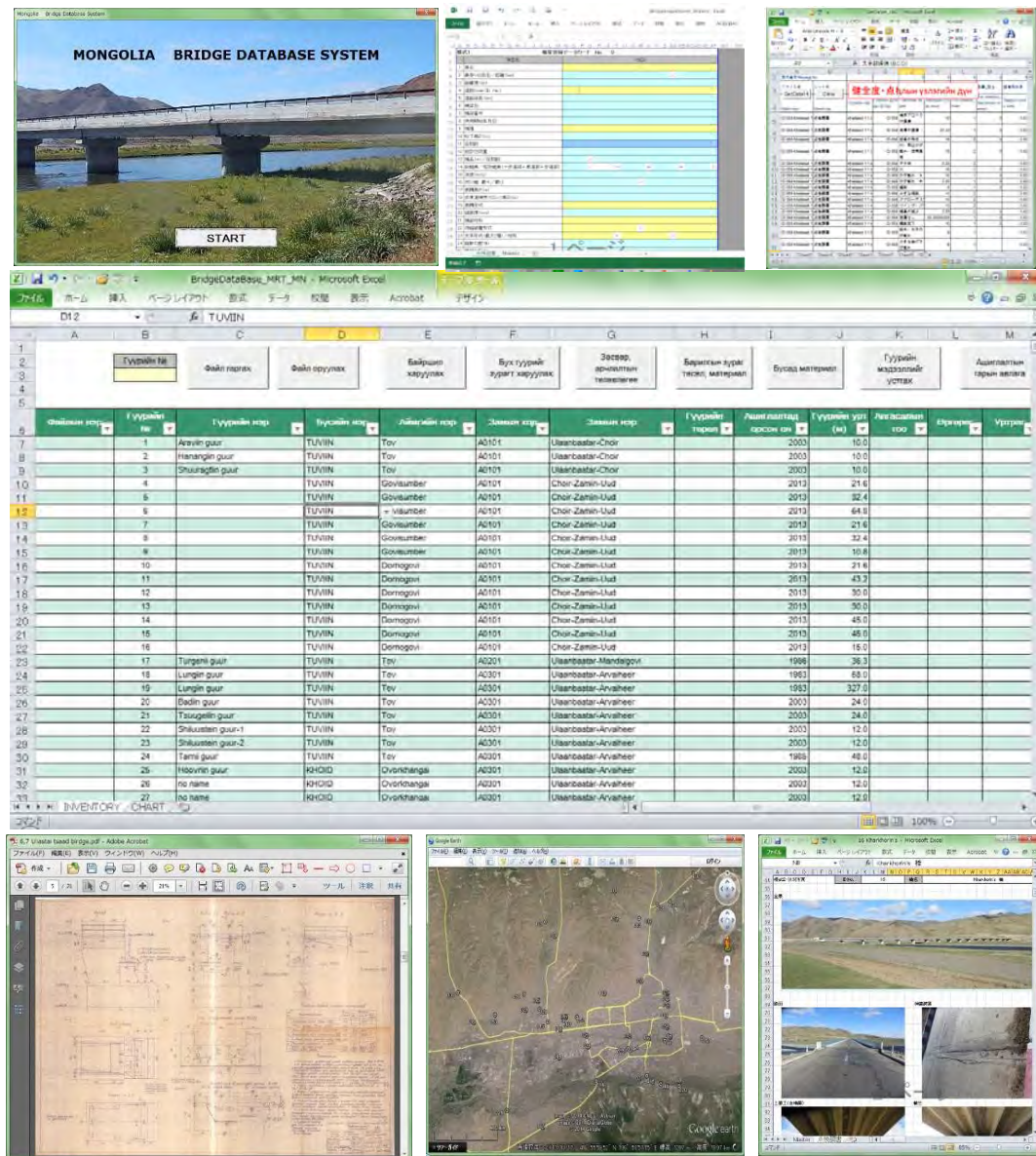
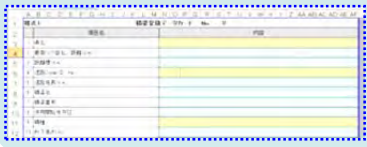


Figure 2.2.7 Screen Image of the Bridge Database System

### Introduction of Bridge Database System


### Inspection Sheet Management

Bridge Inspection Sheet (Excel format) can be downloaded to other PC.  
Modified Inspection Sheet edited in other PC can be saved to the Bridge Database System.



### Location Mapping

Based on coordination data, location of the bridge is plotted on Google Map.  
Bridge inventory data is displayed with the location.



### Maintenance Planning

Bridge Maintenance Plan is developed on the Bridge Database System. Security password will block the modification of the data by outsiders.



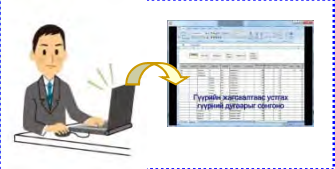
### Document Management

Design documents such as design drawings, specification and construction record which is essential material for bridge maintenance can be stored with Bridge ID. The data is protected by security password.

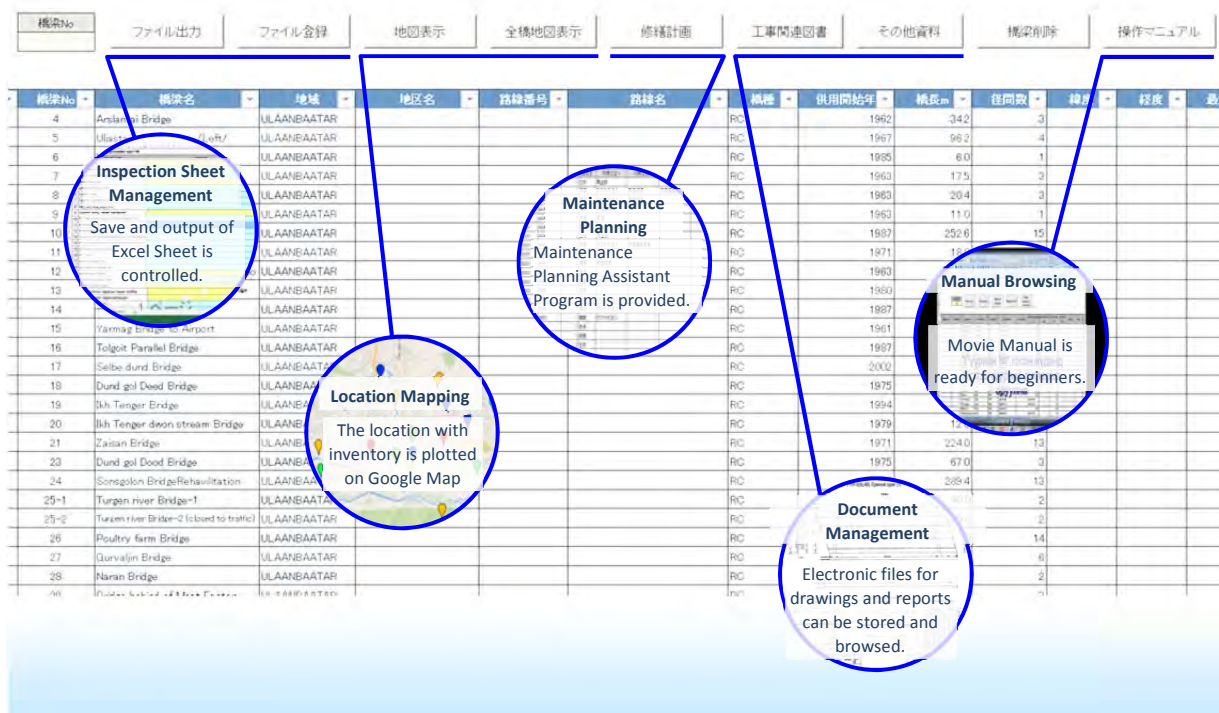


### Manual Browsing

Video manuals for each operation are ready to be browse by beginners for easy understanding.



## What will be possible by the Bridge Database?



The screenshot shows the main interface of the Bridge Database System with several callouts highlighting key features:

- Inspection Sheet Management:** Save and output of Excel Sheet is controlled.
- Location Mapping:** The location with inventory is plotted on Google Map.
- Maintenance Planning:** Maintenance Planning Assistant Program is provided.
- Manual Browsing:** Movie Manual is ready for beginners.
- Document Management:** Electronic files for drawings and reports can be stored and browsed.

Figure 2.2.8 Outline of the Bridge Database System

The Bridge Database System was developed in June 2014 and completed in May 2015 after registration of inspection data. Following modification of the system was made to improve its operational performance.

a) Simplification of data input

Initially, manual data input for registration of the inspection data has been proposed for the database system, but this could create inconvenience in the operation. During Phase-3 of the Project, improvement of the database system was therefore made to lessen the workload of the operator by adding the function of automatic data reading from the inspection data prepared in Excel. As the result of improvement, the time for data input was significantly reduced.

b) Improvement of Map Display

Improvements were made to the location map used for the determination of soundness of bridges. The legend that indicates bridge locations was modified by classifying the level of soundness of bridges from “A” to “D” based on the inspection results. In addition, another improvement to display the inventory data of respective bridges on the map was made for more intuitive browsing of registered data.

c) Automatic Graphic Function

Although training on the operation of MS Excel for data processing and graphic chart development was conducted in Phase-1 and Phase-2, a lot of time was spent for the training and operation of the database system and this may hamper practical operation of the system in the future. To improve the situation, the JICA Expert Team added a new function to automatically create a graphic chart showing the construction year, length of bridge, type of bridge, and soundness evaluation.

### **2.2.7 Manual for Database Operation**

Following considerations were made by the JICA Expert Team to create a practical manual that is easy to understand.

- Operation Manual and Administration Manual were developed to easily distinguish between the contents for administration such as system configuration and the contents for operation such as input and output of the concerned data. In addition, these manuals formatted in PDF enabled easy reference in the database system.
- MTs created the video manual of database operation with assistance from the JICA Expert Team to visually understand the actual operation. The video manual was stored in the database system for reference and modification by the MTs as needed.

## 2.3 Development of National Policy for Bridge Maintenance and Management (Output-3)

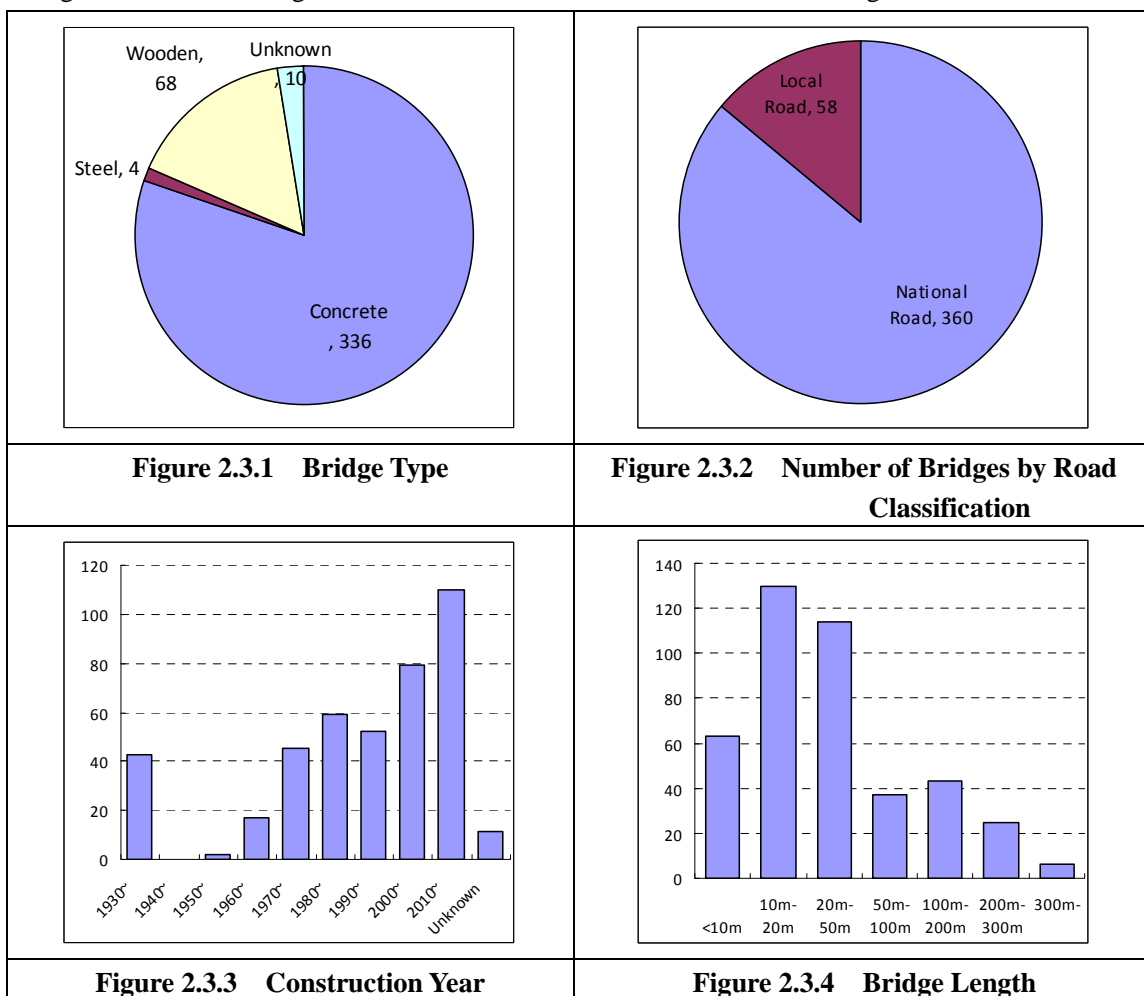
### 2.3.1 Information Collection of Existing Bridge Management System

#### (1) Summary of the Existing Bridges in Mongolia

There are 433 bridges constructed on the international, national and local roads maintained by MRT. In addition, 70 bridges are maintained by UBC. The number of bridges maintained by the municipalities except UBC has not been confirmed.

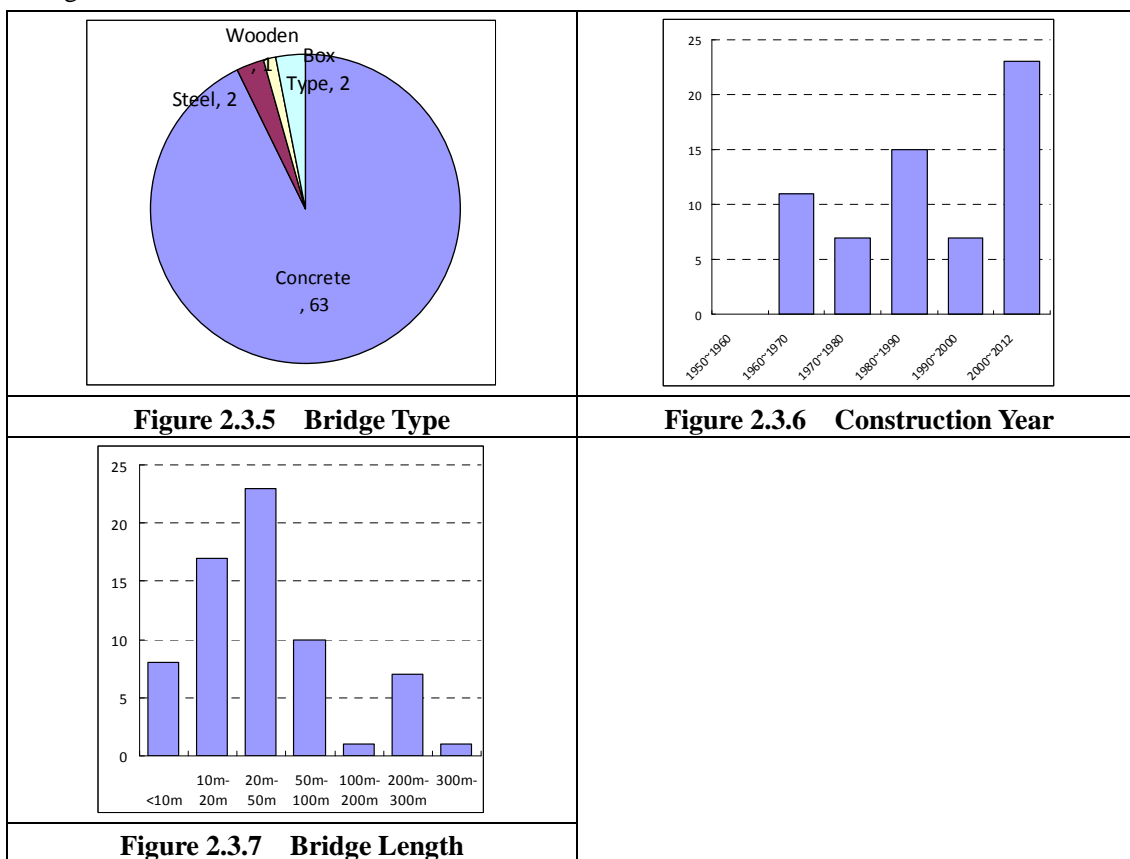
#### (2) Characteristics of MRT Bridges

Eighty percent (80%) of the MRT bridges are concrete bridges, and four (4) are steel bridges. Fifty-five (55) bridges, which account for 13% of the MRT bridges have been constructed since more than 50 years ago. On the other hand, since the construction of new bridges has increased due to the increasing replacement of timber bridges in the provinces, 189 bridges have been constructed after 2000 (including the bridges currently being constructed), which account for 45% of MRT bridges. Small scale bridges shorter than 50m account for 73% of MRT bridges.



### (3) Characteristics of UBC Bridges

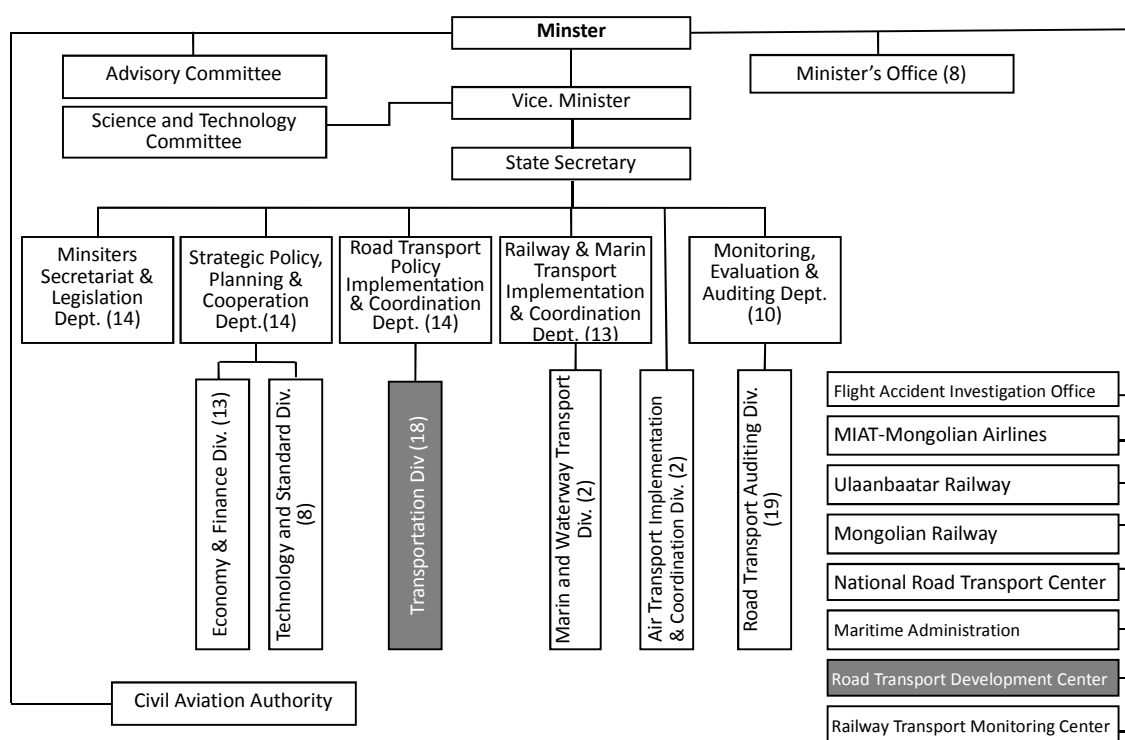
Ninety-three percent (93%) of the UBC bridges in Ulaanbaatar City are concrete bridges, but two (2) steel bridges including “Narny Bridge” were constructed in 2012 and one (1) timber bridge was also constructed. Although the oldest bridge was constructed in the 1960’s, 43% of bridges have been constructed after 2000 due to the increasing replacement of old bridges and the expansion of road network in response to the rapid urbanization of Ulaanbaatar City. Small scale bridges account for a major part of the UBC bridges since 71% of the bridges are shorter than 50m in length.



### (4) Organization for Bridge Maintenance

#### a) Organization of MRT for Bridge Maintenance

The Road Transport Policy Implementation and Coordination Department is responsible for road and bridge maintenance and management in MRT. The Roads Transport Development Center is in charge of periodic inspection of road facilities, database management and supervision of maintenance works as an agency of the MRT. Maintenance of national roads is implemented by 23 private and/or government-owned road maintenance companies based on yearly contracts with the MRT. As for bridge maintenance, private construction companies who have experience and technology on bridge engineering are procured through competitive bidding by the MRT. Daily maintenance of bridges such as cleaning are carried out by the “Bridge Keepers” living near the bridges who are employed by the road maintenance companies.



Note: ( ) shows the number of staff

**Figure 2.3.8 Organizational Chart of MRT**

**Table 2.3.1 List of Road Maintenance Companies**

No.	Name of Company	Type	Covered Road Length (Km)	Responsible Bridge Length (L>100m)	Number of Staff	Number of Engineers	Bridge Keeper
1	Arkhangai AZZA	Gov.	388.4	1108	36	2	8
2	Bulgan AZZA	Gov.	611.8	1210.6	46	1	6
3	Govi-Altai AZZA	Gov.	739.3	222	29	—	1
4	Darkhan AZZA	Gov.	117.0	347	53	2	2
5	Dornogovi AZZA	Gov.	448.	—	32	2	
6	Zavkhan AZZA	Gov.	1,243.5	597.7	47	1	5
7	Orkhon AZZA	Gov.	145.5	92	47	2	1
8	Uvurkhnagai AZZA	Gov.	835.7	166.7	51	3	1
9	Kharkhorin AZZA	Gov.	263.0	290	48	—	1
10	Talin zam AZZA	Gov.	534.2	—	23	1	
11	Selenge AZZA	Gov.	251.3	1405.1	40	2	7
12	Baganuur AZZA	Gov.	142.0	272	38	1	1
13	Tuv AZZA	Gov.	946.5	336	57	2	1
14	Ulaanbaatar AZZA	Gov.	393.0	296.9	49	2	2
15	Erdenbesant AZZA	Gov.	214.0	327	21	2	1
16	Uvs AZZA	Gov.	683.6	612	39	1	5
17	Khovd AZZA	Gov.	1,243.5	442.7	47	1	5
18	Huvsgul AZZA	Gov.	494.9	786.5	31	1	5
19	Khargui AZZA	Gov.	585.0	830.8	35	1	4
20	Dornod Zam AZZA	Priv.	1,299.8	1228	28	—	6
21	Jol AZZA	Priv.	651.3	772.3	44	2	6
22	Ikh Bogd Zam AZZA	Priv.	508.7	522.2	25	—	4
23	Huvsgul Zam AZZA	Priv.	232.6	126	50	4	1

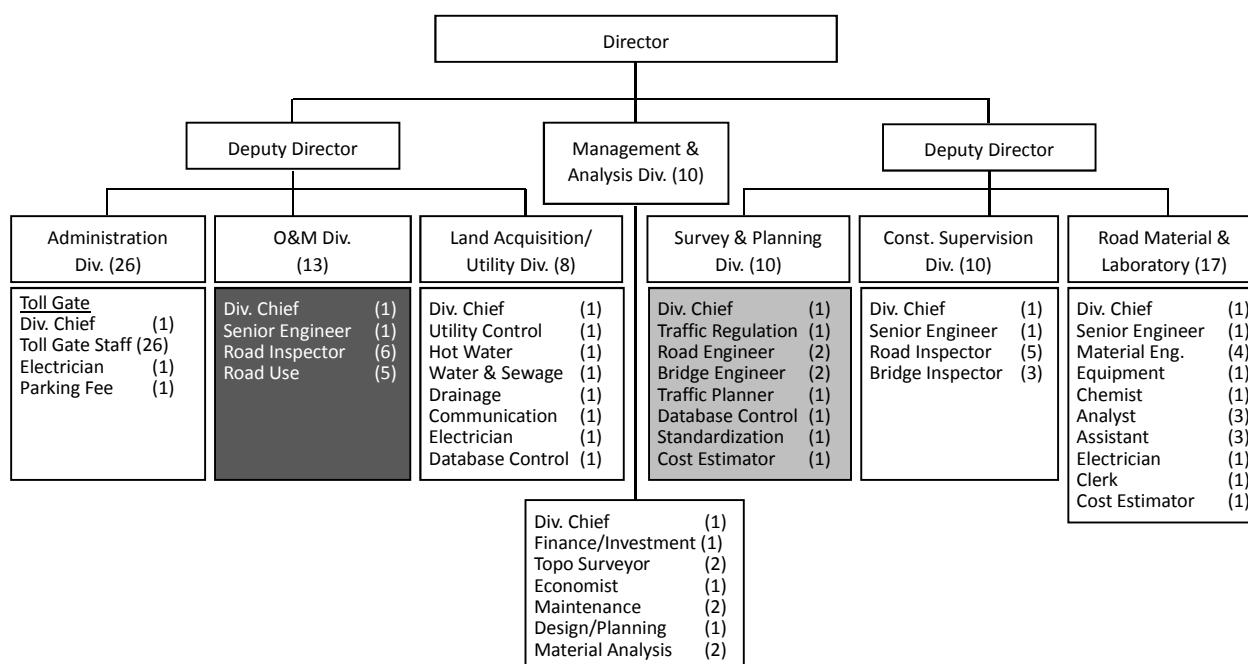
Gov.: Government-Owned Company  
Priv.: Private Company



**Table 2.3.2 Roles of MRT on Bridge Management Cycle**

	Executing Agency	Division	Design Drawings	Daily Inspection and Maintenance	Periodic Inspection and Soundness Evaluation	Database Management	Maintenance Plan/ Design	Maintenance Program / Budgetary Plan	Maintenance Work	Supervision of the Maintenance Work
MRT	Road Transport Policy Implementation & Coordination Dept.	Transportation Div.	✓				✓	✓		✓
	Roads Transport Development Center	Construction and Maintenance Div.			✓	✓				
Others	Private Consultant						✓			
	Construction Company	(Bridge Construction Association)							✓	
	Road Maintenance Company	(Gov. and Priv.)		✓	✓				✓	

b) Organization of UBC for Bridge Maintenance



Note: ( ) shows the number of staff

**Figure 2.3.9 Organizational Chart of Road Department of UBC**

The Operation and Maintenance Division under the Road Department is in charge of a major part of road and bridge maintenance management in UBC. Database for road asset management is being established by using the software provided by the ADB project. Maintenance planning for large scale bridges is outsourced to private consultants by the Planning and Design Division.

**Table 2.3.3 Roles on Bridge Management Cycle under the UBC**

	Executing Agency	Division	Design Drawings	Daily Inspection and Maintenance	Periodic Inspection and Soundness Evaluation	Database Management	Maintenance Plan/Design	Maintenance Program / Budgetary Plan	Maintenance Work	Supervision of the Maintenance Work
UBC	Road Department	Planning and Design Div.	✓			✓	✓			
		Operation and Maintenance Div.			✓			✓		✓
		Road Material Laboratory								✓
	Urban Development and Waste Control Department	(Cleaning only)		(✓)						
Others	Private Consultant						✓			
	Construction Company	(Bridge Construction Association)							✓	

**(5) Maintenance Budget of MRT and UBC**

The National Road Fund and the Local Road Fund are considered as the financial sources for road maintenance by MRT and UBC respectively. Since the National Road Fund is not sufficient for nationwide road maintenance, subvention from the Government is expended. On the other hand, the Local Road Fund for UBC has increased to almost the same level as the National Road Fund in recent years; however, expenditures for road maintenance from the Local Road Fund are small since a large part is diverted to construction investment for new infrastructures. (As an example, only 20% of UBC Local Road Fund was spent for road maintenance in 2011.)

The amounts of 2,418 Million MNT for four (4) MRT bridges and 3,695 Million MNT for eight (8) for UBC bridges were spent for bridge maintenance in 2013 and hence interest on bridge maintenance has gradually increased. (Note: 3,200 Million MNT was allocated by the Development Bank of Mongolia.)

**Table 2.3.4 Income and Expenditure for Road Maintenance by MRT (National Road Fund)**

(Unit: Million MNT)

	2008	2009	2010	2011	2012
Income	9,743	9,949	9,968	11,243	13,360
Expenditure	9,740	9,949	9,722	10,726	14,610

**Table 2.3.5 Income and Expenditure for Road Maintenance by UBC (Local Road Fund)**

	(Unit: Million MNT)				
	2008	2009	2010	2011	2012
Income	4,350	5,350	6,467	9,460	13,245
Expenditure	4,352	5,863	6,020	9,460.	13,945

**(6) Actual Achievement on Bridge Maintenance**

a) Achievement of MRT

Four (4) and seven (7) bridges were rehabilitated in MRT in 2013 and 2014 respectively. About 2.0 Million MNT was spent for the Bridge Keepers. The bridge maintenance budget accounted for only 2 to 3% of road the maintenance budget in 2013 and 2014.

**Table 2.3.6 Maintenance Budget and Bridge Maintenance in MRT**

	2013	2014
Road Maintenance Budget	19,000 Million MNT	22,641 Million MNT
Bridge Maintenance Budget	229 Million MNT	564 Million MNT
Budget for Bridge Keepers	171 Million MNT	248 Million MNT
Number of Repaired Bridges	4 bridges	7 bridges

b) Achievement of UBC

Approximately 500 Million MNT has been allocated to the bridge maintenance budget from the Local Road Fund in UBC every year. In addition, funds from the national budget have been allocated for the replacement and/or large scale rehabilitation works of major bridges. Eight (8) and four (4) bridges were rehabilitated in 2013 and 2014 respectively.

**Table 2.3.7 Maintenance Budget and Bridge Maintenance in UBC**

	2013	2014
Budget in Road Department	367,407 Million MNT	146,044 Million MNT
General Account of UBC	116,117 Million MNT	89,291 Million MNT
Local Road Fund	13,945 Million MNT	24,207 Million MNT
Development Bank of Mongolia	221,279 Million MNT	27,200 Million MNT
National Budget	16,066 Million MNT	5,346 Million MNT
Bridge Maintenance Budget	3,695 Million MNT	500 Million MNT
Number of Repaired Bridges	8 bridges	4 bridges

**2.3.2 Proposal of Basic Policy on Bridge Maintenance and Management**

**(1) Definition of Bridge Maintenance Level**

Bridge Maintenance Level was defined as shown in the following table. The maintenance level was defined in accordance with road priority depending on importance, aiming to allocate the limited budget to bridge maintenance.

**Table 2.3.8 Definition of Maintenance Level**

Maintenance Level	Maintenance Status	Maintenance Cost for Short Term	Life Cycle Cost (LCC)
I	Preventive measures shall be taken to prevent the progress of deterioration.	High	Low
II	Corrective measures shall be taken immediately after confirmation of progress of deterioration.	Middle	Middle
III	Monitoring of deterioration shall be continued with minimum countermeasures to secure the users of bridge.	Low	High

**(2) Definition of Priority Road in Mongolia**

a) Priority Road in MRT and its Maintenance Level

The highest priority roads in MRT are represented by three (3) lines of Again Highway (AH3/AH4/AH32). The bridges constructed along these Again Highways are categorized as “Maintenance Level-I” and bridges along other national and local roads are “Maintenance Level-II” and “Maintenance Level-III” respectively.


**Table 2.3.9 Road Classification and Bridge Number in MRT**

Maintenance Level	MRT	
I	AH-3 / AH-4 / AH-32	156
II	National Road	248
III	Local Road	29
<b>Total</b>		<b>433</b>

b) Priority Road in UBC and its Maintenance Level

Priority roads defined in the Ulaanbaatar Urban Development Master Plan are under “Maintenance Level-I” and other roads are in “Maintenance Level-II”. Due to the large volume of traffic at each road network, “Maintenance Level-III” is not adopted in Ulaanbaatar City. Since new road network is going to be developed in Ulaanbaatar City in the future, priority roads need to be additionally defined in accordance with the same policy mentioned above.

**Table 2.3.10 Road Classification and Bridge Number in UBC**

Maintenance Level	UBC	
		
I	Major Arterial Roads	41
II	Other Than Those Above	29
III	Not Applicable	0
Total		70

### 2.3.3 Selection of Bridge Rehabilitation and Retrofitting Measures

#### (1) Policy on the Selection of Bridge Rehabilitation and Retrofitting Measures

The measures to be utilized in the Mid-Long Term Bridge Maintenance Management Program have been selected from “the Manual for Selection of Bridge Rehabilitation and Retrofitting Measures” taking into account the current technical capacity and procurement condition of materials in Mongolia, as well as the expected improvement of technical capacity as shown in the following table.

**Table 2.3.11 Rehabilitation and Retrofitting Measures for Concrete Bridge**

Maintenance Level	Bridge Type	Rehabilitation of Service Level					Rehabilitation from Damage and Deterioration				Retrofitting of Loading Capacity			
		Periodic Replacement of Bearing Pad	Pavement / Waterproofing	Replacement of Expansion Joint	Railing Repair		Crack Injection	Main Girder (Section Repair)	Deck Slab (Section Repair or Partial Replacement)	Substructure (Section Repair)	Main Girder (CFRP)	Additional Diaphragm	Deck Slab (CFRP or Replacement)	Replacement of Bearing Pad
I	T-shaped RC bridge (L>17m)	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
	Other Concrete Bridge (RC Girder, RC Slab, PC Girder)	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙	⊙		⊙	⊙
II	T-shaped RC bridge(L>17m)	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙				
	Other Concrete Bridge (RC Girder, RC Slab, PC Girder)	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙				
III	T-shaped RC bridge(L>17m)	⊙	⊙	⊙	⊙									
	Other Concrete Bridge (RC Girder, RC Slab, PC Girder)	⊙	⊙	⊙	⊙									

**Table 2.3.12 Rehabilitation and Retrofitting Measures for Steel Bridge**

Maintenance Level	Bridge Type	Rehabilitation of Service Level					Rehabilitation from Damage and Deterioration				Retrofitting of Loading Capacity			
		Periodic Replacement of Bearing Pad	Pavement / Waterproofing	Replacement of Expansion Joint	Railing Repair	Painting	Stop-Hole Method	Steel Plate (Cover Plate or Replacement)	Deck Slab(Section Repair or Partial Replacement)	Substructure(Section Repair)	Main Girder (Reinforced by Steel or CFRP)	Additional Diaphragm	Deck Slab (CFRP or Replacement)	Replacement of Bearings
I	Steel Bridge	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
II	Steel Bridge	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙				
III	Steel Bridge	⊙	⊙	⊙	⊙	⊙								

### 2.3.4 Prioritization of Bridge Maintenance Work

The priority of maintenance works are determined based on the matrix consisting of soundness and maintenance level for each bridge as shown below. The Middle Term Implementation Plan in the Mid-Long Term Bridge Maintenance Management Program was developed with budgetary allocation based on this priority.

**Table 2.3.13 Prioritization of Maintenance Work**

		High ← Soundness → Low			
		A	B	C	D
Maintenance Level	I	(4)	(3)	(2)	(1)
	II	(5)	(4)	(3)	(2)
	III	(5)	(5)	(4)	(3)
Maintenance Priority	Concept of Maintenance				
(1)(2)	Maintenance Work shall be executed under the Middle Term Implementation Plan.				
(3)(4)	Maintenance Work shall be executed under the Mid-Long Term Bridge Maintenance Management Program				
(5)	Detailed plan will be developed after next inspection				

### 2.3.5 Estimate of Work Volume for Bridge Maintenance Work

Approximate work volumes have been estimated based on bridge inspection data and selection of rehabilitation and retrofitting measures. Productivity and manpower required for cost estimate was defined with reference to the Standard for Cost Estimate issued by MRT in 2008 and data of market research conducted in June 2014.

### 2.3.6 Cost Estimate and Implementation Schedule for Bridge Maintenance Works

Based on data collection for procurement condition in Mongolia, required information on cost estimate for bridge maintenance work was obtained. Maintenance cost for all bridges inspected under the Project was estimated, and yearly based maintenance plan for five (5) years was developed in line with the maintenance priority introduced in 2.3.4.

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**Table 2.3.14 Bridge Maintenance Plan for MRT (for 68 Bridges)**

(Unit: Million MNT)

No.	ID	Maintenance Level	Soundness	Priority	Total Cost (A)=(B)+(C)	Maintenance Cost (B)	Replacement Cost (C)	2015	2016	2017	2018	2019	2020
1	6	I	D	(1)	4,186.2		4,186.2	4,186.2					
2	17	I	D	(1)	1,491.8		1,491.8	1,491.8					
3	20	I	D	(1)	1,883.7		1,883.7	1,883.7					
4	2	II	D	(2)	4,666.4		4,666.4		4,666.4				
5	5	II	D	(2)	3,378.3		3,378.3		3,378.3				
6	32	II	D	(2)	2,296.5		2,296.5			2,296.5			
7	40	II	D	(2)	1,398.7		1,398.7	1,398.7					
8	44	II	D	(2)	3,704.6		3,704.6			3,704.6			
9	45	II	D	(2)	3,166.6		3,166.6			3,166.6			
10	49	II	D	(2)	4,231.8		4,231.8				4,231.8		
11	11	I	C	(2)	4,839.1		4,839.1				4,839.1		
12	16	I	C	(2)	8,384.4		8,384.4					8,384.4	
20	65	III	D	(3)	4,353.8		4,353.8						4,353.8
21	66	III	D	(3)	7,003.9		7,003.9						7,003.9
13	14	I	C	(2)	2,022.2	2,022.2		674.1	674.1	674.1			
14	23	I	C	(2)	1,371.9	1,371.9			686.0	686.0			
15	43	I	C	(2)	1,251.0	1,251.0				625.5	625.5		
16	9	I	C	(2)	334.5	334.5			334.5				
17	19	I	C	(2)	339.2	339.2			339.2				
18	41	I	C	(2)	493.2	493.2				493.2			
19	42	I	C	(2)	312.7	312.7				312.7			
22	3	II	C	(3)	185.6	185.6					185.6		
23	26	II	C	(3)	21.6	21.6					21.6		
24	28	II	C	(3)	62.0	62.0					62.0		
25	31	II	C	(3)	24.5	24.5					24.5		
26	33	II	C	(3)	12.2	12.2					12.2		
27	48	II	C	(3)	9.8	9.8					9.8		
28	55	II	C	(3)	50.4	50.4					50.4		
29	1	I	B	(3)	2,125.1	2,125.1					708.4	708.4	708.4
30	22	I	B	(3)	1,487.1	1,487.1					495.7	495.7	495.7
31	50	I	B	(3)	1,281.4	1,281.4					640.7	640.7	
32	51	I	B	(3)	1,652.3	1,652.3						826.2	826.2
33	8	I	B	(3)	96.7	96.7						96.7	
34	10	I	B	(3)	19.3	19.3						19.3	
35	18	I	B	(3)	33.6	33.6						33.6	
36	21	I	B	(3)	505.4	505.4							505.4
37	46	II	B	(3)	21.2	21.2							21.2
38	37	I	B	(3)	1,272.8	1,272.8						636.4	636.4
39	58	III	C	(4)	5.1	5.1							5.1
40	61	III	C	(4)	15.9	15.9							15.9
41	62	III	C	(4)	14.1	14.1							14.1
42	64	III	C	(4)	42.6	42.6							42.6
43	4	II	B	(4)	21.7	21.7							21.7
44	13	II	B	(4)	30.4	30.4							30.4
45	25	II	B	(4)	1.6	1.6							1.6
46	27	II	B	(4)	118.8	118.8							118.8
47	30	II	B	(4)	13.8	13.8							13.8
48	34	II	B	(4)	36.4	36.4							36.4
49	36	II	B	(4)	26.6	26.6							26.6
50	53	II	B	(4)	6.1	6.1							6.1
51	24	II	B	(4)	47.5	47.5							47.5
52	7	I	A	(4)	6.4	6.4							
53	12	I	A	(4)	8.0	8.0							
54	52	I	A	(4)	0.0	0.0							
55	57	III	B	(5)	124.6	124.6							
56	59	III	B	(5)	5.9	5.9							
57	60	III	B	(5)	0.1	0.1							
58	63	III	B	(5)	0.0	0.0							
59	67	III	B	(5)	0.0	0.0							
60	47	II	A	(5)	0.1	0.1							
61	15	II	A	(5)	0.5	0.5							
62	29	II	A	(5)	1.0	1.0							
63	35	II	A	(5)	1.5	1.5							
64	38	II	A	(5)	2.2	2.2							
65	39	II	A	(5)	0.0	0.0							
66	54	II	A	(5)	9.1	9.1							
67	56	II	A	(5)	0.0	0.0							
68	68	III	A	(5)	0.0	0.0							
<b>(1)-1 Replacement Cos</b>					<b>58,379.9</b>	<b>3,394.1</b>	<b>54,985.8</b>	<b>9,634.5</b>	<b>9,404.7</b>	<b>10,527.7</b>	<b>9,070.9</b>	<b>8,384.4</b>	<b>11,357.7</b>
<b>(1)-2 Maintenance Cost</b>					<b>12,131.6</b>	<b>12,131.6</b>	<b>0.0</b>	<b>674.1</b>	<b>2,033.7</b>	<b>2,791.4</b>	<b>2,836.4</b>	<b>3,456.9</b>	<b>3,573.8</b>



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Table 2.3.15 Bridge Maintenance Plan for UBC

								(Unit: Million MNT)					
No.	ID	Maintenance Level	Soundness	Priority	Total Cost (A)=(B)+(C)	Maintenance Cost (B)	Replacement Cost (C)	2015	2016	2017	2018	2019	2020
1	28	I	D	(1)	1,540.1		1,540.1	1,540.1					
2	30	I	D	(1)	454.3		454.3	454.3					
3	33	I	D	(1)	1,303.3		1,303.3		1,303.3				
4	34	I	D	(1)	1,401.8		1,401.8		1,401.8				
5	43	I	D	(1)	848.8		848.8			848.8			
6	25(1)	II	D	(2)	1,516.3		1,516.3			1,516.3			
7	26	II	D	(2)	8,096.5		8,096.5				8,096.5		
8	27	I	C	(2)	2,605.7		2,605.7					2,605.7	
9	29	I	C	(2)	2,219.2		2,219.2					2,219.2	
10	40	II	C	(3)	879.2		879.2						879.2
11	41	II	C	(3)	622.0		622.0						622.0
12	52	II	C	(3)	491.8		491.8						491.8
13	9	I	C	(2)	8.1	8.1			8.1				
14	11	I	C	(2)	120.4	120.4			120.4				
15	16	I	C	(2)	879.1	879.1			293.0	293.0	293.0		
16	18	I	C	(2)	492.5	492.5		492.5					
17	20	I	C	(2)	58.8	58.8			58.8				
18	21	I	C	(2)	2,003.1	2,003.1				500.8	500.8	500.8	500.8
19	38	II	C	(3)	34.4	34.4			34.4				
20	39	II	C	(3)	20.6	20.6			20.6				
21	23	I	B	(2)	0.0	0.0							
22	4	I	B	(3)	7.5	7.5					7.5		
23	5	I	B	(3)	32.6	32.6					32.6		
24	6	I	B	(3)	4.0	4.0					4.0		
25	7	I	B	(3)	3.0	3.0					3.0		
26	8	I	B	(3)	6.5	6.5					6.5		
27	10	I	B	(3)	129.9	129.9						129.9	
28	12	I	B	(3)	0.0	0.0							
29	13	I	B	(3)	24.3	24.3						24.3	
30	23(2)	I	B	(3)	0.0	0.0							
31	24	I	B	(3)	137.1	137.1						137.1	
32	31	I	B	(3)	3.5	3.5						3.5	
33	32	I	B	(3)	299.6	299.6							299.6
34	46	I	B	(3)	0.0	0.0							
35	98	I	B	(3)	89.5	89.5							89.5
36	45	II	B	(4)	0.0	0.0							
37	47	II	B	(4)	0.0	0.0							
38	50	II	B	(4)	11.1	11.1							11.1
39	57	II	B	(4)	2.0	2.0							2.0
40	63	II	B	(4)	0.1	0.1							0.1
41	77	II	B	(4)	0.0	0.0							
42	78	II	B	(4)	20.4	20.4							20.4
43	95	II	B	(4)	7.9	7.9							7.9
44	97	II	B	(4)	0.0	0.0							0.0
45	100	II	B	(4)	8.1	8.1							8.1
46	14	I	A	(4)	26.6	26.6							
47	15	I	A	(4)	3.5	3.5							
48	17	I	A	(4)	2.5	2.5							
49	19	I	A	(4)	23.8	23.8							
50	22	I	A	(4)	0.0	0.0							
51	44	I	A	(4)	0.0	0.0							
52	48	I	A	(4)	1.0	1.0							
53	49	I	A	(4)	1.0	1.0							
54	56	I	A	(4)	23.4	23.4							
55	201	I	A	(4)	0.0	0.0							
56	25(2)	II	A	(5)	0.0	0.0							
57	53	II	A	(5)	3.4	3.4							
58	54	II	A	(5)	9.4	9.4							
59	55	II	A	(5)	0.0	0.0							
60	58	II	A	(5)	0.0	0.0							
61	60	II	A	(5)	0.5	0.5							
62	89	II	A	(5)	0.0	0.0							
63	90	II	A	(5)	0.0	0.0							
64	93	II	A	(5)	7.5	7.5							
65	96	II	A	(5)	0.0	0.0							
66	99	II	A	(5)	1.0	1.0							
67	103	II	A	(5)	0.0	0.0							
68	35	I	B	(3)	0.0	0.0							
69	36	I	B	(3)	0.0	0.0							
70	37	I	A	(2)	0.0	0.0							
<b>①-1 Replacement Cos</b>					21,979.0	0.0	21,979.0	1,994.4	2,705.1	2,365.1	8,096.5	4,824.9	1,993.0
<b>①-2 Maintenance Cost</b>					4,507.7	4,507.7	0.0	492.5	535.3	793.8	847.4	795.6	939.5

**Table 2.3.16 Proposed Budgetary Allocation for Bridge Maintenance of MRT (2015~2020)**

(Unit: Million MNT)

Cost Items	2015	2016	2017	2018	2019	2020	Total
(1) Replacement Cost	26,359	28,219	34,033	31,444	31,043	44,743	142,826
a) Construction Cost	22,448	21,913	24,530	21,135	19,536	26,463	136,025
b) Design and Survey Cost	1,122	1,096	1,226	1,057	977	1,323	6,801
(2) Maintenance Cost	1,649	4,976	6,829	6,939	8,457	8,743	37,594
a) Construction Cost	1,571	4,739	6,504	6,609	8,054	8,327	35,804
b) Design and Survey Cost	78	237	325	330	403	416	1,790
(3) Daily Maintenance Cost	1,760	1,760	1,760	1,760	1,760	1,760	10,558
(4) Detailed Inspection Cost	101	101	85	93	74	93	547
(5) Total Cost of Bridge Maintenance	29,869	35,056	42,707	40,236	41,334	55,339	191,525
(6) Price Escalation	3,204	6,758	11,065	12,917	15,814	23,423	73,181
<b>Total for the Year [(5) + (6)]</b>	<b>33,073</b>	<b>41,814</b>	<b>53,772</b>	<b>53,153</b>	<b>57,148</b>	<b>78,762</b>	<b>264,706</b>

Note: Maintenance cost for MRT 433 bridges

**Table 2.3.17 Proposed Budgetary Allocation for Bridge Maintenance of UBC (2015~2020)**

(Unit: Million MNT)

Cost Items	2015	2016	2017	2018	2019	2020	Total
(1) Replacement	2,094	2,840	2,483	8,501	5,066	2,093	23,078
a) Construction Cost	1,994	2,705	2,365	8,097	4,825	1,993	21,979
b) Design and Survey Cost	100	135	118	405	241	100	1,099
(2) Maintenance Work	517	562	833	890	835	986	4,624
a) Construction Cost	493	535	794	847	796	939	4,404
b) Design and Survey Cost	25	27	40	42	40	47	220
(3) Daily Maintenance	259	259	259	259	259	259	1,555
(4) Detailed Inspection Cost	8	8	11	8	11	8	53
(5) Total Cost of Bridge Maintenance	2,878	3,669	3,587	9,658	6,172	3,346	29,310
(6) Price Escalation	340	831	1,153	4,026	3,169	2,042	11,561
<b>Total for the Year [(5) + (6)]</b>	<b>3,219</b>	<b>4,500</b>	<b>4,740</b>	<b>13,684</b>	<b>9,340</b>	<b>5,388</b>	<b>40,871</b>

### 2.3.7 Development of the Mid-Long Term Bridge Maintenance and Management Program

The Mid-Long Term Bridge Maintenance and Management Program (MLBMP) consists of the Long Term Target, the Middle Term Implementation Plan for Maintenance Work and the Priority Measures was developed under the Project with the necessary action plan up to 2030.

	MRT	UBC
Long Term Target (2030)	Systematic and efficient maintenance will be implemented for all bridges in Mongolia through institutional and technical enhancement.	
Middle Term Implementation Plan (2020)	- Replacement of <b>14</b> critical bridges - Completion of Maintenance Work for “Soundness-C” or worse	- Replacement of <b>12</b> critical bridges. -Maintenance for critical damages and deteriorations of <b>38</b> bridges
Priority Measures	Measure-1: Improvement of Design Measure-2: Improvement of Construction Quality Measure-3: Measures on Over Loaded Vehicle, Measure-4: Cultivation of Bridge Engineer	
Long Term Approach	Organization Enhancement / Standardization of the Manuals	

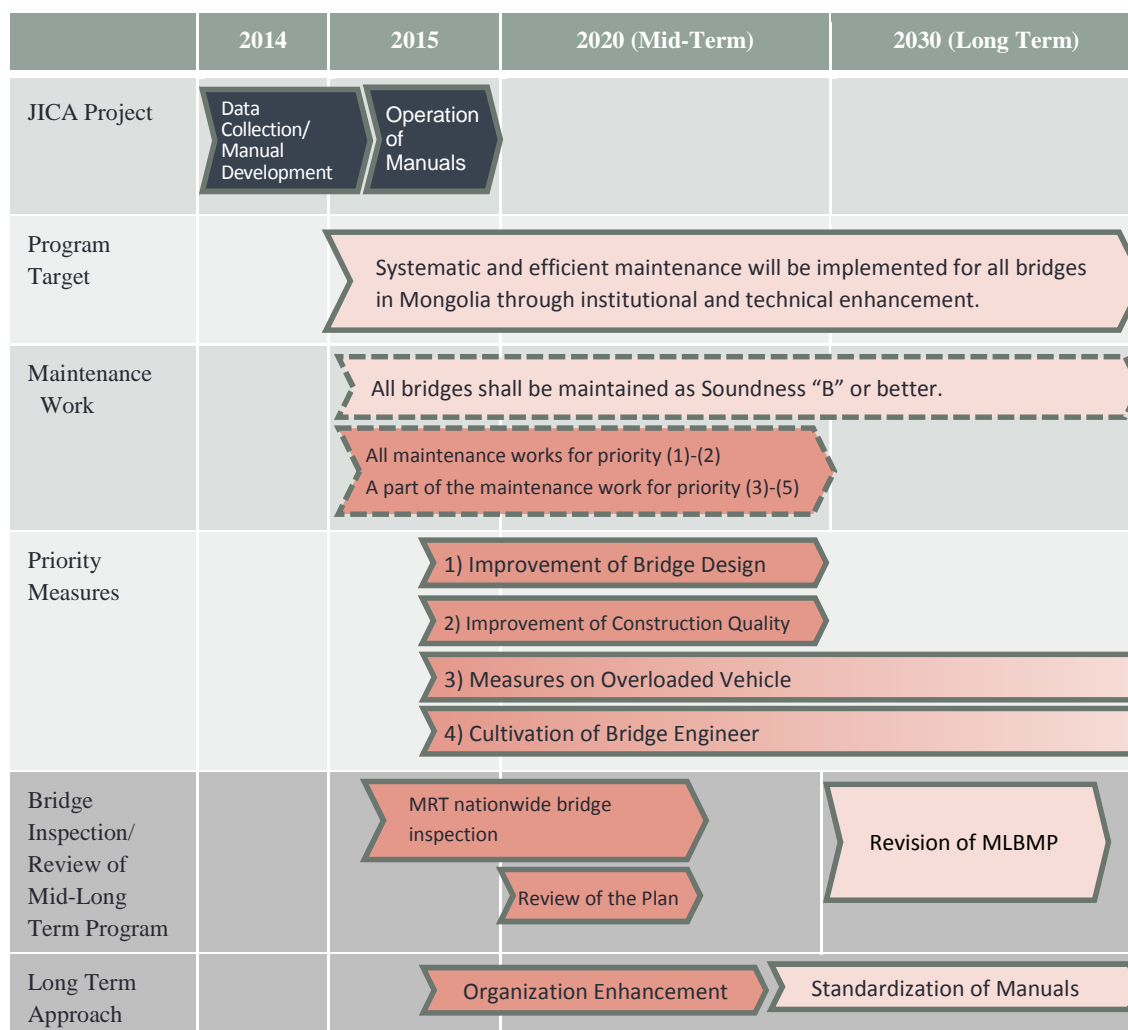


Figure 2.3.10 Framework of the Mid-Long Term Bridge Maintenance and Management Program

### 2.3.8 Bridge Management Level and Performance Requirements

Bridge Management Level has been proposed and defined as stated in “2.3.2, Proposal of Basic Policy on Bridge Maintenance and Management” together with the Performance Requirement. Since the concept of maintenance has been introduced in the MLBMP, establishment of a mechanism for the MLBMP to be widely known in MRT and UBC is required. Although the administrative system to authorize such a mid-long term plan has not been executed in Mongolia, it is also required to introduce the MLBMP into the road administration to implement bridge maintenance based on long term viewpoint.

### 2.3.9 Proposal for Bridge Management and Management System

Organizational and institutional framework in Mongolia need to be improved to implement the Bridge Management Cycle with the effective use of manuals and database system developed in the Project. Taking into account the existing roles of concerned offices in MRT and UBC for bridge maintenance, following institutional framework is proposed for bridge maintenance in the future. From the viewpoint of cultivation of engineers, the Road Association in Mongolia who has governed the qualification system for road and bridge engineers is preferable to be involved in the framework.

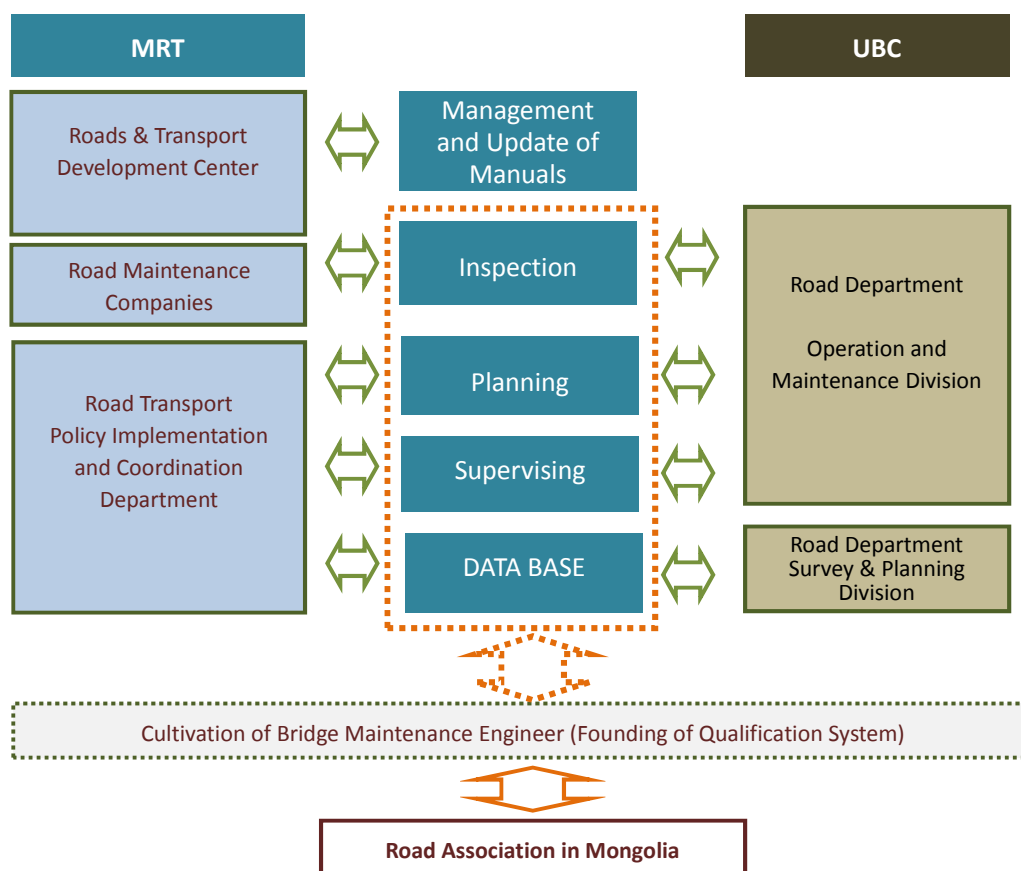


Figure 2.3.11 Proposed Institutional Framework of Bridge Maintenance in Mongolia

**(1) Organization for Bridge Maintenance in MRT**

The Road Transport Policy Coordination and Implementation Department has the main role for bridge maintenance as the central office of MRT. The Road and Transport Development Center is responsible mainly for the maintenance of manuals as an agency of MRT, and the road maintenance companies at each province shall undertake bridge inspection under the MRT.

**(2) Organization for Bridge Maintenance in UBC**

The Operation and Maintenance Division of the Road Department is responsible for bridge maintenance. Management of the manuals is the responsibility of MRT. Inspection, Planning and supervision of the maintenance work is under the responsibility of the Operation and Maintenance Division; however, the Bridge Database System including input of new bridge data and registration of design documents is managed by the staff of the Survey and Planning Division.

**(3) Cultivation of Bridge Maintenance Engineer**

MRT and UBC need to increase and continuously cultivate engineers to be engaged in bridge maintenance in the future. Urgent establishment of the qualification system for bridge maintenance under the Road Association in Mongolia which governs the existing qualification system for road and bridge engineers would be preferable to increase the number of concerned engineers. Continuous implementation of systematic training under the qualification system shall ensure sustainable cultivation of engineers for the Bridge Management Cycle even though the MTs are replaced.

**(4) Effective Utilization of Private Firm**

Due to active exchange of human resources of government employees and private company employees in Mongolia, it is expected that the capacity development of private companies would directly lead to the nationwide improvement in bridge maintenance. Therefore, it will be efficient to shift the in-house operation of the entire bridge maintenance to outsourcing of inspection, planning and supervision to private companies for comprehensive capacity development in bridge maintenance.

## **2.4 Training on Bridge Management (Output-4)**

### **2.4.1 Baseline Survey**

**(1) Capacity Assessment for Bridge Management**

The current bridge management capacity of MRT and UBC such as technical level, organizational framework and social recognition has been evaluated through the questionnaire survey carried out for twenty-two (22) staff members engaged in bridge management in MRT and UBC. The questionnaire consists of the questions on “technical capacity” including specific knowledge and skill required for individual and organization, “core capacity” including will, motivation and management skill, and “enabling environment” including conditions of organization and framework.

a) Technical Capacity (Individual Technical Skill)

More than half of the staff members are of the view that they understand the bridge management cycle. On the other hand, about 30% of the whole answered “Mostly” or “Very well” with regard to the situation of bridge management in Mongolia such as data management method of existing bridges and development procedure of mid-long term maintenance and management program. This shows that the current status of bridge management is not sufficiently understood. Furthermore, over 70% of the staff answered that understanding is not sufficient with regard to elemental skills of bridge inspection, rehabilitation and retrofitting, and drafting of mid-long term maintenance and management program. It was confirmed that capacity improvement of bridge engineering is necessary.

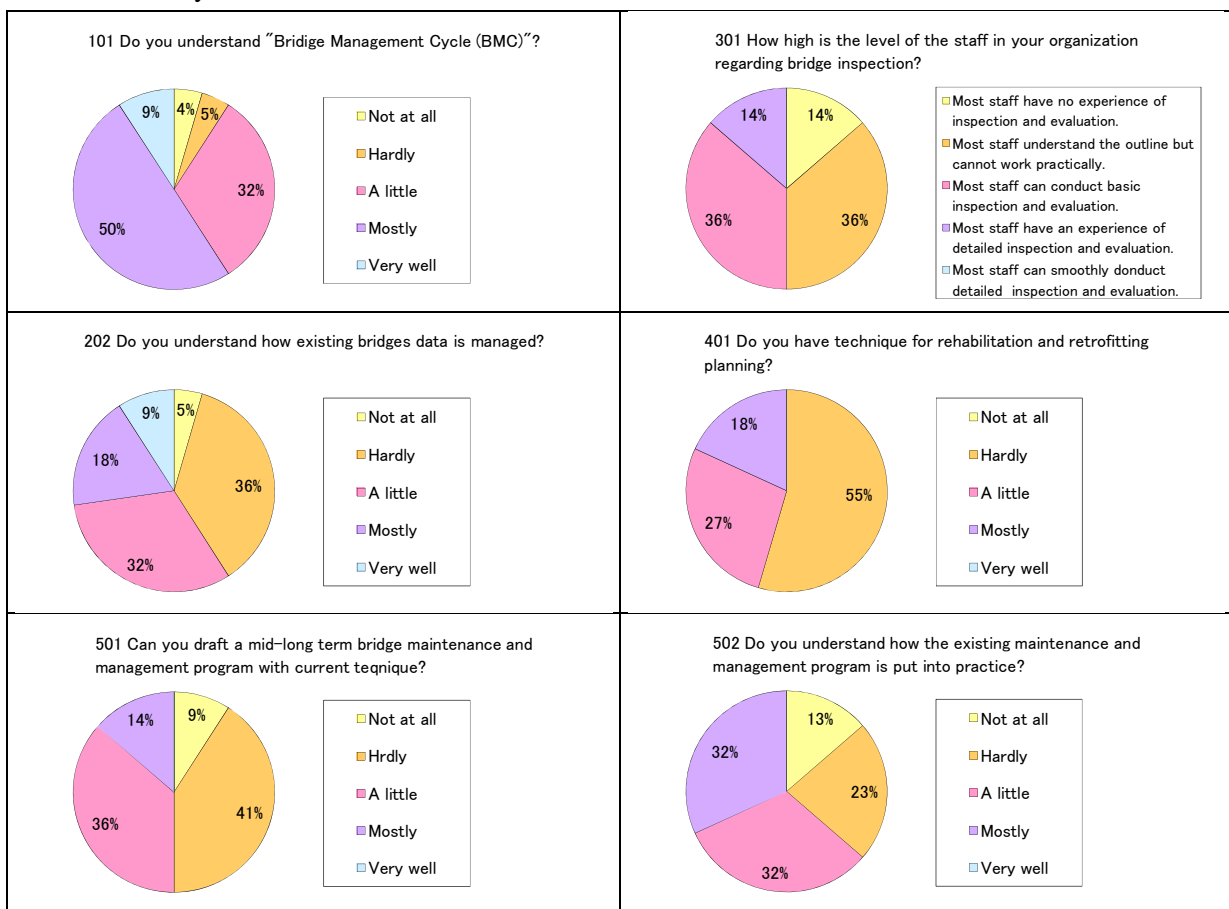


Figure 2.4.1 Results of Questionnaire on Technical Capacity

b) Core Capacity (Problem Awareness, Motivation)

With regard to personal contribution to bridge management, about 70% of the staff members are of the view that think they cannot contribute to the work and this shows that their motivation is low. The number of staff responding “Appropriate” or “Mostly” to the questions about bridge management, inspection, rehabilitation and retrofitting work in the past account for as low as 5% to 23%. Many staff members recognize that there were some problems in the past bridge management.

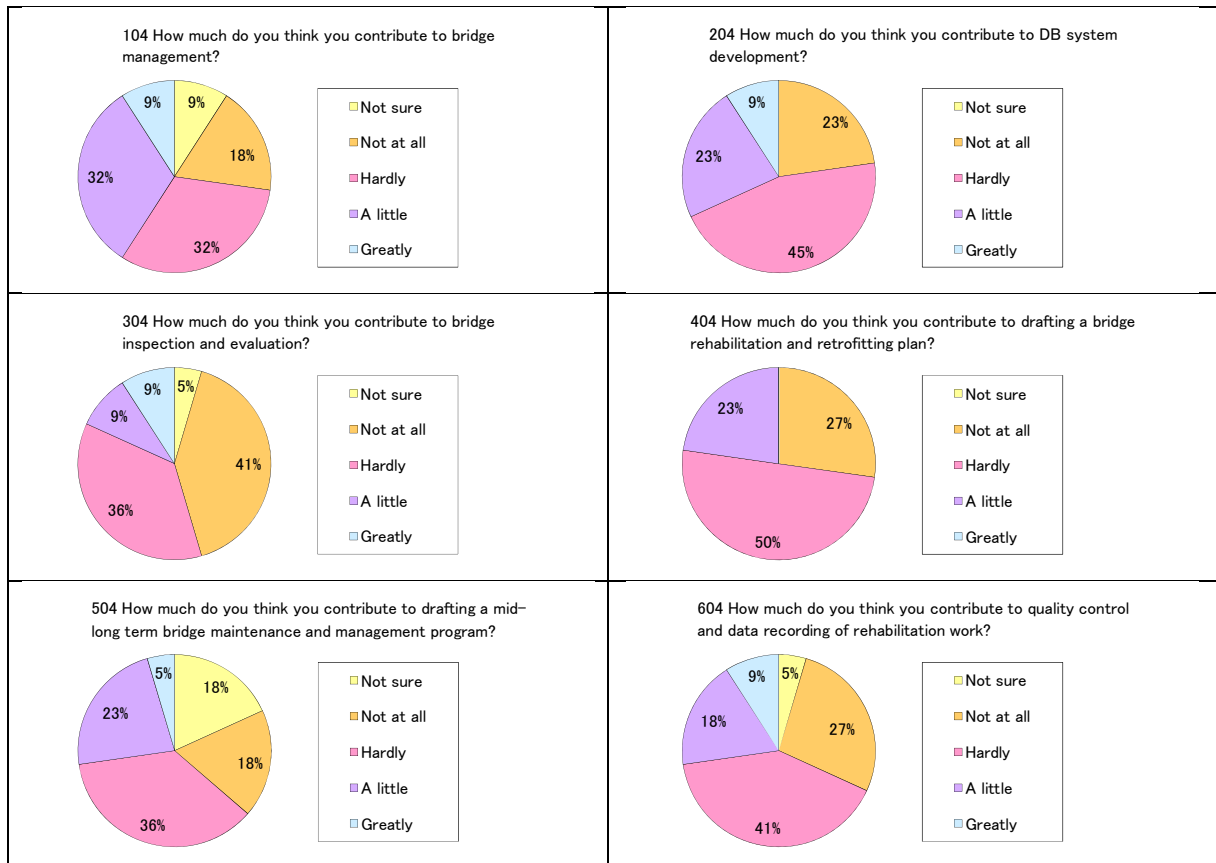


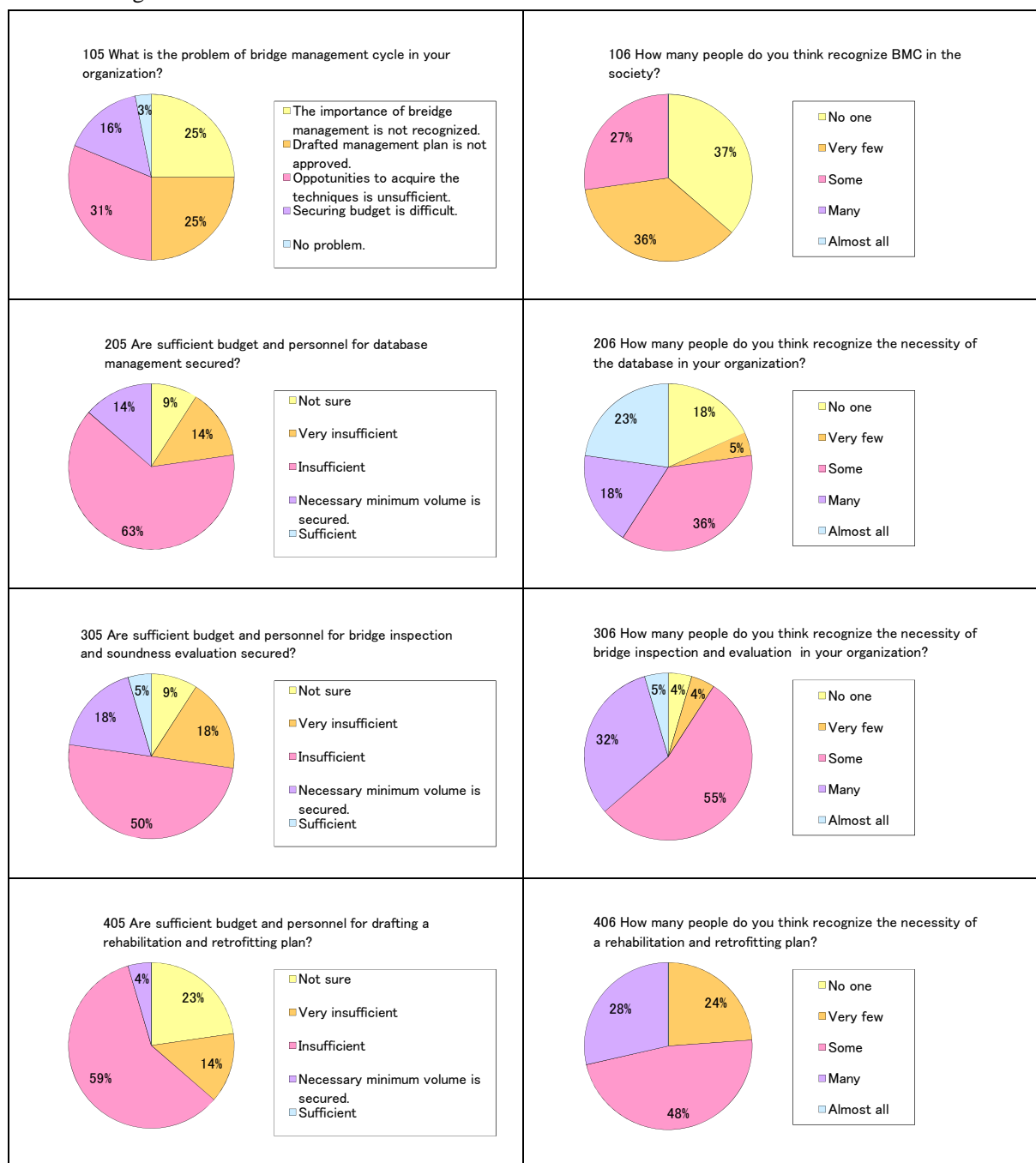
Figure 2.4.2 Motivation for Bridge Management Cycle



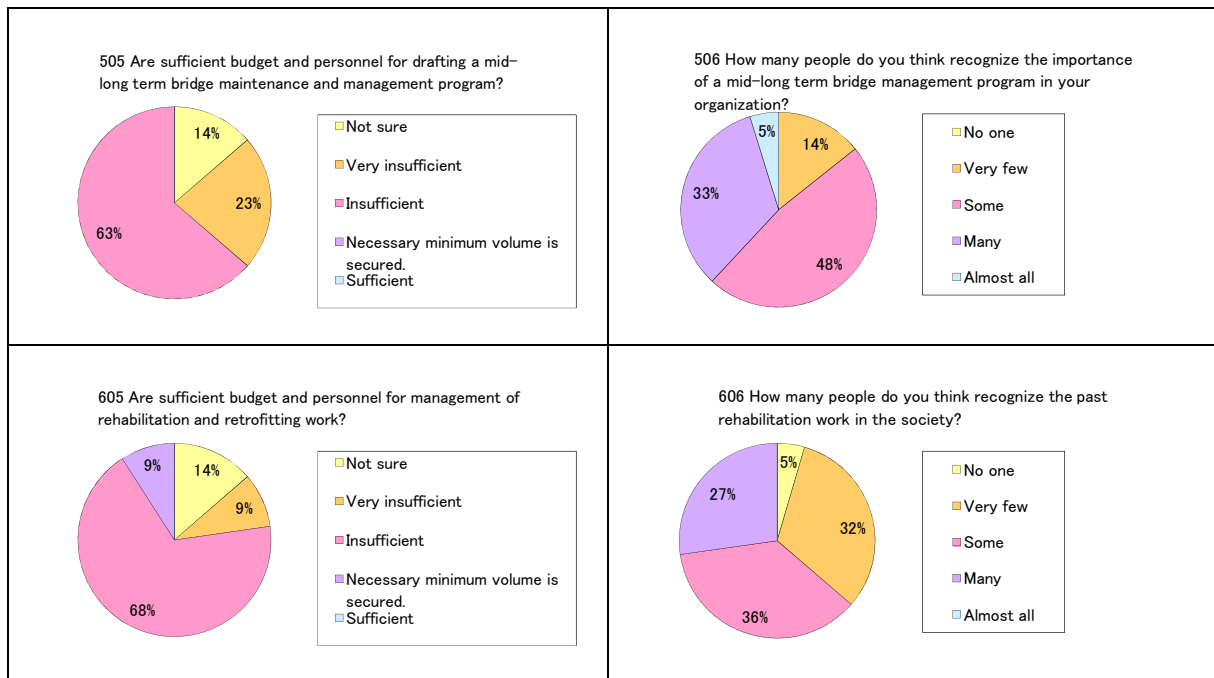
Figure 2.4.3 Problem Awareness of Bridge Management Cycle in the Past

c) Enabling Environment (Organizational Framework, Social Recognition)

Over 80% of the staff members are of the view that organizational framework and budget is insufficient with strong recognition that the social environment for bridge management was undeveloped. The number of staff responding “No one”, “Very few” or “Some” to the questions about the necessity of bridge inspection, rehabilitation plan and bridge management program accounts for about 70%. Organizational recognition of bridge management is low. Furthermore, over 70% responded “No one” or “Very few” to the question about how many people in the community recognize the bridge management cycle and it shows that social request for bridge management is still low.







**Figure 2.4.4 Issues on Organizational Framework and Level of Social Recognition**

d) Conclusion of Capacity Assessment

The result of the baseline survey mentioned above is evaluated in five (5) grades by elemental skills.

The evaluation results are as follows:

Technical Capacity (average 2.50/5.00): Planning ability of rehabilitation plan, etc., is relatively low.

Core Capacity (average 2.54/5.00): Problem awareness of the present situation is comparatively high.

Enabling Environment (average 2.30/5.00): Organizational base (framework and budget) is insufficient.

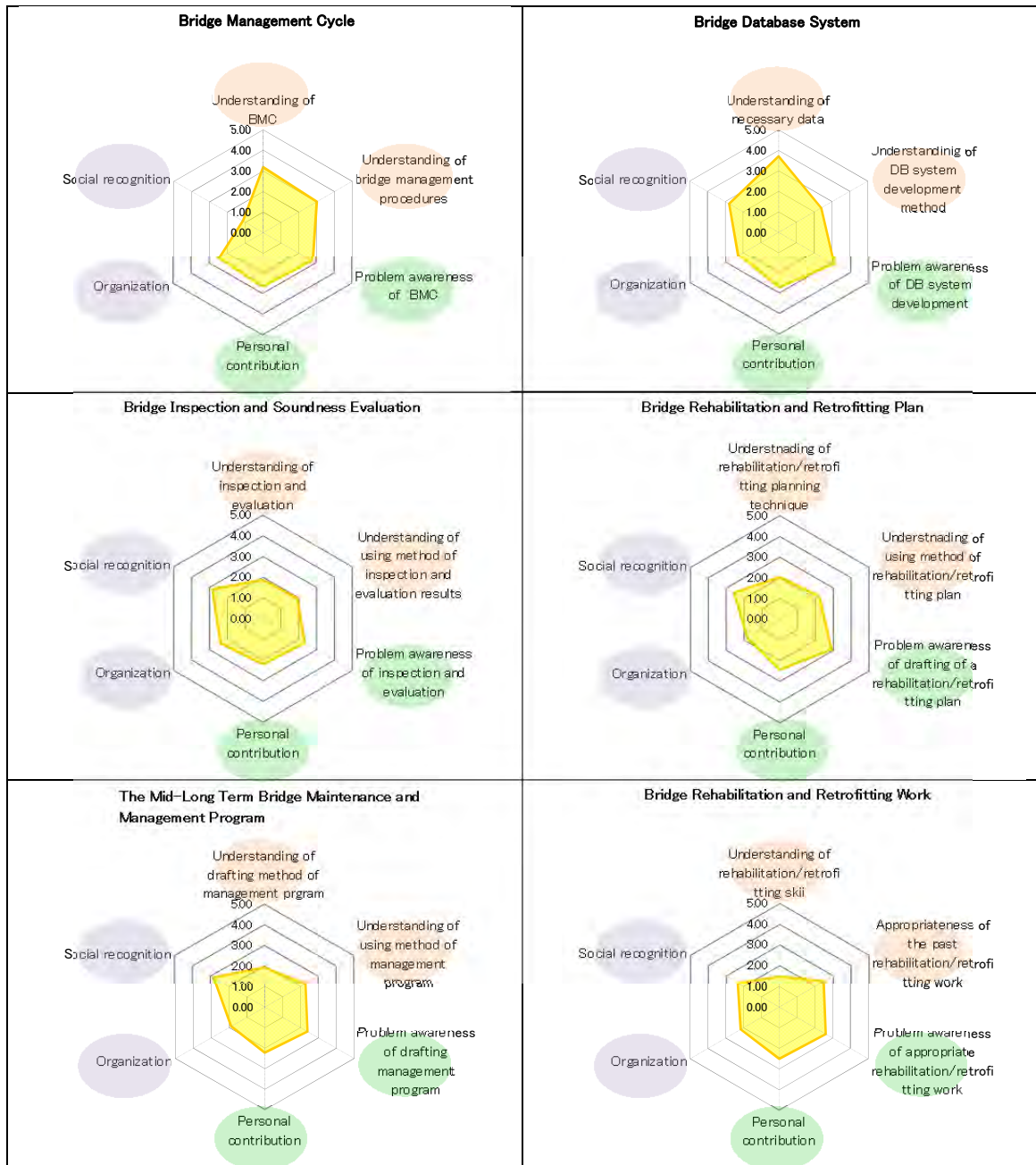


Figure 2.4.5 Results of Capacity Assessment

(2) Identified Issues and Project Policy

Issues on bridge management identified from the results of the baseline survey and the hearing survey as well as the project policy are as follows.

**Table 2.4.1 Issues on Bridge Management and Project Policy**

Issues on Bridge Management	Project Policy
<ul style="list-style-type: none"> <li>- Comprehensive understanding of Bridge Management Cycle has not been spread to the staff.</li> <li>- Social request for bridge management is low.</li> </ul>	<ul style="list-style-type: none"> <li>- Promote the understanding of Bridge Management Cycle by seminars and workshops</li> <li>- Open Seminars to the public and improve social recognition of importance of bridge management in the latter part of the Project</li> </ul>
<ul style="list-style-type: none"> <li>- Management method of drawings and specifications is not developed.</li> <li>- The objective of database development is not clear.</li> <li>- The type of data to be recorded is not clear.</li> <li>- Storage place of each data is not determined or not understood by the staff.</li> <li>- Commercial software is complicated.</li> <li>- Database management is insufficient and a sustainable system is not established.</li> </ul>	<ul style="list-style-type: none"> <li>- Propose development of drawings and specifications in the database system.</li> <li>- Develop a database system corresponding to the level requested by Mongolia in cooperation with MTs in the Project.</li> <li>- Propose a system with a simple operation which can be improved and changed by the staff themselves</li> </ul>
<ul style="list-style-type: none"> <li>- The contents of bridge inspection are not clear. ⇒ They do not have any manual for inspection and soundness evaluation.</li> <li>- The form for bridge inspection is not determined.</li> <li>- Standards of structural mechanics for evaluation are not developed.</li> </ul>	<ul style="list-style-type: none"> <li>- Develop an inspection form in cooperation with MTs</li> <li>- Support MTs providing materials so that they can develop an inspection and evaluation manual</li> </ul>
<ul style="list-style-type: none"> <li>- Rehabilitation and retrofitting method and design method are not established and effective method is not applied.</li> </ul>	<ul style="list-style-type: none"> <li>- Propose the necessary method for rehabilitation and retrofitting</li> <li>- Develop a manual for selection of rehabilitation and retrofitting method ⇒ MTs prepare a manual by themselves easy to use in Mongolia</li> </ul>
<ul style="list-style-type: none"> <li>- Personnel are insufficient.</li> </ul>	<ul style="list-style-type: none"> <li>- Propose clarification of role sharing and establishment of an effective maintenance management system</li> </ul>
<ul style="list-style-type: none"> <li>- The mid-long term bridge maintenance and management program is not developed sufficiently.</li> </ul>	<ul style="list-style-type: none"> <li>- Develop a mid-long term bridge maintenance and management program under the ownership of Mongolia side ⇒ Consider prioritization of rehabilitation jointly</li> </ul>
<ul style="list-style-type: none"> <li>- Role sharing of individual and organization for bridge maintenance and management, the responsibility of each staff and their contribution to the bridge maintenance cycle are not clear.</li> </ul>	<ul style="list-style-type: none"> <li>- Establish ownership of MTs by clarifying the work and the sharing for bridge management cycle</li> </ul>

The following issues need to be considered separately from now on because they are not solved in the Project.

Issues to be considered separately from the Project	Possible solutions
<ul style="list-style-type: none"> <li>- Shortage of bridge engineers</li> </ul>	<ul style="list-style-type: none"> <li>- Technical training of bridge management at universities</li> <li>- Bridge design skills acquisition of staff in related organizations</li> <li>- Construction engineers development at construction companies</li> </ul>
<ul style="list-style-type: none"> <li>- Frequent occurrence of initial defects in bridge construction phase</li> </ul>	<ul style="list-style-type: none"> <li>- Spreading quality control technique</li> </ul>
<ul style="list-style-type: none"> <li>- Shortage of senior engineers</li> </ul>	<ul style="list-style-type: none"> <li>- Improvement of work environment</li> </ul>

## 2.4.2 Development of Training Program

The capacity development under the Project was carried out for sustainable implementation of the Bridge Management Cycle after completion of the Project through not only development of technical and engineering capacity but improvement of collaboration among the organizations, including the building of ownership as well as increase of public awareness of bridge maintenance. Following Training Program was introduced for the Project to achieve the capacity development above.

**Table 2.4.2 Basic Approach to the Training**

Basic Items	Approach and Methodology	Objective
Bridge Management Cycle	(1) Seminar on Bridge Maintenance Management (2) Engineers Seminar by MTs (MRT / UBC / Road Maintenance Company / Bridge Association) (3) Public Seminar in collaboration with the JICA Expert Team, MRT and UBC	(1) C/P and MTs understand the significance of the Bridge management Cycle and its work procedure. (2) Discussion of issues and outlook on bridge maintenance among engineers including MTs is held to share the policy and methodology. (3) Actual condition and status of bridge in Mongolia is disclosed to the public to enhance the awareness on maintenance.
Bridge Inspection and Evaluation	(1) Workshop (WS) by JICA Expert Team (2) In-house Training for staff in MRT and UBC by MTs	(1) MTs understand the core technology for bridge maintenance and the role of MTs in the operation. (2) MTs share the technology such as inspection, evaluation and planning with related office in MRT and UBC.
Maintenance Planning	(3) Review of Manuals by MTs (4) Engineers Seminar by MTs (MRT/UBC/Road Maintenance Company / Bridge Association)	(3) Ownership of MTs is built-up through the review of manuals. (4) Bridge maintenance technologies transferred under the Project are shared with stakeholders on the Bridge Management Cycle.
Development of Implementation Plan for Maintenance Work	(1) WS by the JICA Expert Team for MTs (2) Finalization of the MLBMP by MTs. (3) Budgeting and executing based on the Plan	(1) MTs learn how to develop the systematic maintenance program. (2) Finalization and authorization of the MLBMP by MTs leads to much deeper understanding and ownership. (3) Actual budgetary allocation is supplemented to start the practical maintenance work from 2015.
Database Development	(1) WS for MTs by JICA Expert Team (2) Self-Training by MT (3) In-house Seminar for other staff in MRT and UBC (4) Disclosure of DB information by MTs	(1) Basic training for system configuration for the Database is conducted. (2) Self-training for data input and system configuration is carried out to find the issues on the system (3) Definition of the demarcation of role for data sharing and data updating is discussed. (4) Enabling environment is improved by enhancement of public awareness.

### 2.4.3 Preparation of Training Manual and Material

The Training Manual was prepared through the activities in Phase-2 for the training in Phase-3 by the MTs. In addition, the Training Manual was developed under the prospect that the MTs of MRT and UBC will continue the in-house training to establish the capacity development system that will cultivate new generation MTs.

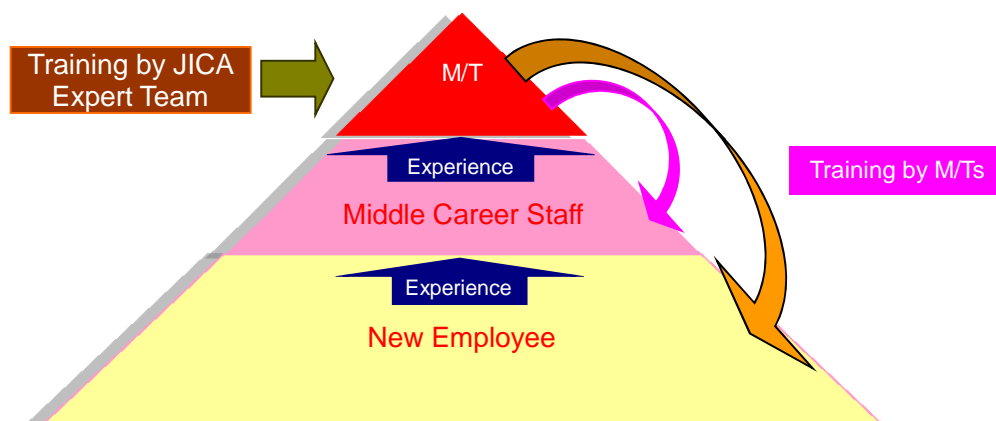


Figure 2.4.6 Image of In-house Training System for Bridge Maintenance

Training program and the target to be achieved by the training proposed under the Training Manual are shown in the following table.

Table 2.4.3 Target of the Training

Training Program	Target to be Achieved
1. Basics of Bridge Engineering	<ul style="list-style-type: none"> <li>To understand the name of each element of bridge.</li> <li>To understand the factors and mechanism of deterioration and damage.</li> </ul>
2. Bridge Inspection	<ul style="list-style-type: none"> <li>To understand the essentials of bridge inspection.</li> <li>To understand how to record the inspection output.</li> </ul>
3. Soundness Evaluation	<ul style="list-style-type: none"> <li>To understand the methodology of the evaluation based on inspection data.</li> <li>To understand how to utilize the evaluation result.</li> </ul>
4. Rehabilitation and Retrofitting Measures	<ul style="list-style-type: none"> <li>To understand the process for selection of rehabilitation and retrofitting measures.</li> <li>To understand the characteristics of each rehabilitation and retrofitting measure.</li> </ul>
5. The Mid-Long Term Bridge Maintenance Management Program	<ul style="list-style-type: none"> <li>To understand the necessity of the MLBMP.</li> <li>To learn work process for development of the MLBMP</li> </ul>
6. Operation of the Bridge Database	<ul style="list-style-type: none"> <li>To learn how to operate the Bridge Database System.</li> <li>To understand how to utilize the output of the Bridge Database System.</li> </ul>

#### (1) Materials for the Training

Following manuals developed under the Project are to be utilized as materials for the training. The training manual was prepared in Phase-1 and completed in Phase-3 through review and correction during Phase-2. The training manual was developed to be used for the in-house training, which would be conducted by MRT and UBC after completion of the Project.

- 1) Manual for Bridge Inspection
- 2) Manual for Bridge Soundness Evaluation
- 3) Manual for Selection of Bridge Rehabilitation and Retrofitting Measures
- 4) Manual for Database Operation / Administration

**(2) Training on Bridge Inspection**

Basic terminology, structure of bridge and deterioration mechanism shall be learned prior to the training on Inspection.

The Objective of Inspection, Preparation of Inspection, Organization for Inspection, Frequency of Inspection, Methodology of Inspection, Example of Deterioration and Damages, and contents of the Bridge Inspection Sheet which are required for the site inspection work are to be trained accordingly. Site Inspection Work shall be exercised at last based on the knowledge trained through the above training. The MTs shall be responsible as lecturer in the training. Manual for Bridge Inspection and other training materials prepared under the Project can be used as materials for the training.

**Table 2.4.4 Training Program of Bridge Inspection**

Item		Description	Training Hours
Objective of Inspection		Objectives and significance	0.125 hour
Preparation of Inspection		Planning of the Inspection / How to use equipment for the inspection	0.125 hour
Organization for Inspection		Institutional demarcation of the inspection	0.125 hour
Frequency of e Inspection		Interval and timing of the inspection	0.125 hour
Methodology of Inspection		Measurement	0.5 hour
		Points to be observed	
		Humming Test	
		Measurement of Concrete Strength	
Example of Deterioration and Damages		Road Surface / Superstructure / Substructure/ Others (revetment, etc.)	0.5 hour
Bridge Inspection Sheet		Contents of Inspection Sheet / Recording technique and procedure / Data arrangement	1.0 hour
Exercise	Site Inspection	Direct measurement / inspection and record of damages	4.0 hours
	Record to the Inspection Sheet	Entry of the Inspection Sheet	2.5 hours
Appraisal Test		20 questionnaires for the above component	1.0 hour
Total			10.0 hours

**(3) Training on Bridge Soundness Evaluation**

Training on the Bridge Soundness Evaluation based on the bridge inspection is started from learning of concept and procedure, followed by the exercise of the evaluation based on the example of inspection data. Actual bridge soundness evaluation is recommended to be conducted. The MT shall be responsible for lecturer of the training. The Manual for Bridge Soundness Evaluation and other training materials prepared under the Project can be used as materials for the training.

**Table 2.4.5 Training Program for Bridge Soundness Evaluation**

Item	Description	Training Hours
Objective of Evaluation	Significance and necessity of the Evaluation	0.5 hours
Evaluation Result and Maintenance Policy	Basic policy for maintenance work according to the result of evaluation	0.5 hours
Procedure of Evaluation	Theory and methodology of the Evaluation	1.0 hour
Exercise of the Evaluation	Practical training based on actual example 1) Concrete Bridge 2) Steel Bridge	2.0 hours
Appraisal Test	20 questionnaire for the above component	1.0 hour
Total		5.0 hours

**(4) Training on the Selection of Bridge Rehabilitation and Retrofitting Measures**

Training shall focus on full understanding of the “Manual for Selection of Bridge Rehabilitation and Retrofitting Measures”. Basic material shall be the above manual, and the following materials prepared under the Project are to be utilized as supplemental materials for the training for easy understanding:

- Current condition of the existing bridge in Mongolia
- Loading capacity and durability of the Bridge
- Examples of rehabilitation measures in Mongolia
- Prospective bridge maintenance in Mongolia

**Table 2.4.6 Training Program for the Selection of Bridge Rehabilitation and Retrofitting Measures**

Item	Description	Training Hour
Type and Characteristics of rehabilitation and retrofitting measures	Type, effect, material and construction of the Rehabilitation and Retrofitting Measures	1.0 hour
Theory on the selection of rehabilitation and retrofitting measures	Flow of selection / Standard of judgment / Recommended measures compatible with Mongolia.	1.0 hour
Practice of Selection	Practice of actual operation based on actual bridge inspection and evaluation data.	2.0 hours
Data processing for output of selection	Practice on data processing and reporting for output of the selection.	1.0 hour
Appraisal Test	20 questionnaires for the above components	1.0 hour
Total		6.0 hours

**(5) Training on the Mid-Long Term Bridge Maintenance and Management Program**

The training aims at learning the development procedure of the Mid-Long Term Bridge Maintenance and Management Program (MLBMP) based on the output of soundness evaluation and the selection of rehabilitation and retrofitting measures. The material for the training is to be the MLBMP developed under the Project. Following program is proposed in the training manual.

**Table 2.4.7 Training Program for the MLBMP**

Item	Description	Training Hour
Outline of the MLBMP	Role of the MLBMP Vision of the Long-term target Framework of the Mid-term Implementation Plan	1.0 hour
Cost estimate for the maintenance work	Procedure on cost estimate / Unit cost analysis	1.0 hour
Priority order of the maintenance work	Road classification and maintenance priority Relationship between the bridge soundness and the maintenance priority	1.0 hour
Short term planning	Budgetary allocation based on the mid-term implementation plan	1.0 hour
Appraisal test	20 questionnaire for the above component	1.0 hour
Total		5.0 hours

**(6) Training on the Bridge Database System**

Following knowledge shall be learned through the training on the Bridge Database System:

- 1) Basic operation of Excel
- 2) Configuration of the Bridge Database System
- 3) Operation of the Bridge Database System
- 4) VBA programming
- 5) Data processing

Basic terminology and structure of bridge need to be learned prior to the training on the Bridge Database System and shall consist of system configuration, operation and data processing. Training items 1), 4) and 5) in the following table aim at modification and correction of the system by using MS Excel, so that grade of the training shall be considered to change depending on the operation skill of trainees on MS Excel. Training material shall be the Operation Manual and Administration Manual with supplemental materials developed under the Project.

**Table 2.4.8 Training Program for the Bridge Database System (DB)**

Item	Description	Training Hours
Outline of the DB	System Configuration and application	1.0 hour
Data to be recorded	Basic data: Inventory Data, Photos, Design Documents Maintenance record: Inspection, Evaluation, Rehabilitation Work Record	0.5 hour
Data Input	Basic operation method	2.0 hours
Programing of the DB	Basic operation, Functions, and Graphic creation by MS Excel VBA Programing (Depending on the skill of trainee)	2.0 hours
Operation of the DB	Utilization of the output / Reporting / Updating of data	1.5 hours
Appraisal Test	20 questionnaires for the above component	1.0 hour
Total		8.0 hours



## 2.4.4 OJT and Seminars

### (1) Summary

Outline of OJT and WS conducted under the Project is summarized in the following table.

**Table 2.4.9 Summary of Trainings under the Project**

	Phase-1 Aug. 2013~Feb. 2014	Phase-2 Feb. 2014~Dec. 2015	Phase-3 March 2015~Sep. 2015
Dissemination of the Bridge Management Cycle	Bridge Maintenance Management Seminar (The Bridge Management Cycle/Issues on the Maintenance in Mongolia / Example of other country)		Supplemental WS In-house Training Engineer's Seminar Public Seminar
Inspection and Evaluation (I&E)	1 <sup>st</sup> WS for I&E: Issue on bridge inspection in Mongolia	2 <sup>nd</sup> WS for I&E: Manual for the Inspection 3 <sup>rd</sup> WS for I&E: Manual for the Evaluation 4 <sup>th</sup> WS for I&E: OJT on Inspection 5 <sup>th</sup> WS for I&E: Review of the inspection and evaluation Others: Operation of Equipment	Supplemental WS In-house Training Engineer's Seminar Appraisal Test Public Seminar
Maintenance Plan	1 <sup>st</sup> WS for Maintenance Plan (Characteristic and factor of bridge deterioration in Mongolia / Introduction of the type of rehabilitation and retrofitting measures.)	2 <sup>nd</sup> Maintenance Plan WS (Manual: Part-1) 3 <sup>rd</sup> Maintenance Plan WS (Manual: Part-II) 4 <sup>th</sup> Maintenance Plan WS (Structural Analysis, Part 1) 5 <sup>th</sup> Maintenance Plan WS (Structural Analysis, Part 2) 6 <sup>th</sup> Maintenance Plan WS (Structural Analysis Part3) 7 <sup>th</sup> Maintenance Plan WS (Manual Review)	Supplemental WS In-house Training Engineer's Seminar Appraisal Test Pilot Implementation Planning Site Seminar Public Seminar
Maintenance and Management Program (MMP)	—	1 <sup>st</sup> MMP WS; Theory of MMP 2 <sup>nd</sup> MMP WS; Data analysis of the Inspection Results 3 <sup>rd</sup> MMP WS; Priority Measures 4 <sup>th</sup> MMP WS; Maintenance Priority 5 <sup>th</sup> MMP WS; Budgetary Plan	Supplemental WS In-house Training Engineer's Seminar Public Seminar
Database Development	1 <sup>st</sup> WS on DB (Required performance for the DB) 2 <sup>nd</sup> WS on DB (Operation-1) 3 <sup>rd</sup> WS on DB (Operation-2)	4 <sup>th</sup> WS on DB: Excel Operation 5 <sup>th</sup> WS on DB: System Management 6 <sup>th</sup> WS on DB: Manual Development 7 <sup>th</sup> WS on DB: VBA Programming 8 <sup>th</sup> WS on DB: Data Analysis 9 <sup>th</sup> WS on DB: Practical Operation 10 <sup>th</sup> WS on DB: Appraisal Test	Supplemental WS In-house Training Engineer's Seminar Appraisal Test Public Seminar

Phase	Phase-1					Phase-2												Phase-3									
Year	2013					2014												2015									
Month	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	
Bridge Management Cycle																											
Inspection and Evaluation																											
Maintenance Plan																											
MMP																											
Database Development																											

**(2) Training on Bridge Inspection and Evaluation**

a) Phase-1

During Phase-1 of the Project, a series of discussions were made among the MTs of MRT and UBC as well as the JICA Expert Team regarding bridge condition in Mongolia, objective of the inspection and its methodology. 1st WS on Bridge Inspection and Evaluation was conducted for C/Ps of MRT and UBC on October 8, 2013 to introduce the result of bridge inspection implemented in Phase-1 focusing on characteristics and typical defect of bridge in Mongolia.

b) Phase-2

After the WS in Phase-1, following WSs were conducted during Phase-2 for technology transfer by means of on-the-job training (OJT):

1) 2<sup>nd</sup> WS for Bridge Inspection and Evaluation

Explanation of the Manual for Bridge Inspection was conducted in the 2nd WS on February 10, 2014 for MRT and on February 26, 2014 for UBC respectively. The JICA Expert Team gave high priority to ownership building in the manual development by means of encouraging the incorporation of opinions made by MTs of MRT and UBC.

2) 3<sup>rd</sup> WS for Bridge Inspection and Evaluation

Explanations of the Manual for Bridge Soundness Evaluation and practice of the soundness evaluation were conducted in the 3rd WS on March 10 2014 for MRT and on March 11 2014 for UBC respectively. The bridge soundness evaluation was practiced based on virtual bridge condition presented by the JICA Expert Team. MTs and the JICA Expert Team discussed the Manual for Bridge Inspection to exchange opinions regarding inspection organization and frequency of inspection. In addition, appraisal tests were conducted after the 2nd and 3rd WSs and it was observed that understanding of the Manual for Bridge Soundness Evaluation was insufficient. Therefore, the JICA Expert Team implemented the next WS focusing on bridge soundness evaluation.

**Table 2.4.10 Appraisal Test after the WS**

	2 <sup>nd</sup> WS (Inspection Manual)	3 <sup>rd</sup> WS (Evaluation Manual)
MRT	74%	47%
UBC	80%	55%
Average	76%	50%

3) 4<sup>th</sup> WS for Bridge Inspection and Evaluation

Clarification of the inspection and evaluation manual, data recording in inspection sheet, site training for the inspection, and practice of soundness evaluation were comprehensively conducted under the 4th WS for Bridge Inspection and Evaluation to facilitate the understanding by MTs.

i) WS for MRT

MTs of MRT instructed the work procedure on bridge maintenance and the soundness evaluation to engineers of the road maintenance companies through seminars under the supervision of the JICA Expert Team. Summary of the seminars is shown in following table.

**Table 2.4.11 Summary of Bridge Inspection Seminars for Road Maintenance Company**

	Western Area	Central/North Area
Date	May 25 2014	June 4, 2014
Location	Hovt	Arkhangai, Tariat
Target Bridge	Buyant's Bridge	Gichigen's Bridge
Participants	21 personnel Bayankhongor Road Maintenance Company Bayanulgi Road Maintenance Company Hovd Road Maintenance Company Gobialtai Road Maintenance Company	19 personnel Kharkhorin Road Maintenance Company Arkhangai Road Maintenance Company Uvurkhangai Road Maintenance Company Bulgan Road Maintenance Company Zavkhan Road Maintenance Company Khuvsgul Road Maintenance Company Erdenesant Road Maintenance Company
MT-MRT	Mr. Munkhbat	Mr. Sugarjav

**Table 2.4.12 Program of Bridge Inspection Seminar for Road Maintenance Company**

Item	Time	Trainer	Remarks
Opening Remarks	8:00~8:05	MT-MRT	Power point presentation
Bridge Management	8:05~8:35	JICA Expert	Power point presentation
Manual for Bridge Inspection and Evaluation	8:35~10:00	MT-MRT	Power point presentation
Clarification of Bridge Inspection Sheet	10:00~11:30	JICA Expert	Exercise with PC
Break Time	11:00~12:30		
Bridge Inspection and Recording	12:30~15:00	MT-MRT (with assistance of JICA Expert)	Practical Training
Processing of inspection data and Soundness Evaluation	15:00~17:00	JICA Expert	Exercise with PC
Appraisal of Understanding	17:00~17:30	JICA Expert	
Closing Remarks	17:30~17:35	MT-MRT	

ii) WS for UBC

To supplement for less opportunities of OJT for MTs of UBC, Self-inspection and follow-up inspection with re-instruction by the JICA Expert Team were conducted as below.

May 23, 2014	WS and OJT on Bridge Inspection (ID-97 Googoin Bridge)
August 18, 2014	Self-Inspection at ID-40 Gachuurt East Bridge / ID-78 Dambadarjaa-Belhi Belhi Bridge
August 28, 2014	Follow-up inspection at No. 40 Gachuurt East Bridge together with JICA Expert Team

During the follow-up WS, the JICA Expert Team gave instructions on the recording manner of bridge inspection sheet prepared by MTs of UBC. Accomplishment of quality in the inspection sheets for both Self-Inspection and the Follow-up Inspection was evaluated as shown in following table. The achievement with 68 points at the time of the Self-Inspection had increased to 90 points at the time of the Follow-up Inspection, which can be evaluated as sufficient level of understanding.

**Table 2.4.13 Confirmation of Inspection Sheet of Self-Inspection and Follow-up Inspection**

Target Bridge		No. 40, Self-Inspection				No. 40, Follow-up Inspection			
Date		2014/8/18				2014/8/28			
MT		UBC				UBC			
Evaluator		Mr. AOYAMA				Mr. AOYAMA			
		Point	Weight	Score	Remarks (to be corrected)	Point	Weight	Score	Remarks (to be corrected)
Inspection Sheet	Form 1	80	0.05	4	Bearing Type	90	0.05	5	
	Form 2	100	0.05	5		100	0.05	5	
	Form 3	80	0.1	8	Girder Height	90	0.1	9	
	Form 4	90	0.1	9	River Width	100	0.1	10	
	Form 5	50	0.4	20	Indication element name	90	0.4	36	
	Form 6	50	0.15	8	-	90	0.15	14	
	Form 7	90	0.05	5	Recording of Inspector	90	0.05	5	Recording of Inspector
	Form 8	—				—			
	Form 9	70	0.1	7	Defects on Wing Wall	70	0.1	7	Defects on Wing Wall
Total Score				65				90	

4) 5<sup>th</sup> WS Bridge Inspection and Evaluation

The JICA Expert Team and MTs discussed the findings and soundness evaluation results based on the bridge inspection carried out from April to June 2014 in the 5<sup>th</sup> WS on September 2, 2015. Explanation of manuals and site training were conducted for half day, and practice on the recording of bridge inspection data as well as soundness evaluation was conducted for further understanding in the remaining half day.

5) OJT for Bridge Inspection Equipment

OJTs on RC Radar, Bridge Inspection Camera, Core Drilling Machine, Neutralization Test, Concrete Compressive Strength Test, and Crack Gauging were conducted through the above-mentioned WSs. Operation manuals for RC Radar and Bridge Inspection Camera were prepared in Mongolian by the JICA Expert Team.

**Table 2.4.14 Training on Inspection Equipment**

Date	Location	MT	Participants	Contents
2014.5.21	Zaisan Bridge	UBC, MRT	7	RC Radar, Bridge Inspection Camera, Core Drilling Machine, Neutralization Test, Concrete Compressive Strength Test
2014.9.2	Turgen River Bridge	MRT	5	RC Radar, Bridge Inspection Camera, Crack Gauge
2014.9.17	Yaarmag Bridge	MRT RTDC	9	RC Radar, Bridge Inspection Camera, Core Drilling Machine
2014.9.10	RTDC Office	MRT RTDC	1	RC Radar, Bridge Inspection Camera

c) Participants of WS and Seminar

Participants of each WS and seminar are shown below.

**Table 2.4.15 Participants of WS on Bridge Inspection/Evaluation**

No.	Name	Office	Position	1 <sup>st</sup> WS (2013/10/8)	2 <sup>nd</sup> WS (2014/2/25-26)	3 <sup>rd</sup> WS (2014/3/10-11)	4 <sup>th</sup> WS (2014/5/23-6/4)	5 <sup>th</sup> WS (2014/9/2)
1	Mr. Sugarjav	MRT	MT/RR, MT/DB, CP/MP	✓	✓	✓	✓	✓
2	Mr. A. Gantulga	MRT	MT/IE, MT/RR	✓		✓		
3	Mr. A. Khanbayr	MRT	(Replacement for Mr. A. Gantulga)					✓
4	Mr. C. Munkhbat	MRT	MT/IE, MT/RR		✓	✓	✓	✓
5	Mr. J. Bayarsaikhan	MRT	MT/RR, CP/MP	✓	✓	✓		
6	Mr. B. Darkhandariya	MRT	CP/MP			✓		
7	Ms. Ts. Khosgerel	MRT	MT/DB	✓	✓	✓	✓	✓
8	Mr. Oyunbileg	MRT						✓
9	Mr. E. Bat-Orshikh	MRT/RTDC	MT/DB	✓		✓		
10	Mr. N. Enkhtulga	MRT/RTDC	MT/IE	✓				
11	Mr. B. Enkhmandakh	UBC	MT/IE, MT/RR	✓	✓	✓	✓	✓
12	Mr. B. Jargalduuren	UBC			✓	✓	✓	✓
13	Mr. B. Olzbayar	UBC	MT/DB	✓			✓	
14	Ms. B. Khishigjargal	UBC			✓	✓		
15	Mr. Ya. Enkhtushin	UBC	MT/DB		✓			
16	Ms. B. Khishigjargal	UBC	MT/DB	✓				
17	Mr. G. Khasbaatar	UBC	C/P	✓			✓	

MRT: Ministry of Road and Transportation

RTDC: Roads and Transportation Development Center

UBC: Ulaanbaatar City Government

ROD: UBC Road Department

d) Photo of Activities



Photo 2.4.1 2<sup>nd</sup> WS (MRT)



Photo 2.4.2 4<sup>th</sup> WS (MRT)



**Photo 2.4.3 Self-inspection by UBC**



**Photo 2.4.4 Bridge Inspection Seminar for Road Maintenance Company**



**Photo 2.4.5 Training on Core Drilling Machine**



**Photo 2.4.6 Training on Bridge Inspection Camera**

**(3) Training on the Selection of Bridge Rehabilitation and Retrofitting Measures**

a) Contents of the Training

Training on the Selection of Bridge Rehabilitation and Retrofitting Measures was implemented focusing on the technology transfer regarding 3 items as follows:

- 1) Study on present situation of bridge and its damage in Mongolia
- 2) Understanding of the Manual for Selection of Bridge Rehabilitation and Retrofitting Measures
- 3) Understanding of the basic theory on structural engineering required for the Selection of Bridge Rehabilitation and Retrofitting Measures

**Table 2.4.16 WS and Seminar for the Selection of Bridge Rehabilitation and Retrofitting Measures**

Theme of WS	Contents	Date
Selection of Bridge Rehabilitation & Retrofitting Measures	Selection of Bridge Rehabilitation & Retrofitting Measures/Seminar (1) Inspection result of bridges in UBC (2) Structural & durability analysis of RC-T beam (Russian-type) (3) Damages & analysis of causes for bridges in UBC (4) Rehabilitation Examples of RC-T beams in UBC (5) Rehabilitation & Retrofitting Measures & Examples	2013.10.8

Theme of WS	Contents	Date
	Manual for selection of Bridge Rehabilitation & Retrofitting Measures (Draft) Chp. 1 Basic policy Chp. 2 Concrete elements 1 Selection of Bridge Rehabilitation & Retrofitting 2 Outline of Main Rehabilitation Measures	MRT: 2014.2.3 UBC: 2014.2.7
	3 Outline of main Retrofitting Measures Chp.3 Steel elements (Outline) Chp.4 Miscellaneous & other (outline)	MRT: 2014.2.10 UBC: 2014.2.11
Structural Mechanism and Bridge Engineering	Exercise regarding stress checking for RC-slab & design for CFRP retrofitting	MRT: 2014.3.13 UBC: 2014.3.14
	Exercise on Bridge design (1) Components of bridge & main points of structural checking (2) Stress checking of RC-T beam (3) Design of Piers (Stress checking of column & stability checking of foundation)	MRT: 2014.5.26 UBC: 2014.5.16
	Exercise regarding road structure Design of T-shape retaining wall / Design of box-culvert	MRT/UBC: 2014.6.3
Seminar for the Manual	Summarization of "Manual for Selection of Bridge Rehabilitation & Retrofitting Measures (Draft)"	UBC: 2014.6.27 MRT: 2014.7.1

b) Participants of Workshop and Seminar

Participants of Workshop and Seminar on the Selection of Bridge Rehabilitation and Retrofitting Measures are as follows.

**Table 2.4.17 Participants of the WSs and Seminar on the Bridge Rehabilitation and Retrofitting Measures**

No.	Name	Office	Roles	1 <sup>st</sup> Seminar for Bridge Rehabilitation & Retrofitting Measures	Selection of Bridge Rehabilitation & Retrofitting Measures WS(1)	Selection of Bridge Rehabilitation & Retrofitting Measures WS(2)	Structural & Bridge design WS(1)	Structural & Bridge design WS(2)	Structural & Bridge design WS(3)	Manual for selection of Bridge Rehabilitation & Retrofitting Measures
1	Mr. .Sugarjav	MRT	MT/RR, MT/DB, CP/MP	✓	✓	✓	✓	✓		✓
2	Mr. A. Gantulga	MRT	MT/IE, MT/RR	✓						
3	Mr.A. Khanbayr	MRT	(Mr. A. Gantulga's replacement)							✓
4	Mr. C. Munkhbat	MRT	MT/IE, MT/RR							✓
5	Mr. J. Bayarsaikhan	MRT	MT/RR, CP/MP	✓	✓					
6	Mr. B. Darkhandariya	MRT	CP/MP							
7	Ms. Ts. Khosgerel	MRT	MT/DB	✓	✓	✓	✓	✓	✓	✓
8	Mr. Oyunbileg	MRT	MT/RR							✓
9	Mr. E. Bat-Orshikh	MRT/RTDC	MT/DB	✓	✓	✓	✓	✓		
10	Mr. N. Enkhtulga	MRT/RSRC	MT/IE	✓						
11	Mr. B. Enkhmandakh	UBC	MT/IE, MT/RR	✓	✓	✓	✓	✓	✓	✓
12	Mr. B. Jargalduuren	UBC								
13	Mr. B. Olzbayar	UBC	MT/DB	✓	✓	✓	✓			
14	Ms. B. Khishigjargal			✓	✓					

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No.	Name	Office	Roles	1 <sup>st</sup> Seminar for Bridge Rehabilitation & Retrofitting Measures	Selection of Bridge Rehabilitation & Retrofitting Measures WS(1)	Selection of Bridge Rehabilitation & Retrofitting Measures WS(2)	Structural & Bridge design WS(1)	Structural & Bridge design WS(2)	Structural & Bridge design WS(3)	Manual for selection of Bridge Rehabilitation & Retrofitting Measures
15	Mr. Ya. Enkhtushin	UBC	MT/DB		✓	✓		✓	✓	✓
16	Mr. G. Khasbaatar	UBC	C/P	✓						

MRT :Ministry of Road and Transportation  
 RTDC: Roads and Transportation Development Center  
 UBC : Ulaanbaatar City Government  
 ROD : UBC Road Department

MT/IE :Master Trainer of Bridge Inspection and Evaluation  
 MT/RR : Master Trainer of Rehabilitation and Retrofitting  
 MT/DB : Master Trainer of Dada Base System  
 CP/MP :Counterpart in charge of Long-Mid Term Bridge Maintenance and Management Plan

c) Photo of Activities



**Photo 2.4.7 Seminar on the Selection of Bridge Rehabilitation and Retrofitting Measures (1)**



**Photo 2.4.8 Seminar on the Selection of Bridge Rehabilitation and Retrofitting Measures (2)**



**Photo 2.4.9 WS for Structural and Bridge Design (1)**



**Photo 2.4.10 WS for Structural and Bridge Design (2)**





**Photo 2.4.11 WS on the Manual for Selection of Bridge Rehabilitation and Retrofitting Measures (1)**



**Photo 2.4.12 WS on the Manual for Selection of Bridge Rehabilitation and Retrofitting Measures (2)**

d) Appraisal of understanding after training

The presentation regarding the “Manual for Selection of Bridge Rehabilitation and Retrofitting Measures” and the contents of the trainings provided by the JICA Expert Team was made by MTs of MRT and UBC at the end of Phase-2. Understanding of the Selection of Bridge Rehabilitation and Retrofitting Measures was appraised in this presentation. It was evaluated that the MTs understood almost everything in the Manual but their presentations were not always adequate for accuracy. Therefore, a supplemental WS to improve their presentation was implemented prior to Phase-3.

**Table 2.4.18 Appraisal of Understanding of Selection of Bridge Rehabilitation and Retrofitting Measures**

		Evaluation Item	MRT	UBC	Remarks
1	Damage to bridges in Mongolia	• Proper explanation?	2.0	2.0	Point : 1.0: Not-good, 2.0: Normal, 3.0: Good
		• Plain explanation?	2.0	3.0	
		• Proper volume & speed of explanation?	2.0	3.0	
2	Loading capacity and durability of RC-T beam (Russian-type)	• Proper explanation?	1.0	1.0	
		• Plain explanation?	2.0	3.0	
		• Proper volume and speed of explanation?	2.0	3.0	
3	”Manual for selection of Bridge Rehabilitation and Retrofitting Measures”	• Proper explanation?	3.0	1.0	
		• Plain explanation?	3.0	3.0	
		• Proper volume and speed of explanation?	3.0	3.0	
4	Rehabilitation and Retrofitting examples in Mongolia	• Proper explanation?	2.0	3.0	
		• Plain explanation?	2.0	3.0	
		• Proper volume and speed of explanation?	2.0	3.0	
5	Policy of Rehabilitation and Retrofitting in Mongolia	• Proper explanation?	1.0	1.0	MRT: Mr. Sugarjav, Ms. Khosgerel
		• Plain explanation?	2.0	3.0	
		• Proper sound volume and speed of explanation?	2.0	3.0	
Total			31/45 69%	38/45 84%	UBC: Mr. Enkhmandakh, Ms. Enkhsaikhan

#### (4) Training on the Bridge Database System

##### a) Phase-1

During Phase-1, the WSs were conducted as shown in the following table to learn the basics of the Bridge Database System (DB). The WSs subject to the MTs for the DB was carried out through practical exercises on PC. Self-training material for the Visual Basic for Application (VBA) was additionally prepared by the JICA Expert Team to enable continuation of the training during the absence of the JICA Expert Team since time for the training for VBA was insufficiently allocated due to routine duties of MTs.

**Table 2.4.19 Training on the DB in Phase-1**

	1 <sup>st</sup> Day	2 <sup>nd</sup> Day	3 <sup>rd</sup> Day	4 <sup>th</sup> Day
<b>1. Development of DB</b>				
(1) Definition of Requirement for the DB	✓	✓		
(2) Table Design (Inventory Data)			✓	✓
<b>2. Training on System Development and Configuration</b>				
(3) VBA Programing	✓	✓	✓	✓
<b>3. Establishment of Operation System of the DB</b>				
(4) Administrative Organization of the DB		✓		
(5) Discussion of the DB management			✓	

##### b) Phase-2

##### 1) Contents of the Workshops

During Phase-2, the trainings on operation and management such as administration of the DB, utilization of the output and preparation of operation manual were implemented through practical utilization of the DB developed by the Project.

**Table 2.4.20 Training on the DB in Phase-2**

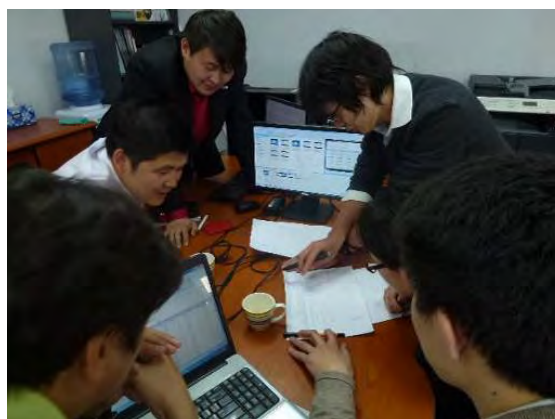
Item	Contents of WS
Review of the Excel Operation (reconfirmation of training in Phase-1)	Re-training on the basic functions of Excel trained in Phase-1 with supplemental exercises and explanations by the JICA Expert Team focusing on the items which the MTs were not proficient.
DB System Configuration	Discussion on the purpose of the DB, ideal DB and required information for better understanding of the DB.
Manual Development	Operation manual to be referred after completion of the Project. Video Manual was developed by the MTs.
VBA Exercise	To enable modification of the system by MTs after completion of the Project, training on the VBA was implemented.
Data Analysis	To utilize the output of the DB, trainings on data processing and graph creation were implemented by using actual bridge information.
Practical Exercise	The duties of operator such as data input and location mapping were exercised by using actual data collected through bridge inspection.
Interim appraisal of understanding	Practical and written examination were carried out to appraise entire understanding on the DB.

**Table 2.4.21 Participants of the Training in Phase-2**

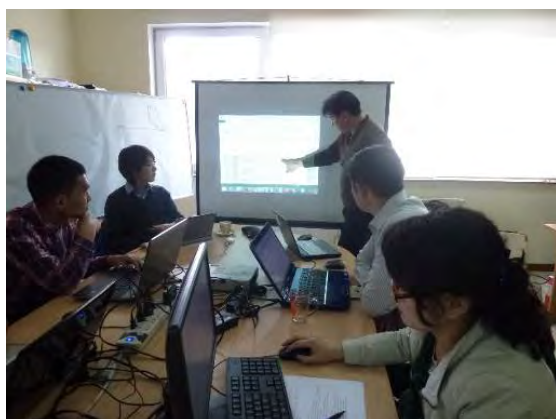
Items	Date	Participants						Participants
		MRT		UBC				
		Ms. Khosgerel	Mr. Bat-Orshikh	Mr. Olzbayar	Mr. Enkhmandakh	Mr. Enkhsaikhan	Ms. Khishigiargal	
Review of the Excel Operation (reconfirmation of training in Phase-1)	April 21	•						1
	April 22			•	•	•	•	4
	May 2		•					1
DB System Configuration	April 29	•		•	•	•		4
	May 2		•					1
Manual Development	May 5	•		•	•	•		4
	May 6		•					1
VBA Exercise	May 9				•	•		2
	May 12	•	•	•				3
	May 15			•		•		2
Data Analysis	May 19	•	•		•	•		4
	May 28	•	•					2
Practical Exercise	May 27			•	•	•		3
	June 10	•	•	•	•	•		5



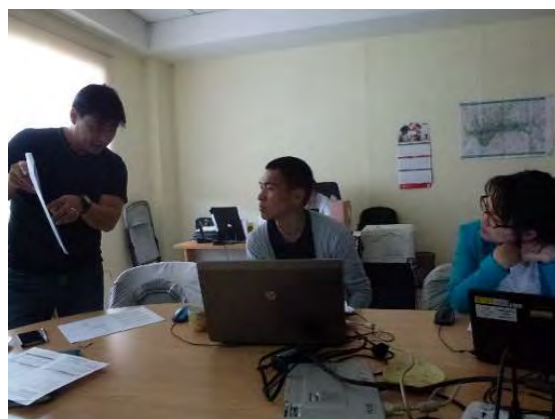
**Photo 2.4.13 Scene of WS (May 2)**



**Photo 2.4.14 Scene of WS (May 5)**



**Photo 2.4.15 Scene of WS (May 19)**



**Photo 2.4.16 Scene of WS (May 28)**



**Photo 2.4.17 Written Examination (June 10)**



**Photo 2.4.18 Practical Examination (June 10)**

## 2) Interim Appraisal of Understanding

To appraise the understanding of the DB trained by the JICA Expert Team up to Phase-2, written and practical examinations were executed. Following were considered for the examinations.

- Priority was given to the check on capacity for practical operation of the DB.
- Opportunity to re-answer was given to careless mistake on the Practical examination to measure fair intelligibility. (point allocation was reduced to half in case of re-try)
- Closed-ended question was applied for the written examination for proper understanding of intended meaning of the questionnaire.

**Table 2.4.22 Results of Interim Appraisal of Understanding**

Examination Items		Number of Questions	Point Allocation	Score				
				MRT		UBC		
				Ms. Khosgerel	Mr. Bat-Orshikh	Mr. Olzbayar	Mr. Enkhmandakh	Mr. Enkhsaikhan
Written	Excel Function	5	5pt (1pt. each)	5pt.	5pt.	2pt.	5pt.	5pt.
	Concept of the DB	7	7pt (1pt. each)	7pt.	5pt.	7pt.	5pt.	6pt.
	Understanding of VBA	3	3pt (1pt. each)	2pt.	0pt.	2pt.	2pt.	3pt.
Practical	Excel Operation	5	5pt (1pt. each)	2pt.	2pt.	4pt.	4pt.	4pt.
	Operation of the DB	19	76pt (4pt. each)	64pt.	72pt.	70pt.	68pt.	74pt.
	Data processing and analysis	1	4pt	4pt.	2pt.	4pt.	4pt.	4pt.
Total Score		40	100pt	84pt.	86pt.	89pt.	88pt.	96pt.

According to the above table, all of the MTs had achieved more than 80 points and thus it was evaluated that sufficient understanding was brought by the Training. On the other hand, the target of understanding the VBA and Excel operation was insufficiently achieved; therefore, it was decided that supplemental workshop shall be implemented at the beginning of Phase-3.

**(5) Seminar on the Mid-Long Term Bridge Maintenance and Management Program (MLBMP)**

The MLBMP was developed through the following series of seminars with the initiative of C/Ps for further understanding and ownership building in Phase-2.

a) Outline of the Seminars

Based on the output of bridge inspection data collected in Phase-1, the series of seminars were planned and implemented to introduce the basic theory of bridge management towards development of the MLBMP by the JICA Expert Team in Phase-2. The seminars focusing on the following five (5) items were implemented twice a week and 19 times in total with verification of understanding of C/Ps from MRT and UBC.

**Table 2.4.23 Seminars on the MLBMP**

No.	Contents of Seminar	Date for MRT	Date for UBC
(1)	Theoretical Concept of Bridge Management (Significance of Systematic Bridge Management, Concept of Life Cycle Design, Structure of MLBMP)	August 4	August 1
(2)	Data analysis on output of bridge inspection (Objective of the analysis, viewpoints, characteristics classification, deterioration condition)	August 7 August 13/14 August 18	August 5 / 8 August 12/15 August 20
(3)	Proposal of Priority Measures (Speculation on the current deterioration and damage of bridges in Mongolia, selection and grouping of issues, introduction of Preventive Maintenance)	August 21 August 25	August 22 August 26
(4)	Prioritization of Maintenance Work (Prioritization by Maintenance Level and Soundness)	September 1	September 2
(5)	Cost Estimate and Budgetary Allocation (Construction Cost Items, methodology, unit cost analysis, quantity analysis, cost of routine maintenance and levelling of budget)	August 28	August 29

b) Considerations for the Seminars

Following four (4) points were taken into account for effective seminars:

- Not only the significance of bridge maintenance but also expected problems without effective bridge maintenance are to be introduced with examples from advanced countries such as the USA and Japan in the training on the “Theoretical Concept of Bridge Management” for easy understanding.
- OJT has to be implemented for (2) to (5) in the above table based on bridge inspection and evaluation results to formulate their own MLBMT respectively in MRT and UBC with the initiative of C/Ps.
- Several items such as understanding of MLBMT, operation of spread sheet and proposal on priority measures have to be the responsibility of the C/P as the road administrator so that the understanding level has to be carefully verified step by step to pursue the training.
- Not only MTs but other staff members related to cost estimate and policy making are to be invited to the seminar.



Photo 2.4.19 Seminar for MRT



Photo 2.4.20 Seminar for UBC

### (6) Supplemental Workshop

To supplement the insufficient understanding of MTs in Phase-1 and Phase-2 and to ensure the successful accomplishment of technology transfer, supplemental workshops were conducted by the JICA Expert Team in February 2015 prior to Phase-3. The MTs were challenged to take the initiative in making the presentations to motivate further understanding and to train themselves as trainers. Although some variations were observed, aggressive challenge by the MTs such as modification of the presentation for easier understanding was confirmed.

**Table 2.4.24 Contents of Supplemental Workshop**

Item	Contents	Lecturer	2/11	2/16	2/17	2/25
1. Bridge Inspection	<ul style="list-style-type: none"> <li>• Entry to the Bridge Inspection Sheet</li> <li>• Equipment Operation</li> </ul>	Mr. B. Enkhmandakh (UBC)		○		
2. Soundness Evaluation	<ul style="list-style-type: none"> <li>• Methodology and procedure of evaluation</li> <li>• Practical Training</li> </ul>	Mr. C. Munkhbat (MRT) Mr. B. Enkhsaikhan (UBC)	○			
3. Selection of Measures for Maintenance	<ul style="list-style-type: none"> <li>• Review of the Manual</li> <li>• Selection of rehabilitation and retrofitting measures</li> </ul>	Mr. N. Sugarjav (MRT)		○		
	<ul style="list-style-type: none"> <li>• Loading Capacity of Bridge</li> </ul>	Mr. Okazaki (JICA)				○
4. Bridge Database System	<ul style="list-style-type: none"> <li>• Database Development</li> <li>• Input of new bridge data</li> <li>• Utilization of Database System</li> </ul>	Mr. E. Bat-Orshikh (MRT) Mr. Olzbayar (UBC)			○	○
5. Mid-Long Term Bridge Maintenance & Management Program	<ul style="list-style-type: none"> <li>• Prioritization and Budgetary Allocation</li> <li>• Additional Explanation on Unit Cost Analysis</li> </ul>	Mr. Kimata (JICA) Mr. Okazaki (JICA) Mr. Mukoyama (JICA)			○	

Note: Implementation period is 2014 (Phase 2 of the Project)



**Photo 2.4.21 Supplemental WS on Soundness Evaluation**



**Photo 2.4.22 Supplemental WS on Bridge Inspection**

**(7) Certification of Master Trainers**

**a) MTs for Bridge Inspection and Soundness Evaluation**

The final appraisal test on Bridge Inspection and Soundness Evaluation for MTs was conducted in Phase-3. A site inspection was conducted by the MTs at the Turgen River Bridge (RC T-shape Girder Bridge, L=36.4m) on May 5, 2015, and the inspection and evaluation sheets were submitted two days later. The JICA Expert Team evaluated the perfection level of inspection and evaluation, and a Certification was provided to each of the MTs who were regarded to have sufficient understanding more than 80% in terms of accuracy of recording of damage and deterioration at the site inspection, quality of inspection sheet (Form 1 to 7) filled by the MTs, and the accuracy of evaluation sheet (Form 9). As to the unsuccessful MT, a supplemental examination was executed through additional WS and re-submission of inspection sheet.



**Photo 2.4.23 Test on Site Inspection**



**Photo 2.4.24 Supplemental WS on the Test**

The result of the appraisal test is shown in following table. Five (5) of the six (6) candidate MTs for the examination received certifications; namely, three (3) from MRT and two (2) from UBC. Three (3) of them were certified in the first examination and two (2) were certified in the supplemental examination.

**Table 2.4.25 Certified MTs for Bridge Inspection and Evaluation**

Candidates		2015.5.8 (1 <sup>st</sup> Exam.)		2015.5.12 (2 <sup>nd</sup> Exam.)	
Office	MRT	Score	Pass/Fail	Score	Pass/Fail
MRT	Sambuu Munkhbat	87(90,82,90)	<b>Pass</b>	-	-
	Battumur Enkhtulga	89(80,92,100)	<b>Pass</b>	-	-
	Amarsaikhan Hanbaeyr	80(90,70,80)	Fail	91 (100,88,80)	<b>Pass</b>
	Amagalan Gantulga	63(100,57,0)	Fail	82 (100,76,60)	Fail
UBC	Baatarjamba Enkhmandakh	81(80,83,80)	<b>Pass</b>	-	-
	Bat-Ochir Enkhsaikhan	74(60,80,90)	Fail	90 (90,90,90)	<b>Pass</b>

Note: Total Score (Accuracy of Record, Quality of Inspection Sheet, Accuracy of Evaluation)

b) MTs for Bridge Rehabilitation and Retrofitting Measures

The final appraisal test for MTs on Bridge Rehabilitation and Retrofitting Measures was conducted in June 2015 (Phase-3). Questionnaires of the examination were to confirm understanding of the “Manual for Selection of Bridge Rehabilitation and Retrofitting Measures”. Closed-ended questions related to items shown below were prepared for the examination.

**Table 2.4.26 Contents of the Examination for MTs on Bridge Rehabilitation and Retrofitting Measures**

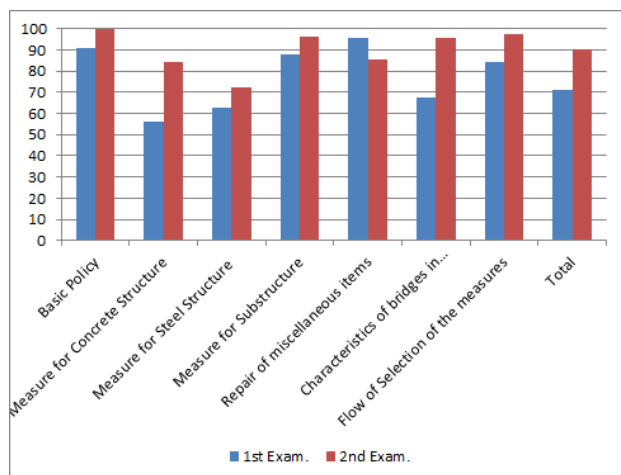
Items	Number of Questions	Items	Number of Questions
1. Basic Policy	4	5. Repair of miscellaneous items	3
2 Rehabilitation and Retrofitting for Concrete Structures	10	6. Characteristics of bridges in Mongolia	12
3 Rehabilitation and Retrofitting for Steel Structures	4	7. Flow of selection of measures	4
4 Rehabilitation and Retrofitting for Substructures	3		

Certifications were provided to MTs who gained 80 points out of 100 points in the examination. High priority of point allocation was given to question item No. 1, 2, 7 and part of 6 due to significance. Since there is some confusion in the questions of the 1st examination, 2nd examination with revised questions was conducted after one week. Based on the result of the 2nd examination, eight (8) C/Ps from MRT and UBC were certified as MTs for Bridge Rehabilitation and Retrofitting Measures.

**Table 2.4.27 Certified MTs for Bridge Rehabilitation and Retrofitting Measures**

Name	Office	1 <sup>st</sup> Examination		2 <sup>nd</sup> Examination	
		Point	Pass/Fail	Point	Pass/Fail
Sugarjav	MRT	71	Fail	95	<b>Pass</b>
Oyunbileg	MRT	75	Fail	90	<b>Pass</b>
Bayanzul	MRT	70	Fail	93	<b>Pass</b>
Giiviishinen	MRT	73	Fail	91	<b>Pass</b>
Khosgerel	MRT	72	Fail	96	<b>Pass</b>
Bayartogtokh	MRT(RTDC)	—	—	81	<b>Pass</b>
Gantulga	MRT	59	Fail	75	Fail
Enkhmandakh	UBC	77	Fail	96	<b>Pass</b>
Enkhsaikhan	UBC	74	Fail	96	<b>Pass</b>
Average		71		90	





**Figure 2.4.7 Results of 1<sup>st</sup> and 2<sup>nd</sup> Examinations on Bridge Rehabilitation and Retrofitting Measures**



**Photo 2.4.25 Appraisal Test for MTs**

c) MTs of the Bridge Database System

The final appraisal test for MTs of the Bridge Database System was conducted according to the schedule shown in the following table. Thirty (30) questions (total score: 100 points) were prepared including the contents of operation for administrator. Ninety (90) points were to be obtained to be certified as MT. Opportunity for re-examination was provided to unsuccessful candidate with extra explanation focusing on incorrect answer.

**Table 2.4.28 Schedule of Final Appraisal Examination for MTs of the Bridge Database System**

Date	Type of Exam.	Name	Office
2015/05/08	Appraisal Test	Ts. Khosgerel	MRT
		Bayansul Lausandonoi	MRT
		B. Olzbayar	UBC
2015/05/11	Appraisal Test	E. Bat-Orshikh	MRT
2015/05/12	Appraisal Test	B. Enkhsaikhan	UBC
	Re-test	B. Olzbayar	UBC



**Photo 2.4.26 MT Appraisal Test in MRT**



**Photo 2.4.27 MT Appraisal Test in UBC**

**Table 2.4.29 Questionnaire for Appraisal Examination of MTs for the Bridge Database System**

No.	Test Item	Point
(1)	Output of empty Inspection sheet	4
(2)	Registration of inspection sheet for new bridge	4
(3)	Confirmation of Thickness of Pavement (ID-19)	2
(4)	Save the bridge inspection sheet (ID-19)	4
(5)	Development of 2 <sup>nd</sup> inspection sheet (ID-19)	2
(6)	Save the bridge 2 <sup>nd</sup> inspection sheet (ID-19)	2
(7)	Indication of Administration Sheet	4
(8)	Cancellation of the Protection (Password: jicabridge)	4
(9)	Indication of Location Map (ID-29)	4
(10)	Delete of the Bridge (ID-999)	4
(11)	Open the file of “Bridge Maintenance Plan” in editable format.	4
(12)	Save new construction drawing	4
(13)	Confirmation of the share of soundness “D” in BAYANKHONGOR Aimag	4
(14)	Save data in “other document” folder.	4
(15)	Open the administration Manual	4
(16)	Create graphic data	4
(17)	Confirmation of the oldest bridge name in soundness “D”	2
(18)	Number of bridges constructed from 1971 to 1980	4
(19)	Change of the password for bridge removal	2
(20)	Change of the password for indication of administration sheet	2
(21)	Share of bridge with length of 50m to 100m	4
(22)	Add new road ID (A999) in the alternative data	4
(23)	Remove the Stone Bridge from the alternative of bridge type	2
(24)	Protect all sheets with password	4
(25)	Indication of location map of whole bridge	4
(26)	Confirmation of the name of easternmost bridge in Mongolia	4
(27)	Output of CSV File	4
(28)	Uploading of CSV file to Google Map	2
(29)	Create new legend depending on soundness on Google Map	2
(30)	Change the location of database file to the desktop	2

The table below shows the result of appraisal test for MTs. Four (4) out of five (5) candidates passed the first examination and the other candidate who failed in the first examination was certified after a makeup examination focusing on the misunderstood part.

**Table 2.4.30 Appraisal Test for MTs of the Bridge Database**

Office	Name	First Examination					Makeup Examination				
		Questions	Perfect Score	Passing Grade	Score	Judgement	Questions	Full Score	Passing Grade	Score	Judgment
MRT	Ts. Khosgerel	30	100	90	92	Pass	—	—	—	—	—
	Bayanzul Lausandonoi	30	100	90	90	Pass	—	—	—	—	—
	E. Bat-Orshikh	30	100	90	100	Pass	—	—	—	—	—
UBC	B. Olzbayar	30	100	90	88	Fail	6	12	12	12	Pass
	B. Enkhsaikhan	30	100	90	96	Pass	—	—	—	—	—

## 2.4.5 Proposal for Training System by Mongolian Side

The training system below which was executed by the Mongolian Side in Phase-3 was proposed after discussion with MRT and UBC.

**Table 2.4.31 Training System Executed by the Mongolian Side in Phase-3**

2015	March	April	May	June	July	August	September
MRT		In-house Training of MRT	Engineer's Seminar (MRT/UBC/JICA Expert Team)			Site Seminar on Pilot Implementation of Bridge Maintenance Work	Public Seminar (MRT/UBC/JICA Expert Team)
UBC		In-house Training of UBC					
Objective		<ul style="list-style-type: none"> <li>Dissemination of technology in MRT and UBC</li> <li>Training for MT to transfer the knowledge to others.</li> </ul>	Information sharing with Road Maintenance Companies			Introduce new technology for Bridge Maintenance	Enhancement of social recognition on bridge maintenance
			Information sharing with Consultant and Construction Company				
	Contents			MRT		UBC	
In-house Training	MTs conduct training for staff related to bridge maintenance in MRT and UBC respectively to share the technology transferred by the JICA Expert Team.			Staff of Road Policy Implementation and Coordination Department should participate.		Staff of Road Department particularly staff of Operation and Maintenance Division should participate.	
Engineer's Seminar	MTs conduct training for the engineers related to road and bridge maintenance outside of MRT and UBC to share the technology transferred by the JICA Expert Team.			Engineers of Road Maintenance Companies should participate.		Engineers of Contractor and Consultant in Ulaanbaatar City.	
Site Seminar	MTs in corroboration with JICA Expert Team introduce the new technology and materials for bridge maintenance such as CFRP and Polymer Cement to concerned engineer.			Bridge engineers of Consultant and Contractor would participate.			
Public Seminar	MTs in corroboration with the JICA Expert Team introduce outputs of the Project to the public to enhance the social recognition of bridge maintenance.			Public, university students, other donors and media should be invited. MTs of MRT and UBC as well as JICA Expert Team will make the presentation.			

## 2.4.6 Training by Mongolian Side

Three (3) kinds of training were carried out by the Mongolian side; namely, i) In-house Training; ii) Engineer's Seminar; and iii) Public Seminar. Presentation materials were prepared by the MTs of MRT and UBC.

**Table 2.4.32 Schedule of Training by the Mongolian Side**

Date	Title of the Training	Target
March 17, 2015 (May 11, 2015)	1 <sup>st</sup> In-house Training (2 <sup>nd</sup> In-house Training)	Staff of MRT, UBC related to road and bridge maintenance
May 14, 2015	Engineer's Seminar	Bridge and Road Engineer in Mongolia
September 10, 2015	Public Seminar	University, Media representative

**(1) In-house Training**

a) 1<sup>st</sup> In-house Training

In March 2015, 1st In-house Training was carried out by the MTs of MRT and UBC at their respective government buildings. Since the impact of the training for MRT was not so high because there were only seven (7) participants, a Second In-house Training for MRT was conducted. With regard to the training in UBC, sufficient level of discussion was made among the 29 participants from other offices such as the Construction Division, Plan and Survey Division and Operation and Maintenance Division. Through the in-house training in UBC, the capacity of MTs was further developed and knowledge on the bridge management cycle was shared in the Road Department of UBC.

**Table 2.4.33 Contents of the In-house Training in MRT and UBC**

Item	MRT Trainer	UBC Trainer	Remarks
Bridge Inspection	ENKHTULGA	ENKHMANKH	Explanation of the manual developed under the Project
Soundness Evaluation	MUNKHBAT	ENKHSAIKHAN	Explanation of the manual developed under the Project
Rehabilitation and Retrofitting Measure	OYUNBILEG	ENKHMANKH	Explanation of the manual developed under the Project
Maintenance Planning	SUGARJAV	HASBAATAR	Introduction of the MLBMP / Report for training in Japan
Bridge Database	BAT-ORSHIKH	OLZBAYAR	Introduction of function of the Database



**Photo 2.4.28 In-house Training in MRT**



**Photo 2.4.29 In-house Training in UBC**

b) 2<sup>nd</sup> In-house Training

Since the 1st In-house Training held by MRT in March 2015 was not effectively implemented, the 2nd In-hose Training was carried out only for MRT in May 2015. Several discussions and questions among 19 participants from the related divisions in MRT were made and it was confirmed that the capacity of MTs in their presentation and answer to the question had been gradually improved.



Photo 2.4.30 2<sup>nd</sup> In-house Training in MRT (1)



Photo 2.4.31 2<sup>nd</sup> In-house Training in MRT (2)

## (2) Engineer's Seminar

The Engineer's Seminar was held by MRT and UBC on May 14, 2015 according to the program below. Approximately 50 engineers from road maintenance companies, consultants and construction companies participated in the seminar. Although the main contents of the presentation made by the MTs were almost the same as those of the In-house Training, it was observed that the understanding level and presentation skill had drastically improved.

**Table 2.4.34 Program of the Engineer's Seminar**

Time	Contents	Trainer	Office
13:00 – 13:20	Project Digest	N. Sugarjav	MRT
13:20 – 13:40	Bridge Inspection	B. Enkhmandakh	UBC
13:40 – 14:00	Soundness Evaluation	C. Munkhbat	MRT
14:00 – 14:10	Break		
14:10 – 14:30	Rehabilitation and Retrofitting Measures	B. Ekhksaikhan	UBC
14:30 – 14:50	Mid-Long Term Maintenance Plan	N. Sugrajav	MRT
14:50 – 15:10	Bridge Database	Ts. Hosgerel	MRT
15:10 – 15:40	Q&A		
15:40 – 15:50	Closing Remarks		



Photo 2.4.32 Engineer's Seminar (1)



Photo 2.4.33 Engineer's Seminar (2)

**(3) Public Seminar**

The Public Seminar was held on September 10, 2015 to introduce the “Bridge Management Cycle” to the general public and not only limited to engineers in order to enhance social recognition on the significance of bridge maintenance in Mongolia. Particularly, university students and members of the Media were invited for the wider dissemination of knowledge and technology introduced by the Project in Mongolia. The presentation was prepared for easy understanding of the public.

- Date: September 10, 2015
- Location: Chinggis Khaan Hotel
- Organized by: MRT/UBC/JICA Expert Team

**Table 2.4.35 Program of the Public Seminar**

Time	Agenda	Trainer
9:45~10:00	Opening Remarks	Mr. Sugarjav (MRT)
10:00~10:30	Project Digest	Mr. Akio OKAZKI (JICA Expert)
10:30~10:50	Inspection/Evaluation Manual	Mr. Enkhmandakh (UBC)
10:50~11:10	Maintenance Manual	Mr. Enkhsaikhan (UBC)
11:10~11:30	Bridge Database	Ms. Bayansul (MRT)
11:30~12:00	Pilot Implementation	Mr. Tatsuo MUKOYAMA (JICA Expert)
12:00 ~ 12:15	Q&A	
12:15 ~ 12:30	Questionnaire on Intelligibility	Ms. Minami KATO (JICA Expert)
12:30~12:40	Closing Remarks	Mr. Khasbaatar (UBC)



**Photo 2.4.34 Public Seminar (1)**



**Photo 2.4.35 Public Seminar (2)**

Interview survey was carried out by the JICA Expert Team to research on the understanding level of participants after the seminar. Based on the results of the survey, it was confirmed that most of the participants had improved their understanding of bridge maintenance. It is particularly noteworthy that around 80% of the participants came to know the works required for bridge maintenance although they had not understood the bridge maintenance before the seminar. It is therefore concluded that a public seminar is effective to enhance the Enabling Environment for implementation of the Bridge Management Cycle.

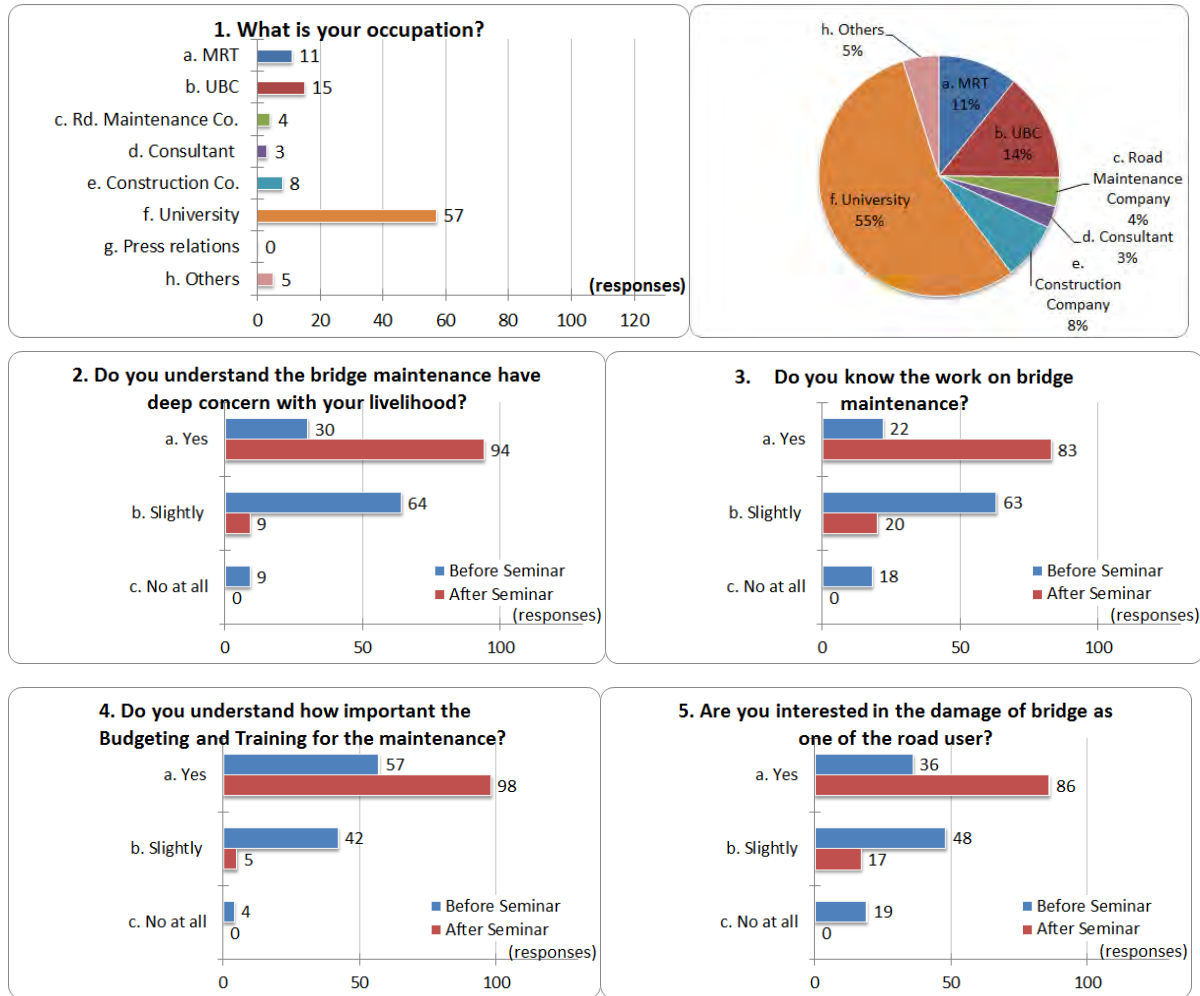


Figure 2.4.8 Summary of Answers to Questionnaire

## 2.4.7 Assistance for Actual Bridge Maintenance Work by Mongolian Side

### (1) General

Actual maintenance work was carried out to rehabilitate two (2) of the existing bridges in Ulaanbaatar City under the maintenance budget for 2015. The JICA Expert Team had assisted in implementing the maintenance work, since it was a valuable opportunity to practice the outputs of the Project as the “Pilot Implementation”. During the construction work, not only the staff of MRT and UBC participated in the site seminars but also engineers from the road maintenance companies and others all to widely introduce the new maintenance technology in Mongolia.

Table 2.4.36 Pilot Implementation and Assistance by the JICA Expert Team

	Implementation Schedule (UBC Road Department)	Assistance to the Project (JICA Expert Team)
June	<ul style="list-style-type: none"> <li>Mobilization</li> </ul>	<ul style="list-style-type: none"> <li>Assistance in construction planning and selection of materials</li> <li>Quality Control Plan</li> </ul>
July	<ul style="list-style-type: none"> <li>Procurement</li> </ul>	<ul style="list-style-type: none"> <li>Assistance in Procurement of Materials</li> </ul>
August to September	<ul style="list-style-type: none"> <li>Commencement of the Work</li> <li>Completion of the Work</li> </ul>	<ul style="list-style-type: none"> <li>Technical assistance in site work for CFRP and Polymer Cement</li> <li>Assistance in Supervision</li> <li>Assistance in recording of the maintenance work</li> </ul>

Year: 2015	April	May	June	July	August	September	October
Survey & Design							
Procurement							
Construction							

Figure 2.4.9 Schedule of Pilot Implementation of Bridge Maintenance (2015)

(2) Assistance in Maintenance Planning (April-May 2015)

The JICA Expert Team assisted in the following items of work to develop a practical maintenance plan for the target bridges selected by UBC. MTs of MRT and UBC were involved to prepare the maintenance plan.

- 1) Selection of Rehabilitation and Retrofitting Measures based on bridge inspection;
- 2) Preparation of detail drawings for the maintenance work;
- 3) Quantity analysis for the maintenance work; and
- 4) Cost estimate for the maintenance work.

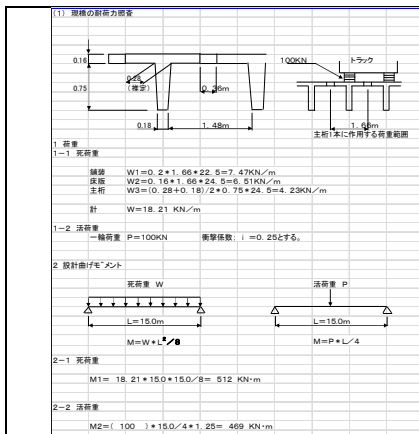


Figure 2.4.10 Design Analysis on Maintenance Plan

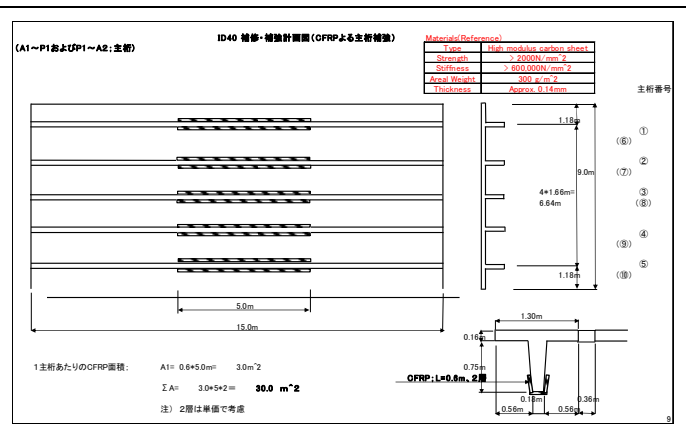


Figure 2.4.11 Design Drawings for the retrofitting by CFRP



Photo 2.4.36 Discussion on Maintenance Plan (1)

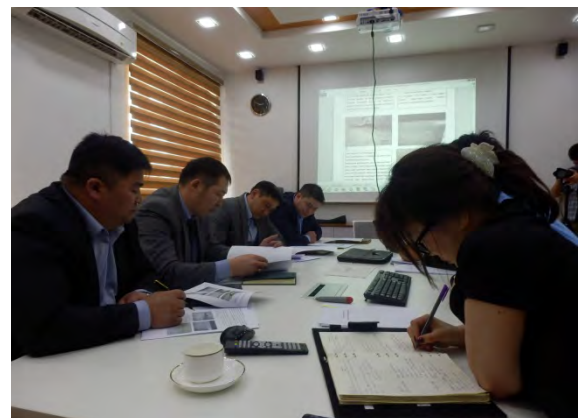


Photo 2.4.37 Discussion on Maintenance Plan (2)



**(3) Assistance in Construction Work**

Selectin of the Contractor was completed in July 2015. The JICA Expert Team provided assistance during the construction work as follows:

- 1) Assistance in Construction Planning;
- 2) Assistance in the procurement of special materials such as CFRP and Polymer Cement;
- 3) Assistance in quality control of materials;
- 4) Assistance in site work for section repair by polymer cement and retrofitting by CFRP; and
- 5) Dissemination of maintenance technology through Site Seminar.



**Photo 2.4.38 Site Inspection with C/Ps**



**Photo 2.4.39 Assistance in Material Procurement**



**Photo 2.4.40 Quality and Safety Control**



**Photo 2.4.41 Site Seminar**



**Photo.2.4.42 Technical Assistance in Section Repair**



**Photo.2.4.43 Technical Assistance for CFRP**



**Photo 2.4.44 Before Rehabilitation  
(Bridge Surface: ID-41)**



**Photo 2.4.45 After Rehabilitation  
(Bridge Surface: ID-41)**



**Photo 2.4.46 Before Section Repair (ID-41)**



**Photo 2.4.47 After Section Repair (ID-41)**



**Photo 2.4.48 Before Retrofitting on Deck  
Slab (ID-41)**



**Photo 2.4.49 After Retrofitting on Deck  
Slab (ID-41)**



**Photo 2.4.50 Before Retrofitting on Main  
Girder (ID-41)**



**Photo 2.4.51 After Retrofitting on Main  
Girder (ID-41)**

### 3. CAPACITY ASSESSMENT

#### 3.1 Survey for Capacity Assessment

##### 3.1.1 Contents of the Survey


- As mentioned in “2.4.1, Baseline Survey,” MRT’s and UBC’s capacity for bridge maintenance and management was confirmed in the baseline survey at the beginning of the Project, in Phase 1. Furthermore, the surveys for intermediate evaluation in Phase 2 and for final evaluation in Phase 3 were conducted and the change in capacity of MTs and C/Ps through the Project, which is called capacity development, were examined.
- The contents of the surveys are to confirm the following capacity according to the themes of technology transfer in the project, same as the baseline survey:
  - i) Technical capacity such as knowledge required for individuals and organizations;
  - ii) Core capacity such as desire, attitude and management skill; and
  - iii) Enabling Environment such as organizations and framework.
- The summary and scope of the survey are shown below.

**Table 3.1.1 Summary of the Survey for Capacity Assessment**

	Baseline Survey (Initial Evaluation Survey)	Intermediate Evaluation Survey	Terminal Evaluation Survey
Purpose	Confirm the baseline for capacity at the beginning of the Project.	Confirm capacity development status by the Project (Phase 1, 2)	Confirm capacity development status by the Project (Phase 1, 2, 3)
Timing	2013.9 (Phase 1)	2014.11.21~2014.12.1 (Phase 2)	2015.9 (Phase 3)
Method	Detention Method	Detention Method	Internet Survey Method (E-mail)
Target	※Related Staff Members	15 (MRT 9 UBC 6) *MT and CP	15 (MRT 9 UBC 6) *MT and CP
Response	22	14 (MRT 8, UBC 6)	15 (MRT 9, UBC 6)

※ Detention Method: Visit targets, leave survey sheets after explanation of the survey and collect them at a later date

**Table 3.1.2 Scope of the Survey**

Themes	Items (Factors)				
	Technical Capacity	Core Capacity	Enabling Environment		
1 Bridge Management Cycle	① Understanding of necessary skill/work contents ② Understanding of procedure/utilizing method	③ Problem awareness ④ Personal contribution	⑤ Organization framework ⑥ Social/organizational recognition		
2 Bridge Database System					
3 Bridge Inspection and Soundness Evaluation					
4 Bridge Rehabilitation and Retrofitting Plan					
5 The Mid-Long Term Bridge Maintenance and Management Program					
※Answer Method: Multiple-Choice ※Allotment:					
Understanding Level	Option 1 0 point	Option 2 1.25 point	Option 3 2.50 point	Option 4 3.75 point	Option 5 5.00 point
	Low  High				

### 3.1.2 Results of the Survey

- Overall, the results of the baseline survey, intermediate evaluation survey and terminal evaluation survey have confirmed that capacity improvement has been attained, although some differences are seen depending on the theme or element affected by replacement of MTs and C/Ps due to resignation or reorganization. Technical capacity has gradually improved from the beginning to the end of the Project, either in “Understanding of necessary technique” and in “Understanding of work procedures”. Core capacity has also improved, and “Problem awareness” has dramatically improved in the intermediate evaluation survey (Phase 2). Enabling environment surrounding bridge maintenance and management has improved, but the capacity change is small compared to technical and core capacity.
- The summary and list of the survey results are shown in Table 3.1.3 and Table 3.1.4, respectively.

**Table 3.1.3 Summary of Survey Results**

Theme	Survey Results
1 Bridge Management Cycle (BMC)	<ul style="list-style-type: none"> <li>• The percentage of “Very well” increased considerably in the question related with Technical Capacity (101, 102).</li> <li>• The percentage of “Continuous training by myself is needed.” increased dramatically in “Problem awareness of BMC (103).”</li> <li>• Little change is confirmed in “Social recognition of BMC (106)”. “Almost all” remains unchanged keeping 0% since the baseline survey and “No one” remains in the terminal evaluation survey.</li> </ul>
2 Bridge Database System	<ul style="list-style-type: none"> <li>• The percentage of “Improving the DB by myself is necessary.” increased dramatically in “Problem awareness of DB system development (203)”.</li> <li>• Capacity of “Budget and personnel for DB system management (205)” improved a little but “Sufficient” remains unchanged at 0% since the baseline survey.</li> <li>• Little change is confirmed in “Organizational recognition of DB system (206)”.</li> </ul>
3 Bridge Inspection and Soundness Evaluation	<ul style="list-style-type: none"> <li>• The percentage of “Very well” increased considerably in the question related with technical capacity (301, 302).</li> <li>• The percentage of “Improving the method of inspection and evaluation by myself is necessary.” increased dramatically in “Problem awareness of bridge inspection and evaluation (303).”</li> <li>• The improvement of Enabling Environment (305, 306) remains small.</li> </ul>
4 Bridge Rehabilitation and Retrofitting Plan	<ul style="list-style-type: none"> <li>• The percentage of “Deepening of understanding and revising the plan is needed. (403)” increased dramatically in “Problem awareness of drafting of rehabilitation and retrofitting plan.”</li> <li>• The improvement remains small in Enabling Environment (405, 406) though a little change is confirmed.</li> </ul>
5 Mid-Long Term Bridge Maintenance and Management Program	<ul style="list-style-type: none"> <li>• The percentage of “Very important and periodical review is needed.” increased considerably in “Understanding of using method of a mid-long term bridge maintenance and management program (502).”</li> <li>• The percentage of “Deepening of understanding and revising the plan is needed.” increased dramatically in “Problem awareness of drafting management program (503).”</li> <li>• The improvement remains small in Enabling Environment (505, 506).</li> </ul>

Table 3.1.4 List of Survey Results

		1. Bridge Management Cycle	2. Bridge Database System (DB)	3. Bridge Inspection and Soundness Evaluation	4. Bridge Rehabilitation and Retrofitting Plan	5. The Mid-Long Term Bridge Maintenance and Management Program
Technical Capacity	Understanding of necessary skill/work contents	<p>101 Do you understand "Bridge Management Cycle (BMC)"?</p>	<p>201 Do you understand data necessary for bridge maintenance?</p>	<p>301 Do you understand bridge inspection and soundness evaluation?</p>	<p>401 Do you have technique for rehabilitation and retrofitting planning?</p>	<p>501 Do you understand a mid-long term bridge maintenance and management program and the planning method?</p>
	Understanding of procedure/utilization method	<p>102 Do you understand procedures of bridge management work?</p>	<p>202 Do you understand configuration and usage of the bridge database system?</p>	<p>302 Do you understand a method of using result of bridge inspection and soundness evaluation?</p>	<p>402 Do you understand drafting method of a rehabilitation and retrofitting plan.</p>	<p>502 Do you think a mid-long term bridge maintenance and management program is important?</p>
	Problem Awareness	<p>103 What do you think is necessary to make BMC function?</p>	<p>202 Do you understand configuration and usage of the bridge database system?</p>	<p>303 What do you think is necessary to continue bridge inspection and soundness evaluation?</p>	<p>403 What do you think is necessary for drafting a rehabilitation and retrofitting plan by yourself?</p>	<p>503 What do you think is necessary for drafting a mid-long term bridge maintenance and management program by yourself?</p>
Core Capacity	Personal contribution	<p>104 How much do you think you can contribute to spreading of BMC concept?</p>	<p>204 How much do you think you can contribute to database operation?</p>	<p>304 How much do you think you can contribute to effective bridge inspection and soundness evaluation?</p>	<p>404 How much do you think you can contribute to draft a rehabilitation and retrofitting plan?</p>	<p>504 How much do you think you can contribute to draft a mid-long term bridge maintenance and management program?</p>
	Organization frameworks	<p>105 Which budget do you think can be secured, for daily maintenance, periodic inspection, rehabilitation/reinforcement or reconstruction?</p>	<p>205 Are sufficient budget and personnel for database management secured?</p>	<p>305 Are sufficient budget and personnel for bridge inspection and soundness evaluation secured?</p>	<p>405 Are sufficient budget and personnel for drafting a rehabilitation and retrofitting plan?</p>	<p>505 Are sufficient budget and personnel for drafting a mid-long term bridge maintenance and management program?</p>
	Social/organizational recognition	<p>106 How many people do you think recognize BMC in the society?</p>	<p>206 How many people do you think recognize the necessity of the database in your organization?</p>	<p>306 How many people do you think recognize the necessity of bridge inspection and soundness evaluation in your organization?</p>	<p>406 How many people do you think recognize the necessity of a rehabilitation and retrofitting plan?</p>	<p>506 How many people do you think recognize the importance of a mid-long term bridge maintenance and management program?</p>

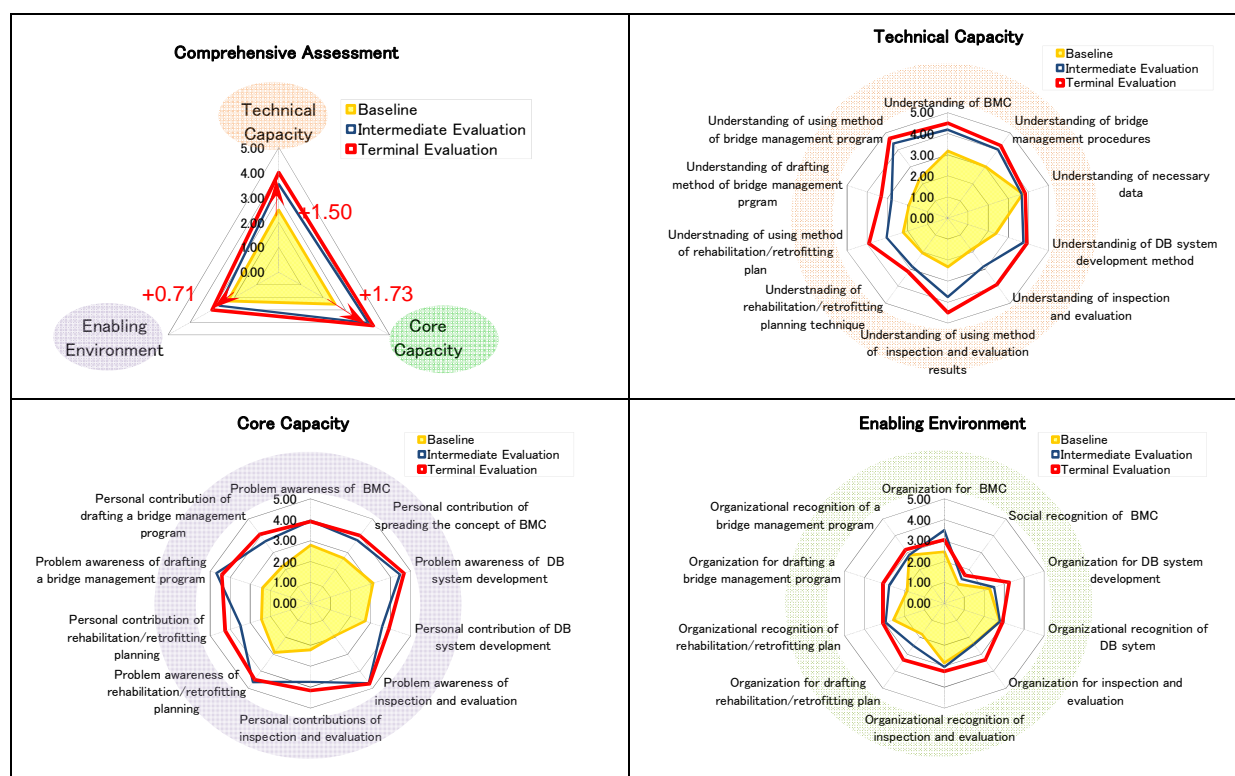


### 3.2 Capacity Assessment

- Capacity development has been evaluated from three points of view: i) Technical Capacity (individual technique); ii) Core Capacity (problem awareness, motivation, etc.); and iii) Enabling Environment (organization framework, social recognition, etc.).
- The results of the capacity assessment show that Core Capacity has improved the most of the three points (+1.73) followed by Technical Capacity (+1.71). On the other hand, Enabling Environment has improved but the growth is low compared to the other two capacities, which is also markedly confirmed in the result by capacity. By capacity, Technical Capacity and Core Capacity have considerably improved similarly in any question of theme. Considerable improvement is confirmed especially in “3. Bridge Inspection and Soundness Evaluation” and “5. The Mid-Long Term Bridge Maintenance and Management Program”.
- The results of the capacity assessment are shown below.

**Table 3.2.1 Results of Capacity Assessment**

	Baseline Survey	Intermediate Evaluation Survey	Terminal Evaluation Survey	Terminal Evaluation Survey – Baseline Survey (Growth Rate)
Technical Capacity	2.50/5.00	3.53/5.00	4.00/5.00	+1.50 (+60%)
Core Capacity	2.54/5.00	4.07/5.00	4.27/5.00	+1.73 (+68%)
Enabling Environment	2.30/5.00	2.67/5.00	3.01/5.00	+0.71 (+31%)
Average	2.45/5.00	3.42/5.00	3.76/5.00	+1.31 (+53%)



**Figure 3.2.1 Results of Capacity Assessment (Comprehensive/By Capacity)**

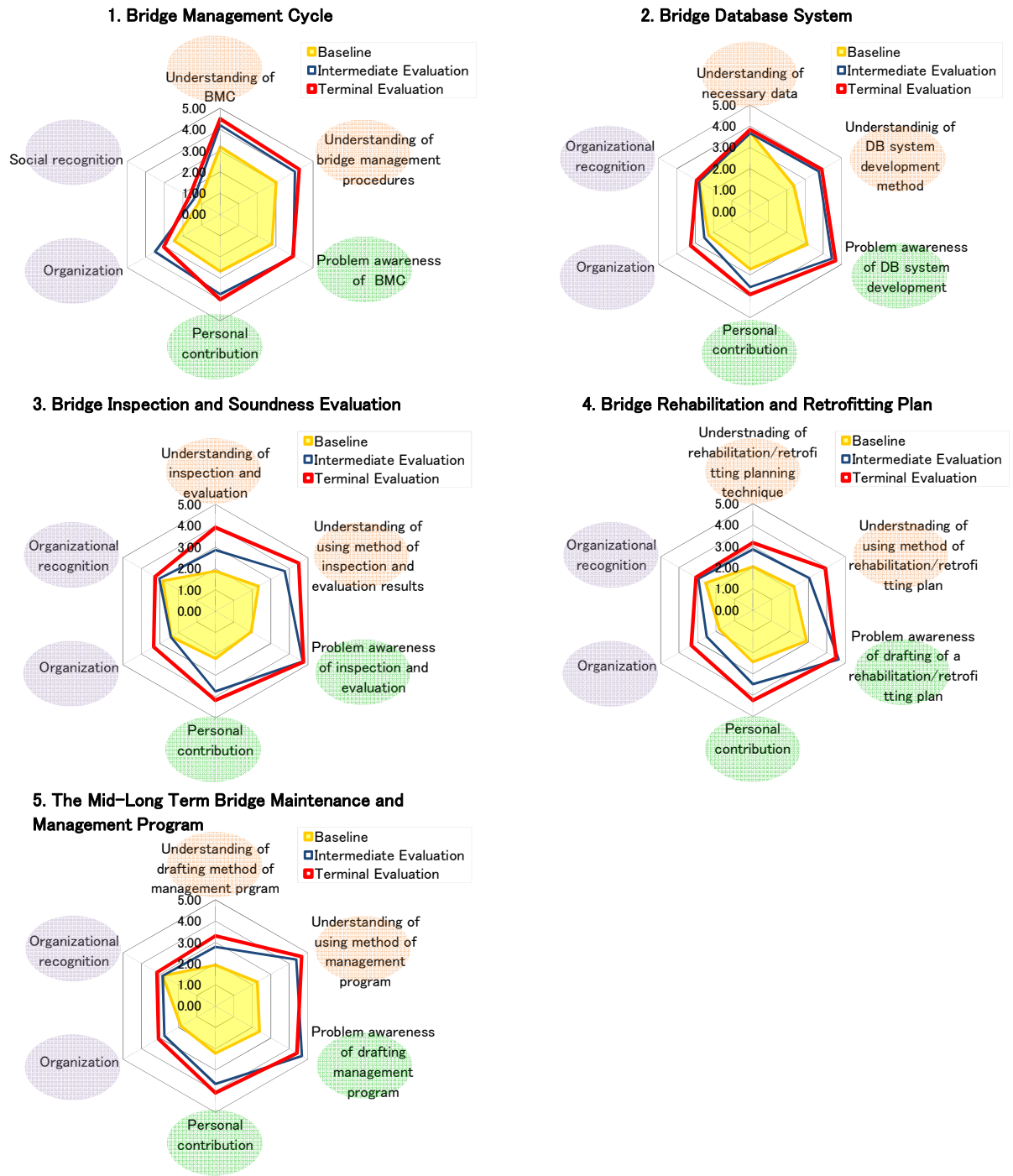


Figure 3.2.2 Results of Capacity Assessment (By Theme)



### **3.3 Conclusion of the Capacity Assessment**

- Conclusions of the Capacity Assessment are as follows:
  - Technical Capacity (understanding of technique) has considerably improved in the theme poorly understood at the beginning of the Project. The understanding of techniques, work procedures and utilization methods of data and plans related to bridge maintenance and management has developed. In particular, understanding of the use of bridge inspection, rehabilitation and retrofitting plan, and the Mid-Long Term Bridge Maintenance and Management Program has improved. Not only the method of obtaining elemental technique, but also deep understanding of the method necessary for the operation of the technique should be a great achievement.
  - Core Capacity (problem awareness and motivation) has drastically improved. It is considered that problem awareness, motivation to work and individual confidence would increase by deeply understanding the technique of bridge management. Almost all staff members did not have clear problem awareness at the beginning of the Project. However, almost all staff members have realized that continuous training by themselves is important and, in addition, positive attitude in playing a role in the bridge management cycle for the future was produced. It is expected that such changes in attitude of the staff members would further improve each individual capacity and contribute to the capacity improvement of individual organizations.
  - Enabling Environment surrounding bridge management could not be comprehensively improved through the Project. On the other hand, with regard to organizational framework including budget and personnel necessary for operation of the bridge management cycle, almost all of the staff members thought it was “Insufficient” at the beginning of the project. However, almost all of the staff members came to think that “Necessary minimum volume is secured.” Especially, as for the organizational structure, it should be understood that the bridge management cycle can be operated under the current organizational structure. As to the budget, it is commonly understood that the current budget is not enough to continue sufficient bridge management considering the current economic condition, so that the budget for bridge management need to be increased. For organizational recognition which has not considerably improved, long-term improvement is very important and should be attained by conducting activities to develop the environment such as periodical in-house training, engineers’ seminar and public seminar.



## **4. ACHIEVEMENT OF THE PROJECT**

### **4.1 Outline of the Terminal Evaluation**

The Terminal Evaluation was carried out from April 19 to May 2, 2015 with the following objectives:

- To review the progress of the Project on the basis of the RID, the PDM, and the PO, and to assess the achievement of outputs, project purpose and overall goals in terms of the set indicators;
- To review the implementation process of the Project;
- To evaluate the Project in terms of the five criteria (relevance, effectiveness, efficiency, impact and sustainability);
- To make recommendations on necessary arrangements to be made for: i) the successful completion of the Project; and ii) the sustainable development after the Project completion; and
- To compile lessons learned from the Project which could be utilized for planning and implementation of similar types of project in the future.

Based on the investigation aiming at above, the following conclusions were made and the Minutes of Meeting was concluded among MRT, UBC and JICA.

- This Project is still relevant, since it is in line with Mongolian development policies, Japanese ODA policies, and needs of C/P organizations.
- For implementing pilot bridge rehabilitation works, relevant activities were added to the Project and its duration was extended by three (3) months, which is in line with the needs of C/P organizations, thus relevant.
- Project activities have been efficiently implemented in general and generated sufficient level of the outputs. Project purpose has also been achieved to a certain extent. Thus, efficiency and effectiveness of the Project is regarded as high. However, further development of the system of MRT and UBC as organizations for planning and implementing bridge maintenance and management is required.
- Further development of system for planning and implementing bridge maintenance and management and ensuring necessary budgets are keys for achieving the Overall Goal.
- Regarding sustainability after Project completion, although there would not be big changes in related policies, there remains issues with organizational and budget aspects for establishing skills/knowledge transferred under the Project in MRT/UBC and planning and actually implementing bridge maintenance and management by MRT/UBC.

## 4.2 Achievement of Outputs

The achievements of outputs at the time of the Terminal Evaluation are as listed in the following table. All twenty (20) of the objectively verifiable indicators are regarded as achieved or expected to be achieved.

**Table 4.2.1 Verification Indicators and Achievements based on the Terminal Evaluation**

Outputs	Verification Indicators	Achievements	Evaluation
Output-1: Concept of "Bridge Management Cycle" is widely understood, and guidelines and/or manuals regarding inspection, evaluation, priority assessment and selection of measures are developed.	1-1. A manual for bridge inspection is developed by June 2015.	<ul style="list-style-type: none"> <li>• Following manuals had been developed and their final versions were submitted to MRT in February 2015 for approval. Minister of MRT approved these 3 manuals on 11th Mar. 2015. Thus, this indicator was achieved.                             <ol style="list-style-type: none"> <li>1) Manual for Bridge Inspection</li> <li>2) Manual for Bridge Soundness Evaluation</li> <li>3) Manual for Selection of Bridge Repairing Method</li> </ol> </li> <li>• 200 copies each were printed by JICA expert's budget and distributed to concerned personnel at the "Bridge Seminar" held on 20th May 2015.</li> <li>• MRT is responsible for printing of additional manuals.</li> <li>• JICA experts plan to propose uploading these manuals to webpage of MRT.</li> </ul>	As seen in the achievement levels of the indicators, "Manual for Bridge Inspection," "Manual for Bridge Soundness Evaluation" and "Manual for Selection of Bridge Repairing Method" were prepared and approved and the understanding of C/Ps on "Bridge Management Cycle" has been enhanced. Both the JICA Expert Team and the Mongolian C/Ps recognize that C/Ps especially MTs have had sufficient understanding of the Bridge Management Cycle through such project activities as trainings. Thus, it could be said that Output-1 was sufficiently achieved.
	1-2. A manual for the evaluation of condition deterioration of bridges is developed by June 2015.		
	1-3. A guideline for selection of bridge rehabilitation/retrofitting measures of bridge is developed by June 2015.		
	1-4. All the trained staff members for planning of bridge maintenance including inspection, evaluation, priority assessment etc. pass the final exam.		
Output-2: Database system to record information of bridge is developed in nation-wide and UBC.	2-1. A database system with necessary information for maintenance planning of bridges is developed by December 2014.	Development of the database system with information on results of bridge inspection and soundness evaluation was completed in December 2014.	Judging from the achievement levels on the indicators, it could be said that sufficient level of Output-2 was achieved.
	2-2. A manual for data input is developed by December 2014.	"Administration Manual" and "Operational Manual" (draft) were already prepared in Dec. 2014. They will be modified and finalized by	

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<b>Outputs</b>	<b>Verification Indicators</b>	<b>Achievements</b>	<b>Evaluation</b>
		May 2015 in accordance with requests from MTs.	
	2-3. Data on bridge database system is updated appropriately.	Data on 68 MRT bridges and 70 UBC bridges were updated in the database system.	
	2-4. Four (4) master trainers for data collection and input are trained and certified by June 2015.	2 MTs for MRT and 2 MTs for UBC will be certified by May 2015.	
	2-5. All of the master trainers hold at least three (3) workshops on data collection and input for their responsible sections.	<ul style="list-style-type: none"> <li>• Follow-up workshop on database system was held in February 2015 with MTs as presenters.</li> <li>• On the 17th day of March 2015, in-house seminars including topic of database system were conducted respectively for MRT and UBC.</li> <li>• Seminar for engineers including topic of database system is planned to be held in May 2015.</li> </ul>	
Output-3: National policy on maintenance and management are developed.	3-1. Bridge Maintenance Policy is developed by September 2014.	<ul style="list-style-type: none"> <li>• Mid/Long-term bridge maintenance and management plan with implementation plan and budget allocation was drafted in September 2014.</li> <li>• Finalized plan was submitted to MRT and UBC in March 2015 for their approval. Discussion between the JICA Expert Team and MRT/UBC on how this plan should be positioned in MRT/UBC will be continued.</li> </ul>	Since Mid/Long-term Bridge Maintenance and Management Plan with implementation plan and budget allocation was prepared and necessary structure for bridge management would be proposed by the end of the Project, the Output 3 is expected to be achieved.
	3-2. A bridge maintenance plan of Mongolia with annual budget and implementation schedule is prepared by September 2014.		
	3-3. A bridge maintenance plan of UBC with annual budget and implementation schedule is prepared by September 2014.		
	3-4. Necessary organization structure and/or personnel for bridge maintenance are proposed by December 2014.	As for MRT, structure with clarifying roles of MRT HQ, RTDC (former RSRC), and local road management companies will be proposed. As for UBC, structure with clarifying functions, roles and responsibilities among divisions of ROD would be proposed.	
Output-4: Staff members related to bridge / structure maintenance and management in MRT and UBC are trained, and trainings are	4-1. A training manuals and materials for general bridge technologies and bridge maintenance technologies are developed by February 2014.	Bridge maintenance and management training manual and training materials (manuals on inspection, soundness evaluation, selection of measures of rehabilitation, data inputs and operation) were developed.	Training manual and materials were prepared and MTs were trained; that is, the basis for the Mongolian side to implement trainings has been established. In addition, trainings with MTs as lecturers were
	4-2. Four (4) master trainers for bridge inspection are trained and	2 MTs for MRT and 2 MTs for UBC 1 would be certified by May 2015.	

<b>Outputs</b>	<b>Verification Indicators</b>	<b>Achievements</b>	<b>Evaluation</b>
conducted by Mongolian Side	certified by June 2015.		conducted. Thus, it could be said that Output 4 has been achieved. Further enhancement of MTs' capacity and strengthening of structure for implementing trainings are expected to be attained by conducting further trainings and seminars with the initiative of the Mongolian side by the end of the Project.
	4-3. Four (4) master trainers for the condition / deterioration evaluation of bridges are trained and certified by June 2015.	2 MTs for MRT and 2 MTs for UBC would be certified by May 2015.	
	4-4. Four (4) master trainers for the measures of rehabilitation/ retrofitting of bridges are trained and certified by June 2015.	2 MTs (or MRT and 2 MTs for UBC would be certified by June 2015. They participated in the pilot bridge rehabilitation work conducted by UBC.	
	4-5. All the master trainers hold at least two (2) workshop(s) on bridge inspection for their responsible sections.	<ul style="list-style-type: none"> <li>• Follow-up workshop on bridge inspection was held in February 2015 with MTs as presenters.</li> <li>• On the 17th day of March 2015, in-house seminars including topic of bridge inspection were conducted respectively for MRT and UBC.</li> <li>• Seminar for engineers including topic on bridge inspection was held in May 2015.</li> </ul>	
	4-6. All the master trainers hold at least two (2) workshop(s) on the condition / deterioration evaluation of bridges for their responsible sections.	<ul style="list-style-type: none"> <li>• Follow-up workshop on evaluation was held in February 2015 with MTs as presenters.</li> <li>• On the 17th day of March 2015, in-house seminars including topic on evaluation were conducted for MRT and UBC respectively.</li> <li>• Seminar for engineers including topic on evaluation was held in May 2015.</li> </ul>	
	4-7. All the master trainers hold at least two (2) workshop(s) on the measures of rehabilitation / retrofitting of bridges for their responsible sections.	<ul style="list-style-type: none"> <li>• Follow-up workshop on rehabilitation measures was held in February 2015 with MTs as presenters.</li> <li>• On the 17<sup>th</sup> day of March 2015, in-house seminars including topic on rehabilitation measures were conducted for MRT and UBC respectively.</li> <li>• Seminar for engineers including topic on rehabilitation measures was held in May 2015.</li> </ul>	

### **4.3 Measures Taken on the Recommendations of the Terminal Evaluation**

The JICA Expert Team and the Mongolian C/Ps have taken four (4) measures in accordance with the recommendations of the Terminal Evaluation, to enhance the achievement of the Project Purpose, to achieve the Overall Goal and to ensure sustainability of the Project, as shown in the following table.

**Table4.3.1 Measures Taken by the Project for the Recommendation of the Terminal Evaluation**

Recommendations	Objectives/Details	Measures taken by the Project
<p><b>(1) Dissemination of significance of bridge maintenance and management</b></p> <p>In order to consolidate awareness on the significance of bridge maintenance and management and to disseminate this awareness to other related organizations and persons, the tree (3) activities should be steadily conducted:</p>	<p>To facilitate the utilization of manuals as the outcome of the Project through distribution, uploading to MRT website, and so forth.</p>	<p>A new page on Bridge Maintenance Management was launched in the MRT website to introduce a part of the Bridge Database that discloses information.</p>
	<p>To steadily implement planned seminars for engineers and the public on bridge maintenance and management.</p>	<p>Engineers' Seminar and Public Seminar were successfully held respectively by C/Ps with assistance from the JICA Expert Team.</p>
	<p>To actively transit information on contents of the Project activities and significance of bridge maintenance and management to several media such as technical journals.</p>	<p>Engineers' Seminar and Public Seminar were introduced in the website of related organization and broadcasted in TV respectively.</p>
<p><b>(2) Strengthening of capacity of MTs</b></p> <p>Capacity of MTs should be further enhanced through steady implementation of planned seminars on bridge maintenance and management with initiatives of the Mongolian side. The JICA Expert Team should offer necessary assistance for their implementation.</p>		<p>MTs took the initiative to present the Bridge Management Cycle to the engineers and the public in the seminars.</p> <p>These activities firmly established the understanding of MTs on the technology trained by the JICA Expert Team and strengthened the capacity of MTs to conducting trainings for other personnel concerned at the same time.</p>
<p><b>(3) Implementation of pilot bridge rehabilitation works</b></p> <p>It is important to steadily implement pilot bridge rehabilitation works in terms of establishing knowledge/skills so far transferred to CIP organizations through project activities and of introducing new technologies. Although the client for these works is UBC, concerned MRT C/Ps should be involved with related activities and the JICA Expert Team should offer necessary assistance for their implementation.</p>		<p>Pilot implementation of Bridge Rehabilitation Work was conducted and MTs of MRT and UBC were subjectively involved in the pilot implementation. New technologies in bridge rehabilitation and retrofitting proposed by the Project were introduced to several C/Ps and engineers through the Site Seminar during the pilot implementation activities.</p>
<p><b>(4) Discussion and agreement on system for ensuring sustainability</b></p> <p>Both parties should discuss and agree on the system for sustaining and developing the outputs by the Project in consideration with the following points:</p>	<p>How to authorize and utilize Mid/Long-term Bridge Maintenance and Management Plan in accordance with current financial situation.</p>	<p>MRT and UBC confirmed through the JCC Meeting that yearly budget for bridge maintenance would be requested based on the Long-Mid Term Bridge Maintenance and Management Program developed by the Project.</p>
	<p>Roles, functions and responsibilities among concerned divisions of MRT and UBC in collaboration with private organizations such as Mongolian Road Association.</p>	<p>Roles and responsibilities were clarified in the Progress Report and agreed upon the C/Ps and the JICA Expert Team.</p>
	<p>Periodical update of database and preparation and update of budget and implementation plans on bridge maintenance and management.</p> <p>Introduction of qualification system for engineers on bridge maintenance and management, measures of ensuring necessary personnel, and technology transfer within organizations.</p>	<p>Updating of Bridge Database, review of Long-Mid Term Bridge Maintenance and Management Program and continuous capacity development of bridge engineers were recommended in the 3<sup>rd</sup> JCC meeting and recorded on the Minutes of Meeting.</p>

## **4.4 Achievement of Project Purpose**

Based on the results of the Terminal Evaluation and the measures taken by the Project, it could be concluded that the Project Purpose has been totally achieved. Meanwhile budgetary allocation based on the Mid-Long Term Bridge Maintenance and Management Program will be gradually achieved through long term approach towards dissemination of concept of the Bridge Management Cycle to improve public awareness on the significance of bridge maintenance in Mongolia.

### **4.4.1 Achievement of Verification Indicator**

Project Purpose : MRT's and UBC's capacity for planning skills of bridge maintenance is improved.

Verification Indicators:

- (1) Maintenance budget document with breakdowns for existing bridges is prepared by June 2015.
- (2) Implementation schedule of maintenance for existing bridges is prepared by June 2015.
- (3) Data from the newly developed database system is utilized for formulating maintenance budget and implementation schedule for existing bridges.

Achievement:

The Mid-Long Term Bridge Maintenance and Management Program including implementation plan and yearly budget allocation was drafted in September 2014 and finalized in March 2015. Though authorization of the Program has been recommended, it was agreed that the yearly budget would be requested according to the Program without its authorization since there is not such administration system to authorize the long term maintenance budget at this moment. However, it could be concluded that the Project Purpose was achieved based on the fact that the Bridge Database System developed by the Project was utilized to prepare the Program

### **4.4.2 Achievement based on Capacity Assessment**

According to the Capacity Assessment shown in Chapter 3, it was confirmed that the capacity on inspection, soundness evaluation, rehabilitation and retrofitting plan and database system had all improved compared to the condition at the beginning of the Project. Particularly, intelligibility for technical part and work procedure have much improved. Furthermore, consciousness and incentive to conduct bridge maintenance related to the core capacity have drastically improved. On the other hand, improvement of institutional and/or public awareness on the Bridge Management Cycle remained modest and shall be tackled in long term to keep the project effect in the future.



## **5. RECOMMENDATIONS FOR OVERALL GOAL**

### **5.1 Dissemination of Bridge Management Cycle (Output-1)**

#### **5.1.1 Bridge Maintenance Manuals**

The bridge maintenance manuals developed under the Project have been authorized in a Decree of the Minister of MRT for use as standard manuals for engineers belonging to road maintenance companies and consultants in Mongolia. These manual shall have to be revised or updated periodically to accord with the latest issues on new types of bridges in the future. The Mid-Long Term Bridge Maintenance and Management Program have proposed revision of these manuals after five (5) years, which would require accumulation of information by the Roads and Transport Development Center to be obtained through the bridge maintenance activities in these years.

#### **5.1.2 Establishment of Bridge Management Cycle**

The maintenance of roads and bridges in Mongolia is being undertaken based on “Corrective Maintenance” where repair of damage is made after deterioration to some extent. In contrast, the technology transfer carried out in the Project aims at the transition to “Preventive Maintenance” that would take measures earlier based on periodic inspection and efficient data management or the so called “Bridge Management Cycle”. To implement sustainable bridge maintenance and management based on the Bridge Management Cycle, it is, therefore, important to continue dissemination and awareness campaigns through periodic seminars and/or strategic training of engineers at the initiative of the Road Association in Mongolia. These long term approaches will foster the interest to prioritize the expansion of budget and staffing for the maintenance activity.

### **5.2 Bridge Management Database (Output-2)**

#### **5.2.1 Organizational Management of the Database**

Frequent personnel changes have been happening due to resignation of personnel or reorganization of MRT and UBC. In order to keep the database operational, however, it is important to impose database operation and update as daily duty, to turn over the duty to the next personnel in case of personnel change, and to keep two (2) or more personnel who are able to operate the database in MRT and UBC respectively.

#### **5.2.2 Improvement of Core Skill in Software Operation**

Microsoft Excel is applied as the basic software for the database system under the Project. This is intended to soften resistance to the database operation, and to make possible self-modification of the system as needed by means of applying common versatile software. Since MS Excel is a relatively productive tool for data analysis as well, the database operator should devote himself to train on its operation through regular duties to improve skill in software operation.

### **5.2.3 Comprehensive Data Analysis to Practical Use**

The Bridge Database has been developed for the purpose of defining the direction of bridge maintenance in Mongolia by data analysis from comprehensive viewpoints of bridge engineering. The database operator needs, not only to process the data, but to examine the data according to the actual condition of bridge and interpretation of inspection results. For practical use of the Bridge Database, it is important that the database operator should have sufficient knowledge of bridge maintenance and management technologies to perform his work.

### **5.2.4 Updating and Monitoring**

Information on local bridges obtained from local road maintenance companies shall be collected and processed by staff members of the MRT Head Office. The data transfer system shall work smoothly and securely; otherwise, the Bridge Database System will be useless and lose substance in the future. Thus updating of the Bridge Database should be systematically monitored and verified periodically. A part of database information such as inventory data and soundness evaluation is being currently disclosed to the public at the website of MRT, so that it will be possible to monitor the situation of data updating through the website.

### **5.2.5 Bridge Inspection and Soundness Evaluation**

#### **(1) Training and Certification of MT**

MRT and UBC need to keep assigning a number of MTs to continuously train the staff of each office. MTs certified by the Project shall train and certify the next MT to keep the training system for inspection and soundness evaluation formulated by the Project.

#### **(2) Bridge Inspection System in MRT**

Road maintenance companies, who are responsible for road maintenance of each Aimag, are going to carry out the inspection and soundness evaluation for bridges of MRT. Therefore, qualified engineers of the road maintenance company, who will be trained through periodic workshops/seminars held by MTs, shall be systematically responsible for the bridge inspection and soundness evaluation for MRT. MTs of MRT and the Roads Transport Development Center shall keep their capability to review and verify the data collected by the engineers of the road maintenance company.

#### **(3) Noteworthy Bridge Damage Type**

The noteworthy bridge damage in Mongolia is fatigue failure at the end of concrete girders with no diaphragm installed. In case symptom of fatigue failure is confirmed, urgent measures such as replacement of bearings and installation of diaphragms shall be conducted together with emergency repair work. In this regard, damage at the end of girders has to be carefully detected at the time of bridge inspection. It should be noted during the bridge inspection that heavy traffic with overloaded vehicles will exert a considerable effect on fatigue failure.

## **5.3 Bridge Maintenance Policy (Output-3)**

### **5.3.1 Authorization of the Mid-Long Term Bridge Maintenance and Management Program**

The Middle Term (2015~2020) implementation plan for bridge maintenance and the Long Term (2015~2030) bridge maintenance policy and objective to be addressed were proposed in the Project. However, there is no such administrative system to authorize the long term plan for budgetary allocation in Mongolia. Thus stable budget to implement the Bridge Management Cycle introduced by the Project has not been guaranteed yet. It is, therefore, very important to establish such administrative system to authorize the mid-long term plan, in parallel with ensuring stable budget for maintenance such as effective use of road fund through amendment of the Road Law which is currently ongoing.

### **5.3.2 Revision of the Mid-Long Term Bridge Maintenance and Management Program**

The Mid-Long Term Bridge Maintenance and Management Program was developed with assumption of update in 5-year intervals. In line with the above assumption, MRT is to conduct nationwide bridge inspection survey to correct 433-bridge conditions by 2017 and the Program is going to be reviewed based on the inspection data. In case dedicated bridge rehabilitation work could not be implemented due to budgetary constraint, measures which shall not leave dangerous bridges as they are shall be taken through revision of the Program. At the same time, recording of every rehabilitation work in the Bridge Database, monitoring of the progress in the Program and revision of the Program as needed shall be systematically performed by MRT and UBC.

### **5.3.3 Gradual Expansion of Maintenance Budget**

Gradual expansion of the bridge maintenance budget is essential to implement the Mid-Long Term Bridge Maintenance and Management Program proposed by the Project. It is supposed to be difficult to expand the budget under the situation that every budget has been constrained due to economic downturn in Mongolia, although the existing budget scale cannot suffice for the cost of bridge maintenance to keep traffic safety. In order to improve such situation and assure budget expansion, review of budgetary allocation among new construction and maintenance of existing bridges, and cost saving with its rationalization shall be addressed by MRT and UBC through organizational awareness about the significance of bridge maintenance and its cost.

### **5.3.4 Implementation of Priority Measures**

Following four (4) priority measures are proposed in the Mid-Long Term Bridge Maintenance and Management Program to be implemented in parallel with the rehabilitation work. Items i) to iii) are the most important measures to help minimize the maintenance cost by eliminating fundamental issues on bridge deterioration. Item iv) for human resource development shall focus on not only capacity development for maintenance engineers, but for all bridge engineers in Mongolia including improvement of academic education for bridge engineers:

- i) Improvement of quality of bridge design
- ii) Improvement of quality of bridge construction
- iii) Enforcement of control on overloaded vehicles
- iv) Human resource development for bridge engineers

### **5.3.5 Review of Maintenance Level and Performance Level**

The maintenance and performance level of bridges proposed by the Project are based on technical, financial and institutional considerations to assure minimum requirement of traffic safety in Mongolia. In accordance with the expansion of economic scale and improvement of engineering technology in Mongolia in the future, more advanced bridge maintenance will be required. To accommodate such situation, the enlargement of budget for maintenance and training of engineers will be a further important issue.

At the time of revision of the Program in 2020, new maintenance and performance level shall be proposed in accordance with the change of situation in Mongolia. Advanced bridge maintenance level can be achieved by means of transition to “Preventive Maintenance”; however, tremendous data such as characteristics of material deterioration and aging in Mongolia need to be accumulated and strategic investment for research on this field shall be implemented with the initiative of MRT.

## **5.4 Training for Bridge Maintenance (Output-4)**

The Project had enhanced the effect of training and ownership building by adopting the Master Trainer (MT) System that MTs of MRT and UBC trained by the JICA Expert Team disseminates knowledge to other staff members in the same division and/or related divisions. Since sound technology transfer within an organization as introduced by the Project has not been implemented before the Project in Mongolia, work performance of the organization has depended in large part on the personal capacity of individual staff in MRT and UBC. It is expected after the Project that technology transfer in the organization can be smoothly implemented through strategic training by MTs using the training and maintenance manuals developed by the Project. It is essential for implementation of the Bridge Management Cycle to ensure improvement of the organization related to bridge maintenance by the training together with comprehensive enhancement of bridge engineering capacity in Mongolia through the establishment of a qualification system for bridge maintenance and the improvement of academic education on bridge engineering.

## **5.5 Others**

Several issues on organization and administration system in MRT and UBC to achieve the Overall Goal have been revealed through activities of the Project. Following are the priority measures to be addressed by MRT and UBC.

**(1) Quality Management for Bridge Construction**

According to the bridge inspection and soundness evaluation by the Project, many deteriorations and damages due to defects in quality management of design and construction of bridges have been observed. Although a part of defects on design and construction of bridges have been improved under foreign-financed projects, these issues have not been sufficiently shared with engineers in Mongolia. It will be difficult for MRT and UBC to drastically increase the total number of engineers in their offices since the number of structure engineers is quite limited under the condition of small population as a characteristic of Mongolia. Establishment of quality management system for design and construction by small staff is essential for Mongolia to improve the current situation by executing the following measures:

- i) Development of Standard Bridge Design in Mongolia.
- ii) Development of Standard Design Drawings for typical bridges and specifications of the design and construction.
- iii) Development of Standard BOQ (Bill of Quantities) for typical bridges
- iv) Development of Standards for Construction Quality Control

**(2) Establishment of Engineering Qualification System for Bridge Maintenance**

Although the qualification system for road and bridge engineers has been established in Mongolia, the bridge maintenance engineers have not been cultivated since no effective training system on bridge maintenance has been developed. Since it is important for bridge engineers in Mongolia to reinforce their incentive for sustainable development in bridge maintenance technology such as inspection, soundness evaluation and rehabilitation plan, the establishment of qualification system for bridge maintenance can be one of the solutions. Since the “Road Association in Mongolia” has governed the qualification and training system for road and bridge engineers, it will be possible to establish a qualification and training system for bridge maintenance in collaboration with the Road Association for sustainable cultivation of bridge maintenance engineers.

**(3) Smooth Execution of Budget for Bridge Maintenance**

Approval of yearly budget to be fixed in December is likely to be delayed in the next year. While procurement of maintenance work is started in May or June due to the long process of planning and cost estimation, it is observed that site work which is limited to performance in spring and summer (from April to August) due to constraints of natural condition, could not be performed sufficiently due to the short construction period. Consequently, it is possible that such administrative management is one of the reasons for the drop of quality in construction works.

On the other hand, the required budget and priority of rehabilitation work in the Mid-Long Term Bridge Maintenance Program formulated by the Project have already been proposed. Therefore, MRT and UBC are strongly recommended to early establish the budget execution system to secure a

sufficient contract period for rehabilitation and retrofitting work by using the Program for budgeting and procurement process.

**(4) Control of Overloaded Vehicles**

Freight trucks passing in Mongolia have increased in number and size as economic development in recent years. Large dump trucks are also increasing due to the booming mining development, so that enforcement of overloaded vehicle control is an urgent issue to be addressed by the Government of Mongolia. The increasing axle load of vehicles will adversely affect bridge structures, and substantial increase in bridge maintenance cost is possible due to rapid development of damage and/or deterioration of bridges (particularly, substandard bridges) in case strict control of overloaded vehicles will not be enforced. Thus, enhancement of overloaded vehicle control through legislation is urgently necessary for Mongolia.

## **6. LESSONS LEARNED FROM THE PROJECT**

### **6.1 Approaches to Identified Issues on the Project**

#### **6.1.1 Capacity of C/P's in Bridge Engineering**

Among the road administrators and private companies in Mongolia, there are few experts versed in bridge engineering, particularly, those equipped with the basic knowledge of maintenance of bridges. It is, therefore, expected that bridge maintenance systems developed in foreign countries would hardly be sustainable in Mongolia.

Taking account of this situation, the JICA Expert Team had implemented the Project with the following considerations:

- Basics bridge engineering are incorporated as a part of the training provided by the JICA Expert Team to facilitate MT's understanding of bridge structural components requiring maintenance.
- In order to facilitate the C/P's understanding, many exercise lessons are introduced into the on-the-job training (OJT), so that practical work processes of bridge maintenance are experienced by the MTs.
- Bridge structures are simply illustrated in the manuals prepared under the Project to facilitate the understanding of an unskilled engineer.
- Human resource development for bridge engineers is proposed in the Mid-Long Term Bridge Maintenance and Management Program.
- Bridge experts in Mongolia except the C/P are involved in developing the bridge maintenance manuals to make them technically accurate and consistent with the existing Mongolian standards.

#### **6.1.2 Consideration to Severe Natural Environment**

Field work such as bridge inspection is limited to the period from April to October because ambient temperature in midwinter reaches up to minus 40°C in Mongolia. Consequently, major construction works are concentrated in the April to October season, and staff members of MRT and UBC related to road construction and maintenance are tied up in the construction work. In keeping with this circumstance, the mechanism of bridge maintenance management work needs to be effective to save time. The following considerations were thus taken by the JICA Expert Team:

- Bridge Inspection Sheet is simplified as much as possible to collect basic data on bridge condition. In addition, frequency of periodic bridge inspection is stipulated in the Manual for Bridge Inspection to carry out in every 5 years, in principle, to reduce the work load of maintenance staff, since deterioration speed is very slow due to less precipitation in Mongolia.
- Data input for the Bridge Database System is simplified by developing the automatic data transfer function from bridge inspection sheet.

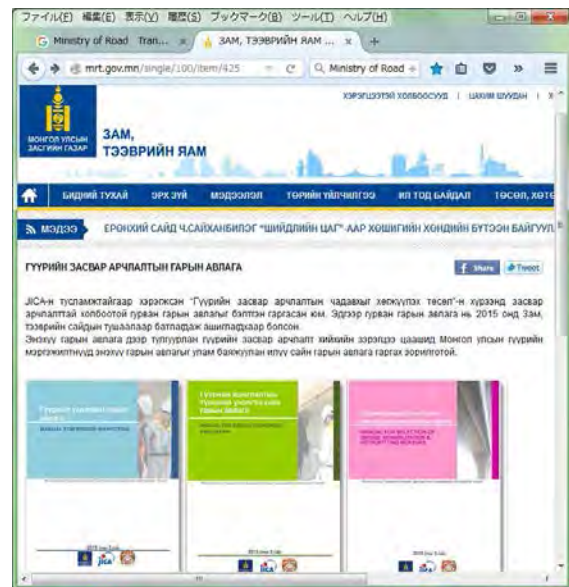
### 6.1.3 Lessons from Past Project

The following issues were recognized in the technical cooperation project for road sector implemented by another donor:

- Since the manuals prepared under the technical cooperation project were not officially authorized, they have not been efficiently utilized or properly filed after completion of the technical cooperation project.
- Though off-the-shelf advanced software for database was provided, complexity of its operation and hard work for data input are impeditive for sustainable utilization.
- Since consistency with the Bridge Management Cycle is not assured in the manuals and database, the output of the technical cooperation project was not linked to practical maintenance operation.

Taking account of the above issues and lessons, the following considerations were given to the implementation of the Project:

- Bridge maintenance manuals developed under the Project were authorized as the Manuals in Mongolia through official procedure in MRT. Copies of the manuals were distributed to the engineers who participated in the seminars. Downloading of its soft copies from the Website of MRT has enabled wider dissemination of the manuals.
- Bridge Database System consists of versatile software such as Microsoft Excel and Google map to enhance the user-friendliness in operation. In addition, operation manuals in Mongolian language and video-manuals were created by the C/Ps to ensure the sustainable operation in Mongolia after the Project.
- Bridge maintenance manuals were developed to be utilized in conjunction with the Bridge Database System to establish the Bridge Management Cycle compatible with the existing organization and capability of MRT and UBC.



(<http://mrt.gov.mn/single/100/item/425>)

**Figure 6.1.1 Home Page of MRT  
(Download Site of Manuals)**

### 6.1.4 Demonstration of Practical Operation

In Mongolia, elemental technology such as bridge inspection, rehabilitation work and database development had been introduced and operated before the Project. However, these technologies have not led to efficient bridge maintenance cycle of inspection, planning and implementation since these elemental technologies have been intermediately operated without collaboration. Furthermore, a part of rehabilitation and retrofitting measures proposed by the manuals developed in the Project



have not been experienced in Mongolia which would make the construction phase difficult. To improve this situation, technical assistance for actual rehabilitation and retrofitting work as a pilot project financed by UBC was supplemented in the Project to confirm the feasibility of the Bridge Management Cycle proposed by the Project.

Following outputs were confirmed by the pilot implementation of rehabilitation and retrofitting work and were shared with C/Ps:

- Inspection results, selection of rehabilitation and retrofitting measures, procurement and construction work were practiced as a series of operation by C/P, which was the training for implementation of the Bridge Management Cycle proposed by the Project.
- The pilot implementation demonstrated that section repair by polymer cement and retrofitting by CFRP (Carbon Fiber Reinforced Plastic) would be feasible in Mongolia.

## **6.2 Lessons Learned**

The Joint Terminal Evaluation Team has suggested the following lessons for similar projects in future in its evaluation report.

### **6.2.1 Establishment of the System in addition to Capacity Enhancement of Individual C/Ps**

In this Project, frequent resignation and transfer of C/Ps occurred due to the restructuring of MRT, which have negatively affected implementation of project activities. For countries where change of government heavily affects the personnel system of administrative organizations, it is important to establish the system which could be dealt with by new staff through such preparation of manuals, database system and bridge maintenance and management plans as done by this Project, in addition to capacity strengthening of individual C/P.

### **6.2.2 Sustainable Utilization and Dissemination of Outcomes**

In JICA technical cooperation projects, such case is often observed that outcomes of the project such as manuals and plans were not officially approved by the government of counterpart country, which affected utilization and dissemination of these outcomes. In this Project, by setting a goal of obtaining official approvals on the manuals as the Project outcomes before their dissemination and having close collaboration with C/P organizations on this matter, these manuals were approved by the Minister of MRT. It could be thought that these approvals would positively affect utilization and dissemination of these manuals. Thus, it is required to discuss measures for sustainable utilization and dissemination of the project outcomes including their formal approvals at the project planning stage.

### **6.2.3 Linkage to Regular Duties of C/P Organizations**

In JICA technical cooperation projects, the means of integrating outputs and results of the projects into the regular duties of C/P organizations is a key issue. In this Project, the activities correspond to

regular duties and needs of concerned departments of MRT and UBC, and their officers whose regular duties are in accordance with the Project activities were appointed as C/Ps, which have led to efficiency. For technical cooperation projects, their activities should be designed in full consideration of C/Ps' regular responsibilities and duties.

# **APPENDICES**



**Appendix-1 Project Design Matrix (PDM)**



**LOGICAL FRAMEWORK (PROJECT DESIGN MATRIX: PDM)**

Version 4 (March, 2015)

Project Title: Technical Cooperation Project for Capacity Development on Bridge Maintenance and Management in Mongolia

Period: August 2013- October 2015, 27 months

Implementation Organizations: Ministry of Roads and Transportation (MRT), Ulaanbaatar City Government (UBC)

Project Sites: MRT's Headquarters, Ulaanbaatar city government

Target Groups : Road Utilization and Maintenance Division, Road Policy Implementation and Cooperation Department in MRT, Road Supervision and Research Center in MRT  
: Planning and Research Div, Operation and Maintenance Division in Road Department of UBC

I-11

<b>Project Summary</b>	<b>Objectively Verifiable Indicators</b>	<b>Means of Verification</b>	<b>Important Assumptions</b>
<p><b>Overall Goal</b> Maintenance status of bridges is improved in Mongolia.</p>	<p>The percentage of defective bridges repaired increases by 30% in comparison with the equivalent percentage from 2013.</p>		
<p><b>Project Purpose</b> MRT's and UBC's capacity for planning skills of bridge maintenance is improved.</p>	<p>1. Maintenance budget document with breakdowns for existing bridges is prepared by [June, 2015] 2. Implementation schedule of maintenance for existing Bridge is prepared by [June, 2015] 3. Data from the newly developed database system is utilized for formulating maintenance budget and implementation schedule for existing bridges.</p>	<p>1. Maintenance budget document for existing bridges 2. Implementation schedule for maintenance of existing bridges 3. Analysis of the quality of data from the newly developed database system</p>	<ul style="list-style-type: none"> <li>• Bridge maintenance budget does not decrease dramatically.</li> <li>• The Government of Mongolia secure necessary budget and personnel to continue activities.</li> <li>• A drastic natural disaster with the high risk of damages on bridges does not occur in existing bridge sites.</li> </ul>
<p><b>Outputs</b> 1. Concept of "Bridges management cycle" is widely understood , and guidelines and/or manuals regarding inspection, evaluation, priority assessment and selection of measures are developed.  2. Database system to record information of bridge is developed in nation-wide and UBC.</p>	<p>1-1. A manual for bridge inspection is developed by [June, 2015] 1-2. A manual for the evaluation manual for condition deterioration of bridges is developed by [June, 2015] 1-3. A guideline for selection of bridge rehabilitation / retrofitting measures of bridge by [June, 2015] 1-4. All the trained staff members for planning of bridge maintenance including inspection, evaluation, priority assessment etc. pass the final exam.  2-1. A database system with necessary information for maintenance planning of bridges is developed by [December, 2014] 2-2. A manual for data input is developed by [December, 2014]</p>	<p>1-1. Manual for bridge inspection 1-2. Manual for the condition/ deterioration evaluation of bridges 1-3. Guideline for selection of bridge rehabilitation retrofitting measures 1-4. Project Report  2-1. Database system 2-2. Manual for data input of database system 2-3. Record of Data update on bridge database system</p>	

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p>3. National policy on maintenance and management are developed.</p>	<p>2-3. Data on bridge database system is updated appropriately</p> <p>2-4. Four (4) master trainers for data collection and input are trained and certified by [June, 2015]</p> <p>2-5. All the master trainers hold at least three (3) workshop(s) on data collection and input for their responsible sections.</p> <p>3-1. Bridge Maintenance Policy is developed by [September, 2014]</p> <p>3-2. A bridge maintenance plan of Mongolia with annual budget and implementation schedule is prepared by [September, 2014]</p> <p>3-3. A bridge maintenance plan of UBC with annual budget and implementation schedule is prepared by [September, 2014]</p> <p>3-4. Necessary organization structure and/or personnel for bridge maintenance are proposed by [December, 2014]</p>	<p>2-4. Project report, master trainers report</p> <p>2-5. Project Report, training report</p> <p>3-1. Bridge Maintenance Policy</p> <p>3-2. Bridge Maintenance Plan in Mongolia</p> <p>3-3. Bridge Maintenance Plan in UB city</p> <p>3-4. Project reports</p>	
<p>4. Staff members related to bridge / structure maintenance and management in MRT and UBC are trained, and trainings are conducted by Mongolian Side</p>	<p>4-1. A training manuals and materials for general bridge technologies and bridge maintenance technologies are developed by [February, 2014]</p> <p>4-2. Four (4) master trainers for bridge inspection are trained and certified by [June, 2015]</p> <p>4-3. Four (4) master trainers for the condition / deterioration evaluation of bridges are trained and certified by [June, 2015]</p> <p>4-4. Four (4) master trainers for the measures of rehabilitation / retrofitting of bridges are trained and certified by [June, 2015]</p> <p>4-5. All the master trainers hold at least two (2) workshop(s) on bridge inspection for their responsible sections.</p> <p>4-6. All the master trainers hold at least two (2) workshop(s) on the condition / deterioration evaluation of bridges for their responsible sections.</p>	<p>4-1. Training manuals and materials</p> <p>4-2. Project Report, training report</p> <p>4-3. Project Report, training report</p> <p>4-4. Project Report, training report</p> <p>4-5. Project Report, master trainers' report</p> <p>4-6. Project Report, master trainers' report</p> <p>4-7. Project Report, master trainers' report</p>	



Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
	4-7. All the master trainers hold at least two (2) workshop(s) on the measures of rehabilitation / retrofitting of bridges for their responsible sections.		
<p><b>Activities</b></p> <p>1-1. To draft, review and finalize a bridge inspection manual.</p> <p>1-2. To draft, review and finalize an evaluation manual for condition / deterioration of bridges.</p> <p>1-3. To draft, review and finalize a guideline for selection of bridge rehabilitation / retrofitting measures.</p> <p>1-4. To conduct trainings / seminars on the concept of "Bridge management cycle".</p> <p>2-1. To collect information and/or documents related to existing bridges.</p> <p>2-2. To collect information on the condition of existing bridges through site survey and to developed existing bridge inventories.</p> <p>2-3. To inspect existing bridges.</p> <p>2-4. To evaluate condition / deterioration of existing bridges.</p> <p>2-5. To propose rehabilitation / retrofitting measures of existing bridges.</p> <p>2-6. To develop bridge database systems including inventory, design report / drawings, results and history of inspection etc. of existing bridges.</p> <p>2-7. To establish the procedure and to develop manuals for input, reporting and update of bridge database system.</p> <p>3-1. To collect information and data on the existing bridge management system, budget, laws/regulations, policy and standard.</p> <p>3-2. To draft a bridge maintenance and management policy.</p> <p>3-3. To select necessary bridge maintenance works in accordance with the draft bridge maintenance and management policy.</p> <p>3-4. To prioritize the selected bridge maintenance works.</p> <p>3-5. To confirm total bridge maintenance work of the nation and to evaluate overall condition of existing bridges.</p>	<p><b>Inputs</b></p> <p><u>Japanese side</u></p> <p>1. Experts</p> <p>1) Bridge Operation and Maintenance Adviser</p> <p>2) Bridge Expert / Capacity Development</p> <p>3) Bridge Inspection</p> <p>4) Bridge Rehabilitation</p> <p>5) Bridge Database System</p> <p>6) Cost Estimator</p> <p>7) Construction for Bridge Rehabilitation</p> <p>8) Interpreters</p> <p>2. Equipment</p> <p>1) Computers for database</p> <p>2) Non-destructive testing equipment</p> <p>3) Concrete Core drilling equipment</p> <p>4) Crack Scales</p> <p>5) Test Hammers</p> <p>6) Bridge Inspection Camera</p> <p>3. Trainings In Japan</p> <p>4. Expenses</p> <p>1) Expenses on expert activities</p> <p>2) Expenses on holding training course in Mongolia</p> <p>3) Other expenses needed for the Project implementation</p> <p>(Input other than indicated here will be determined through mutual consultation between MRT, UBC and JICA during the implementation of the Project, as necessary.)</p>	<p><b>Inputs</b></p> <p><u>Mongolian side</u></p> <p>1. Personnel</p> <p>1) Project Director</p> <p>2) Project Managers</p> <p>3) Counterpart staffs of MRT</p> <p>4) Counterpart staffs of UBC</p> <p>5) Other staffs</p> <p>2. Facility and Equipment</p> <p>1) Office Space for Bridge O/M Adviser in MRT</p> <p>2) Office Space for PIU in UBC</p> <p>3) Basic Utilities (electricity, telephone line etc.)</p> <p>3. Expenses for activities</p> <p>1) Domestic Expenses for participants to attend on-the-job trainings, seminars or training courses conducted in Mongolia</p> <p>2) Other expenses for the Project management and implementation</p>	<ul style="list-style-type: none"> <li>• MRT and UBC coordinate the project activities of other donors and JICA properly</li> <li>• Trained counterparts do not resign, or are transferred, too frequently.</li> <li>• Mongolian side provides appropriate financial and personnel allocation for the Project.</li> <li>• Mongolia and other neighboring countries do not fall into conflict or turmoil due to social, economic, political reasons or famine.</li> </ul> <p><b>Preconditions</b></p> <ul style="list-style-type: none"> <li>• No significant changes are made in policies related to transportation infrastructure development.</li> </ul>

Project Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
<p>3-6. To develop an implementation schedule and to estimate a cost necessary for the bridge maintenance including the discussion with relevant organizations / agencies.</p> <p>3-7. To develop a bridge maintenance and management program (long term and/or middle term).</p> <p>3-8. To decide a bridge maintenance and management level and/or performance requirements.</p> <p>3-9. To propose necessary bridge maintenance and management structure (organization, personnel etc.).</p> <p>4-1. To conduct surveys to confirm the capacity of organizations / officers in MRT and UBC related to bridge / structure maintenance and management.</p> <p>4-2. To develop a training program for bridge / structure engineers.</p> <p>4-3. To prepare training manuals and materials for capacity development of bridge engineers.</p> <p>4-4. To conduct on-the-job trainings, seminars and/or trainings for the bridge maintenance and management technologies including inspection condition / deterioration evaluation and rehabilitation / retrofitting measures.</p> <p>4-5. To propose the training system and plan for capacity development of officers related to bridge maintenance and management by Mongolian side.</p> <p>4-6. To implement the training for officers related to bridge maintenance and management by Mongolian side.</p> <p>4-7. To assist preparation, coordination and implementation of actual bridge rehabilitation works to be done by Mongolian side at its own budget</p>			

Revision of the PDM

	Before Revision	After Revision	Reason of the Revision
<b>Target Groups:</b>	<ul style="list-style-type: none"> <li>• Road Utilization and Maintenance Division, Road Policy Implementation and Cooperation Department in MRT,</li> <li>• Operation and Maintenance Division in Road Department of UBC</li> </ul>	<ul style="list-style-type: none"> <li>• Road Utilization and Maintenance Division, Road Policy Implementation and Cooperation Department in MRT,</li> <li>• <b>Road Supervision and Research Center in MRT</b></li> <li>• Operation and Maintenance Division in Road Department of UBC</li> <li>• <b>Planning and Research Div, Division in Road Department of UBC</b></li> </ul>	<ul style="list-style-type: none"> <li>• Road Supervision and Research Center in MRT: This section has been in charge of activity in bridge inspection and database management for MRT.</li> <li>• Planning and Research Div, Division in Road Department of UBC: This section has been in charge of database management in Road Department of UBC.</li> </ul>
<b>Output</b>	<p>3. National policy on maintenance and management are developed</p> <p>3-1. Bridge Maintenance Policy is developed by [December, 2014]</p> <p>3-2. A bridge maintenance plan of Mongolia with annual budget and implementation schedule is prepared by [June, 2015]</p> <p>3-3. A bridge maintenance plan of UBC with annual budget and implementation schedule is prepared by [June, 2015]</p>	<p>3. National policy on maintenance and management are developed</p> <p>3-1. Bridge Maintenance Policy is developed by [<b>September, 2014</b>]</p> <p>3-2. A bridge maintenance plan of Mongolia with annual budget and implementation schedule is prepared by [<b>September, 2014</b>]</p> <p>3-3. A bridge maintenance plan of UBC with annual budget and implementation schedule is prepared by [<b>September, 2014</b>]</p>	<p>Responding to request from Mongolian side, draft of the Bridge Maintenance Plan was to be submitted by September 2014 to allocate the bridge maintenance budget in 2015.</p>
<b>Activities</b>	<p>4-1. To conduct surveys to confirm the capacity of organizations / officers in MRT and UBC related to bridge / structure maintenance and management.</p> <p>4-2. To develop a training program for bridge / structure engineers.</p> <p>4-3. To prepare training manuals and materials for capacity development of bridge engineers.</p> <p>4-4. To conduct on-the-job trainings, seminars and/or trainings for the bridge maintenance and management technologies including inspection condition / deterioration evaluation and rehabilitation / retrofitting measures.</p> <p>4-5. To propose the training system and plan for capacity development of officers related to bridge maintenance and management by Mongolian side.</p>	<p>4-1. To conduct surveys to confirm the capacity of organizations / officers in MRT and UBC related to bridge / structure maintenance and management.</p> <p>4-2. To develop a training program for bridge / structure engineers.</p> <p>4-3. To prepare training manuals and materials for capacity development of bridge engineers.</p> <p>4-4. To conduct on-the-job trainings, seminars and/or trainings for the bridge maintenance and management technologies including inspection condition / deterioration evaluation and rehabilitation / retrofitting measures.</p> <p>4-5. To propose the training system and plan for capacity development of officers related to bridge maintenance and management by Mongolian side.</p>	<ul style="list-style-type: none"> <li>• To assist the implementation of bridge maintenance work financed by the budget of UBC in 2015 in compliance with the manuals developed by the Project, the activity was supplemented.</li> </ul>

*Project for Capacity Development on Bridge Maintenance  
and Management in Mongolia  
Project Completion Report*

	Before Revision	After Revision	Reason of the Revision
	4-6. To implement the training for officers related to bridge maintenance and management by Mongolian side.	4-6. To implement the training for officers related to bridge maintenance and management by Mongolian side.  <b>4-7. To assist preparation, coordination and implementation of actual bridge rehabilitation works to be done by Mongolian side at its own budget</b>	
<b>Input</b> Japanese Side	1. Experts 1) Bridge Operation and Maintenance Adviser 2) Bridge Expert / Capacity Development 3) Bridge Inspection 4) Bridge Rehabilitation 5) Bridge Database System 6) Cost Estimator 7) Interpreters	1. Experts 1) Bridge Operation and Maintenance Adviser 2) Bridge Expert / Capacity Development 3) Bridge Inspection 4) Bridge Rehabilitation 5) Bridge Database System 6) Cost Estimator <b>7) Construction for Bridge Rehabilitation</b> 8) Interpreters	<ul style="list-style-type: none"> <li>To assist the implementation of the bridge maintenance, skilled expert of the construction work has to be added to transfer the technology in the site work.</li> </ul>
	2. Equipment 1) Computers for database 2) Non-destructive testing equipment 3) Concrete Core drilling equipment 4) Crack Scales 5) Test Hammers	2. Equipment 1) Computers for database 2) Non-destructive testing equipment 3) Concrete Core drilling equipment 4) Crack Scales 5) Test Hammers <b>6) Bridge Inspection Camera</b>	<ul style="list-style-type: none"> <li>Through the bridge investigation conducted in Phase 1 of the Project, it was confirmed that there were several long bridges crossing the large river. To investigate the condition of the bridges, the Bridge Inspection Camera for specialized in the bridge inspection needed to be procured.</li> </ul>

**Appendix-2 Work Breakdown Structure**



<b>Overall Goal</b>
Maintenance status of bridges is improved in Mongolia.
<b>Project Purpose</b>
MRT's and UBC's capacity for planning skills of bridge maintenance is improved.

Output-1: Concept of "Bridges management cycle" is widely understood, and guidelines and manuals regarding inspection, evaluation, priority assessment and selection of measures are developed.

1-1 To draft, review and finalize a bridge inspection manual.	1-2 To draft, review and finalize an evaluation manual for condition / deterioration of bridges.	1-3 To draft, review and finalize a guideline for selection of bridge rehabilitation / retrofitting measures.	1-4 To conduct trainings / seminars on the concept of "Bridge management cycle".
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1-1-1 To draft the bridge inspection manual.	1-2-1 To draft the evaluation manual for condition / deterioration of bridges.	1-3-1 To draft the guideline for selection of bridge rehabilitation / retrofitting measures.	1-4-1 1st Work Shop and 1st Seminar on the concept of "Bridge management cycle".
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1-1-2 To review the bridge inspection manual.	1-2-2 To review the evaluation manual for condition / deterioration of bridges.	1-3-2 To review the guideline for selection of bridge rehabilitation / retrofitting measures.	1-4-2 2nd Work Shop and 2nd Seminar on the concept of "Bridge management cycle".
--	--	--	---

1-1-3 To finalize the bridge inspection manual.	1-2-3 To finalize the evaluation manual for condition / deterioration of bridges.	1-3-3 To finalize the guideline for selection of bridge rehabilitation / retrofitting measures.	1-4-3 3rd Work Shop and 3rd Seminar on the concept of "Bridge management cycle".
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Output-3: National policy on maintenance and management are developed.

3-1 To collect information and data on the existing bridge management system, budget, laws/regulations, policy and standard.	3-2 To draft a bridge maintenance and management policy.	3-3 To select necessary bridge maintenance works in accordance with the draft bridge maintenance and management policy.	3-4 To prioritize the selected bridge maintenance works.	3-5 To confirm total bridge maintenance work of the nation and to evaluate overall condition of existing bridges.	3-6 To develop an implementation schedule and to estimate a cost necessary for the bridge maintenance including the discussion with relevant organizations / agencies.	3-7 To develop a bridge maintenance and management program (long term and/or middle term).	3-8 To decide a bridge maintenance and management level and/or performance requirements.	3-9 To propose necessary bridge maintenance and management structure (organization, personnel etc.).
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3-3-1 To select rehabilitation and/or retrofitting measures for existing bridge.
3-3-2 To estimate the required cost for the rehabilitation and/or retrofitting.

3-7-1 To develop the long term program.
3-7-2 To develop the mid term program.

Output-2: Database system to record information of bridge is developed in nation-wide and UBC.

2-1 To collect information and/or documents related to existing bridge inventories.	2-2 To collect information on the condition of existing bridges through site survey and to developed existing bridge inventories.	2-3 To inspect existing bridges.	2-4 To evaluate condition / deterioration of existing bridges.	2-5 To propose rehabilitation / retrofitting measures of existing bridges.	2-6 To develop bridge database systems including inventory, design report / drawings, results and history of inspection etc. of existing	2-7 To establish the procedure and to develop manuals for input, reporting and update of bridge database system.
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2-1-1 To collect design and/or construction document.	2-2-1 To conduct site survey for MRT bridges.	2-3-1 To conduct primary inspection for MRT bridges.	2-4-1 To evaluate condition of MRT bridges.	2-5-1 To propose the measures for MRT bridges.	2-6-1 Development the DB System	2-7-1 Workshop for the Manuals.
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2-1-2 To collect existing "Passport" data.	2-2-2 To conduct site survey for UBC bridges.	2-3-2 To review result of inspection for UBC bridges.	2-4-2 To evaluate condition of UBC bridges.	2-5-2 To propose the measures for UBC bridges.	2-6-2 Input the required data.	2-7-2 Draft, review and finalize the manuals.
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2-1-3 To collect information on existing database system.		2-3-3 To conduct secondary inspection for selected bridges.			2-6-3 Integration and visualization of the DB System	
--	--	--	--	--	---	--

Output-4: Staff members related to bridge / structure maintenance and management in MRT and UBC are trained, and trainings are conducted by Mongolian Side

4-1 To conduct surveys to confirm the capacity of organizations / officers in MRT and UBC related to bridge / structure maintenance and	4-2 To develop a training program for bridge / structure engineers.	4-3 To prepare training manuals and materials for capacity development of bridge engineers.	4-4 To conduct on-the-job trainings, seminars and/or trainings for the bridge maintenance and management technologies including inspection condition / deterioration evaluation and rehabilitation/retrofitting measures.	4-5 To propose the training system and plan for capacity development of officers related to bridge maintenance and management by Mongolian side.	4-6 To implement the training for officers related to bridge maintenance and management by Mongolian side.	4-7 To assist preparation, coordination and implementation of actual bridge rehabilitation works to be done by Mongolian side at its own budget.
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4-1-1 Baseline survey for MRT.	4-2-1 To examine existing training program in MOTC and UBC.
4-1-2 Baseline survey for UBC.	4-2-2 To assess the capacity of engineers.
	4-2-3 To prepare training program.

4-4-1 Training on bridge inspection
4-4-2 Training on deterioration evaluation.
4-4-3 Training on rehabilitation and retrofitting measures.

**Work Breakdown Structure (WBS)**





**Appendix-3 Plan of Operation (PO)**











**Appendix-4 Minutes of Meeting on JCC**





**Technical Cooperation Project for Capacity Development  
on Sustainable Bridge Maintenance and Management  
in Ulaanbaatar City, Mongolia**

**MINUTES OF MEETING  
ON  
1<sup>st</sup> JOINT COORDINATING COMMITTEE**

28 February, 2014

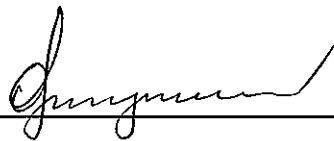
Joint Coordinating Committee (hereinafter referred to as "JCC") meeting on Technical Cooperation Project for Capacity Development on Sustainable Bridge Maintenance and Management in Ulaanbaatar City, Mongolia (hereinafter referred to as "the Project") was held on 28<sup>th</sup> February 2014 with attendance of JCC members representing the Ministry of Roads and Transportation (MRT), Ulaanbaatar City Government (UBC), Japan International Cooperation Agency (JICA), and members of the JICA Project Team to discuss schedule and progress of the Project based on Progress Report submitted by JICA Project Team in February 2014.

As a result of the discussions, the details are shown in ATTACHMENT 1, JCC members mutually accepted the Progress Report.

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**Mr. Baasandorj BATZAYA**  
Chair Person  
State Secretary  
Ministry of Roads and Transportation  
Mongolia

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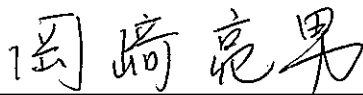
**Mr. Dookhuu NANZADDORJ**  
Director  
Ulaanbaatar City Road Department

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**Mr. Yutaka WAKISAKA**  
Representative  
Japan International Cooperation Agency  
Mongolia Office

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**Mr. Akio OKAZAKI**  
Team Leader of JICA Project Team  
Bridge Maintenance and Capacity  
Development Expert

## ATTACHMENT 1: DETAILS OF THE MEETING

### 1. The Progress Report

The Progress Report which had been submitted by JICA Project Team, and the implementation policy in Phase-2 were accepted through the JCC meeting.

### 2. Long-Mid Term Bridge Maintenance Management Plan

Draft of Long-Mid Term Bridge Maintenance Management Plan for target bridges is expected to be prepared by the end of August 2014 by Master Trainers and Counterparts of the Project with the support from JICA Project Team, since the period for approval procedure in Ministry of Finance would be needed. The detailed information regarding specific material and schedule for the process on budgetary allocation shall be specified by MRT and UBC.

### 3. Master Trainers

- (a) Counterparts of MRT and UBC to be trained by JICA Experts during Phase-2 of the Project, and to become Master Trainers who will be responsible for the training of other staff members in Phase-3 were confirmed by JCC member.
- (b) MRT and UBC shall facilitate Master Trainers to participate in the trainings of the Project in preference to their daily round.

### 4. Project Implementation Unit (PIU)

Mr. Sugarjav was officially appointed by State Secretary of MRT as the member of PIU to be in charge of project coordination with support of other MRT staff. In addition, an engineer would be scheduled to participate in PIU as supporting member. Staff of UBC will also be considered to participate in PIU through discussion with Road Department, UBC.

### 5. The Schedule of JCC Meeting

Next JCC meeting will be held in the end of Phase-2 and Phase-3 of the Project in 2014 and 2015 respectively.

### 6. Others

- (a) The manuals prepared under the Project will be approved by the Science and Technology Committee after confirmation of the contents by the counterparts.
- (b) There is no specific objection to proposed schedule for Phase-2 in 2014. Detailed training schedule will be confirmed by Mongolian side and it will be informed if the schedule needs to be changed.

**ATTACHMENT 2: LIST OF ATTENDEES**

**1. Mongolian Side**

<b>No.</b>	<b>Name</b>	<b>Organization</b>	<b>Position</b>
1	Mr. Baasandorj BATZAYA (Project Director)	Ministry of Roads and Transportation (MRT)	State Secretary
2	Mr. Rentsendorj ONON (Project Manager)	Road Policy Implementation and Coordination Department, MRT	Director General,
3	Mr. B.MANDAT	Road Policy Implementation and Coordination Department, MRT	Director, O&M Div.
4	Mr. N.SUGARJAV (MT/RR, MT/DB, CP/MP)	Road Policy Implementation and Coordination Department, MRT	O&M Div. Senior Specialist, Central Area
5	Mr. A.GANTULGA (MT/IE, MT/RR)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. North Area
6	Mr. C. MUNKHBAT	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. South Area
7	Ms. Ts.KHOSGEREL (MT/DB)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. Local Road
8	Ms. E. ENKHEMAA	Sstrategic Policy and Planning Department, MRT	Projects Programs and Foreign Cooperation Division
9	Mr. Kh.KHURELSUKH	Road Supervision and Research Center, MRT	Director, Construction and Maintenance Division
10	Mr. E.BAT-ORSHIKH (MT/DB)	Road Supervision and Research Center, MRT	Specialist, Construction and Maintenance Division
11	Mr. B. ENKHMANKH (MT/IE, MT/RR)	Ulaanbaatar City Road Department	ROD, Operation and Maintenance Division, Control Specialist
12	Mr. B.OLZBAYAR (MT/DB)	Ulaanbaatar City Road Department	Specialist, ROD, Planning and Research Div.

**2. Japanese Side**

<b>No.</b>	<b>Name</b>	<b>Organization</b>	<b>Position</b>
1	Mr. Yutaka WAKISAKA	JICA Mongolia Office	Representative
2	Ms. Ts. KHOROLSUREN	JICA Mongolia Office	Program Administrative Officer
3	Mr. Akio OKAZAKI	JICA Project Team	Team Leader
4	Mr. Tatsuo MUKOUYAMA	JICA Project Team	Expert
5	Mr. Minobu AOYAMA	JICA Project Team	Expert
6	Ms. Minami KATO	JICA Project Team	Expert

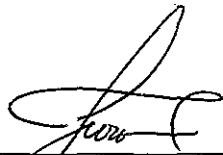
**Project for Capacity Development on Bridge Maintenance and Management in Mongolia**

**MINUTES OF MEETING  
ON  
2<sup>nd</sup> JOINT COORDINATING COMMITTEE**

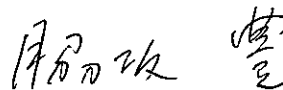
25 November, 2014

Joint Coordinating Committee (hereinafter referred to as "JCC") meeting on Project for Capacity Development on Bridge Maintenance and Management, Mongolia (hereinafter referred to as "the Project") was held on 25<sup>th</sup> November 2014 with attendance of JCC members representing the Ministry of Roads and Transportation (MRT), Ulaanbaatar City Government (UBC), Japan International Cooperation Agency (JICA), and members of the JICA Project Team to discuss schedule and progress of the Project based on 2<sup>nd</sup> Progress Report submitted by JICA Project Team in November 2014.

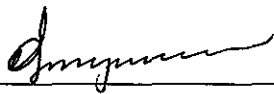
As a result of the discussions, the details are shown in ATTACHMENT 1, JCC members mutually accepted the Progress Report.



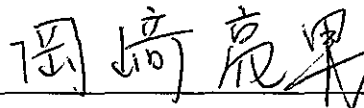
**Mr. Rentsendorj ONON**  
Director General  
Road Policy Implementation and  
Coordination Department  
Ministry of Roads and Transportation  
Mongolia



**Mr. Yutaka WAKISAKA**  
Representative  
Japan International Cooperation Agency  
Mongolia Office



**Mr. Dookhuu NANZADDORJ**  
Chairman Road Department  
Implementing Agency of the Capital City  
Governor



**Mr. Akio OKAZAKI**  
Team Leader of JICA Project Team  
Bridge Maintenance and Capacity  
Development Expert

## ATTACHMENT 1: DETAILS OF THE MEETING

### 1. The Progress Report

The Progress Report submitted by JICA Project Team and implementation policy of trainings in Phase-3 consists of following workshops and seminars were accepted through the JCC meeting.

- 1) In-house Workshop to introduce and share the know-how of bridge maintenance developed by the Project under the support of JICA Project Team.
- 2) Seminar for Road Maintenance Company and Engineering Organization related to bridge maintenance to introduce the manuals to be utilized for bridge maintenance management.
- 3) Public Seminar aimed at introduction of future activities on bridge maintenance management cycle to be implemented by MRT and UBC.

### 2. Schedule of Phase-3

- It was agreed by MRT, UBC and JICA Project Team that the detailed schedule and the program of training to be implemented by Mongolian side during Phase-3 in 2015 should be confirmed by the end of 2014.
- Seminars for Road Maintenance Company and Engineering Organization related to bridge maintenance may be jointly held by MRT and UBC in Ulaanbaatar City under the support of JICA Project Team.

### 3. Long-Mid Term Bridge Maintenance Management Plan

- Draft of Long-Mid Term Bridge Maintenance Management Plan submitted by JICA Project Team in September 2014 (hereinafter referred to as “the Plan”) was confirmed by MRT and UBC, and following comments were stated by representatives of MRT and UBC respectively.

MRT; The Cost Estimate should be confirmed more detail through supplemental workshop early in next year.

UBC; Approximately 1.0 Billion MNT has been applied to be allocated to bridge maintenance work such as rehabilitation and/or retrofitting in 2015, which would be able to suffice for the cost proposed by the Plan. Yearly budget allocation proposed in the Plan up to 2020 would be feasible for UBC.

- It was confirmed that the Master Trainers would examine the Plan to formalize it in their organizations within the project period. After due examination of Master Trainers, MRT and UBC shall submit written comments on the Plan to JICA Project Team for finalization of the Plan.

### 4. Approval of Manuals for Bridge Inspection, Soundness Evaluation and Selection of Rehabilitation and Retrofitting Measures

- Three (3) manuals for i) Bridge Inspection, ii) Soundness Evaluation and iii) Selection of Rehabilitation and Retrofitting Measures were discussed and principally approved by the Science and Technology Committee through the meeting held on 10<sup>th</sup> November 2014 prior to the approval by MRT.
- JICA Project Team was requested to respond in written to the comments stated by member of the committee such as errors in translation of technical terms and conformity with other manual prepared

by ADB in the past.

- MRT shall be responsible for photo-copy of the approved manuals, and for delivery the manuals to the concerned agencies.

**5. Others**

- It was agreed that the project information including workshops and seminars shall be disclosed on the official websites of MRT and UBC.
- It was also proposed that the project information would be introduced by quarterly of the Road Supervision and Research Center and/or publication of Mongolian Road Association.
- International Conference for 85 anniversary of Road Construction in Mongolia will be organized in January 2015, and JICA Project Team may be invited to the conference to introduce the Project.

**ATTACHMENT 2: LIST OF ATTENDEES**

**1. Mongolian Side**

No.	Name	Organization	Position
1	Mr. R. ONON (Project Manager)	Road Policy Implementation and Coordination Department, MRT	Director General
2	Mr. N. SUGARJAV (MT/RR, MT/DB, CP/MP)	Road Policy Implementation and Coordination Department, MRT	Senior Specialist, O&M Div. Central Area
3	Mr. S. MUNKHBAT (MT/IE, MT/RR)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. South Area
4	Ms. Ts. KHOSGEREL (MT/DB)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. Local Road
5	Mr. A. KHANBAYAR (MT/IE,RR)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. North Area
6	Mr. B. ENKHTULGA	Road Supervision and Research Center, MRT	Specialist, Construction and Maintenance Div.
7	Mr. Kh. BAYARTOGTOKH	Road Supervision and Research Center, MRT	Specialist, Construction and Maintenance Div.
8	Mr. D. TURBILEG	Ulaanbaatar City Road Department	Division Chief, Operation and Maintenance Div.
9	Mr. B. ENKHMANKH (MT/IE, MT/RR)	Ulaanbaatar City Road Department	Control Specialist, Operation and Maintenance Div.
10	Mr. G. KHASBAATAR	Ulaanbaatar City Road Department	Specialist for foreign relation and project, Administration Div.

**2. Japanese Side**

No.	Name	Organization	Position
1	Mr. Yutaka WAKISAKA	JICA Mongolia Office	Representative
2	Mr. Toshio KIMATA	JICA Expert	
3	Ms. Ts. KHOROLSUREN	JICA Mongolia Office	Program Administrative Officer
4	Mr. Akio OKAZAKI	JICA Project Team	Team Leader
5	Ms. Minami KATO	JICA Project Team	Expert

**Project for Capacity Development on Bridge Maintenance and Management in Mongolia**

**MINUTES OF MEETING  
ON  
3<sup>rd</sup> JOINT COORDINATING COMMITTEE**

17 September, 2015

Joint Coordinating Committee (hereinafter referred to as “JCC”) meeting on Project for Capacity Development on Bridge Maintenance and Management, Mongolia (hereinafter referred to as “the Project”) was held on 16<sup>th</sup> September 2015 with attendance of JCC members representing the Ministry of Roads and Transportation (MRT), Ulaanbaatar City Government (UBC), Japan International Cooperation Agency (JICA), and members of the JICA Project Team to inform outputs of the Project, and to close activities under the Project based on 3<sup>rd</sup> Progress Report submitted by JICA Project Team on 7<sup>th</sup> September, 2015.

As a result of the discussions, JCC members mutually accepted the Progress Report. The details of discussion are shown in ATTACHMENT 1.



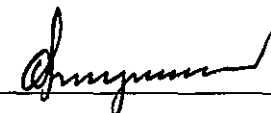
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**Ms. DORJKHAND Dashdorj**  
Director General  
Road Policy Implementation and  
Coordination Department  
Ministry of Roads and Transportation  
Mongolia



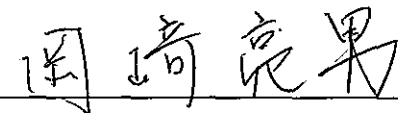
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**Mr. Keita IZUMI**  
Representative (Transport, Urban  
Development)  
Japan International Cooperation Agency  
Mongolia Office



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**Mr. Dookhuu NANZADDORJ**  
Chairman Road Department  
Implementing Agency of the Capital City  
Governor



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**Mr. Akio OKAZAKI**  
Team Leader and Bridge Maintenance and  
Capacity Development Expert  
JICA Project Team



## ATTACHMENT 1: DETAILS OF THE MEETING

### 1. The Progress Report

The Progress Report submitted by JICA Project Team including achievements in outputs of the Project was accepted through the JCC meeting with regard to following aspects.

- 1) Achievements in four (4) outputs were confirmed by means of Objectively Verifiable Indicators stipulated in PDM.
- 2) The Project activities were completed without significant delay in the implementation according to original schedule stipulated in the PDM.

### 2. Pilot Implementation of Actual Bridge Rehabilitation Works

- Technical assistance for the pilot implementation was successfully completed through the site seminars for concrete rehabilitation method and retrofitting method.
- The feasibility of the bridge rehabilitation works and retrofitting works introduced by the Project was confirmed in terms of engineering and economic aspects.

### 3. Achievement of the Project Reported by the Mongolian Side

- Four (4) times trainings for Road Maintenance Company at Hovd Aimag and Arhangai Aimag, Tuv Aimag and Hentii Aimag were conducted from 2014 to 2015 by MRT.
- Bridge maintenance manuals developed by the Project is significant output of the Project. The manuals will be improved through the bridge maintenance activity by Mongolian side.
- Project implementation aiming at the four outputs specified in PDM was efficiently accomplished. In addition, pilot implementation of bridge rehabilitation work in Ulaanbaatar City supported by the Project was successfully completed.

### 4. Certified Master Trainers

- Twelve (12) Master Trainers for Bridge Inspection and Evaluation, Bridge Rehabilitation and Retrofitting and Bridge Maintenance Database were respectively certified by JICA Project Team.
- It was confirmed that the Master Trainers should be in charge of activities related to bridge maintenance cycle and its technology transfer into each organizations.

### 5. Recommendations by JICA Project Team

MRT and UBC agreed following recommendations proposed by JICA Project Team.

- Manuals on bridge maintenance developed through the Project shall be periodically reviewed and updated to be sustainably used in Mongolia.
- It is important to continue the training and the engineering development to implement effective bridge maintenance cycle towards the Preventive Maintenance.
- Bridge Maintenance Database shall be maintained and updated through daily maintenance work by the Master Trainers and/or operators trained by the Master Trainers.
- Mid-Long Term Bridge Maintenance Plan formulated through the Project (the Plan) shall be regarded

as policy in respective organization revising based on periodic bridge inspection. MRT and UBC needs to ensure a stable maintenance budget to implement the bridge maintenance cycle in accordance with the Plan.

- Four (4) priority measures and policies proposed by the Plan, namely i) Improvement of the bridge design, ii) Improvement of Quality Control in Construction, iii) Enforcement of Overloaded Vehicle Control, and iv) Training of Engineer for Bridge Maintenance, shall be executed in parallel with bridge maintenance works.
- MRT and UBC need to not only continue in-house training for the bridge maintenance, but also establish the qualification system for bridge maintenance in corroboration with related agencies such as Mongolian Road Association to provide incentives to improve their engineering capacity for the bridge maintenance.

#### **6. Recommendations by JICA Office**

- The Master Trainers certified in the Project need to play as role models for the bridge maintenance and train other staff of their organization in the bridge maintenance activities.
- Budgetary allocation and assignment of sufficient staff to the bridge maintenance need to be ensured by the Government of MRT and UBC respectively for sustainable bridge maintenance and for economic development eventually.

#### **7. Others**

JICA Project Team supplementary informed following points related to succeeding activities after JCC meeting.

- Final Report for the Project would be prepared in Japan to be submitted to JICA by the beginning of December 2015.
- Project office provided by MRT will be handed over on 18<sup>th</sup> September 2015 after investigation of property management staff appointed by MRT.

**ATTACHMENT 2: LIST OF ATTENDEES**

**1. Mongolian Side**

No.	Name	Organization	Position
1	Ms. R. Dorjkhand	Road Policy Implementation and Coordination Department, MRT	Director General
2	Mr. N. SUGARJAV (MT/RR, MT/DB, CP/MP)	Road Policy Implementation and Coordination Department, MRT	Senior Specialist, O&M Div. Central Area
3	Mr. S. MUNKHBAT (MT/IE, MT/RR)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. South Area
4	Ms. B.GIIVIISHINEN (MT/DB)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. Local Road
5	Mr. L.BAYANZUL (MT/IE,RR)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. North Area
6	Mr. D.OYUNBILEG (MT/IE,RR)	Road Policy Implementation and Coordination Department, MRT	Specialist, O&M Div. North Area
7	Mr. B. ENKHTULGA	Road Supervision and Research Center, MRT	Specialist, Construction and Maintenance Div.
8	Mr. Kh. BAYARTOGTOKH	Road Supervision and Research Center, MRT	Specialist, Construction and Maintenance Div.
9	Mr. D. TURBILEG	Ulaanbaatar City Road Department	Division Chief, Operation and Maintenance Div.
10	Mr. G. KHASBAATAR	Ulaanbaatar City Road Department	Specialist for foreign relation and project, Administration Div.
11	Mr. B. ENKHSАIKHAN (MT/IE, MT/RR)	Ulaanbaatar City Road Department	Control Specialist, Operation and Maintenance Div.
12	Mr. B. ENKHMАNDАKH (MT/IE, MT/RR)	Ulaanbaatar City Road Department	Control Specialist, Operation and Maintenance Div.
13	Mr. B. OLZBAYAR (MT/IE, MT/RR)	Ulaanbaatar City Road Department	Control Specialist, Operation and Maintenance Div.

**2. Japanese Side**

No.	Name	Organization	Position
1	Mr. Keita IZUMI	JICA Mongolia Office	Representative (Transport, Urban Development)
2	Ms. Ts. KHOROLSUREN	JICA Mongolia Office	Program Administrative Officer
3	Mr. Akio OKAZAKI	JICA Project Team	Team Leader
4	Ms. Minami KATO	JICA Project Team	Capacity Assessment Specialist and Project Coordinator



**Appendix-5 Schedule of JICA Experts**



*Project for Capacity Development on Bridge Maintenance and  
Management in Mongolia  
Project Completion Report*

1) Short-term Experts

No.	Name	Expertise	Period from	Period to	Days	Total	Affiliation
1	Akio OKAZAKI	Team Leader Bridge Expert/Capacity Development	11-Aug-2013	9-Oct-2013	60 days	324 days	CTI Engineering International Co., Ltd.
			7-Dec-2013	21-Dec-2013	15 days		
			12-Feb-2014	13-Mar-2014	30 days		
			15-May-2014	28-Jun-2014	45 days		
			15-Aug-2014	16-Sep-2014	33 days		
			9-Nov-2014	28-Nov-2014	20 days		
			14-Dec-2014	20-Dec-2014	7 days		
			1-Feb-2015	28-Feb-2015	28 days		
			15-Apr-2015	15-May-2015	32 days		
2	Toshiyuki OKA	Bridge Expert	18-Aug-2013	6-Sep-2013	20 days	60 days	Central Nippon Expressway Co., Ltd.
			22-Oct-2013	30-Nov-2013	40 days		
3	Kei MAMIYA	Bridge Expert	15-May-2014	28-Jun-2014	45 days	90 days	Central Nippon Expressway Co., Ltd.
			22-Jul-2014	4-Sep-2014	45 days		
4	Minobu AOYAMA	Bridge Inspection	18-Aug-2013	11-Oct-2013	55 days	210 days	Central Nippon Expressway Co., Ltd.
			23-Feb-2014	19-Mar-2014	25 days		
			23-Apr-2014	9-Jun-2014	48 days		
			16-Jun-2014	5-Jul-2014	20 days		
			26-Aug-2014	26-Sep-2014	32 days		
23-Apr-2015	22-May-2015	30 days					
5	Yasufumi WATANABE	Bridge Inspection	23-Apr-2014	21-Jun-2014	60 days	60 days	CTI Engineering International Co., Ltd.
6	Tatsuo MUKOUYAMA	Bridge Rehabilitation	18-Aug-2013	16-Oct-2013	60 days	285 days	Oriental Consultants Global Co., Ltd.
			17-Feb-2014	28-Mar-2014	40 days		
			9-May-2014	2-Jul-2014	55 days		
			5-Dec-2014	19-Dec-2014	15 days		
			23-Jan-2015	21-Feb-2015	30 days		
			3-Apr-2015	29-Apr-2015	27 days		
			5-Jun-2015	3-Jul-2015	29 days		
31-Jul-2015	11-Sep-2015	43 days					
7	Yasuhiro SHIDA	Rehabilitation Work Supervisor (1)	10-Jun-2015	25-Jun-2015	16 days	35 days	CTI Engineering International Co., Ltd.
			18-Aug-2015	5-Sep-2015	19 days		
8	Yusuke HASEGAWA	Rehabilitation Work Supervisor (2)	21-Aug-2015	10-Sep-2015	21 days	21 days	CTI Engineering International Co., Ltd.
9	Keigo KUNIKATA	Bridge Database System	27-Aug-2013	25-Sep-2013	30 days	120 days	CTI Engineering International Co., Ltd.
			14-Apr-2014	12-Jun-2014	60 days		
			20-Apr-2015	19-May-2015	30 days		
10	Gantumur Burneebaatar	Bridge Database System	27-Aug-2013	25-Sep-2013	30 days	75 days	CTI Engineering International Co., Ltd.
			15-Apr-2014	29-May-2014	45 days		
11	Shuichi NISHI	Cost Estimator	30-May-2014	28-Jun-2014	30 days	105 days	CTI Engineering International Co., Ltd.
			1-Aug-2014	14-Sep-2014	45 days		
			7-Aug-2015	5-Sep-2015	30 days		
12	Yuji IDE	Bridge Retrofitting	27-Aug-2013	25-Sep-2013	30 days	60 days	CTI Engineering International Co., Ltd.
			7-Dec-2013	27-Dec-2013	21 days		
			11-Jan-2014	19-Jan-2014	9 days		
13	Yumi IWASHITA	Coordinator/Capacity Assessment	11-Aug-2013	10-Sep-2013	31 days	31 days	CTI Engineering International Co., Ltd.
14	Minami KATO	Coordinator/Capacity Assessment	19-Feb-2014	19-Mar-2014	29 days	89 days	CTI Engineering International Co., Ltd.
			9-Nov-2014	8-Dec-2014	30 days		
			22-Aug-2015	20-Sep-2015	30 days		
						1,389 days	

2) Long-term Experts

1	Toshio KIMATA	Bridge Operation and Maintenance Advisor	27-May-2014	26-July-2015	309 days	426 days	JICA
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**Appendix-6 List of Equipment transferred by the Project**



**Equipment List Transferred by JICA Expert Team**

<b>Name of Equipment</b>	<b>Model / Number</b>	<b>Quantity</b>	<b>Remarks</b>
Desk Top PC	Dell Optiplex 701n MT	2	MRT & UBC
Core Drilling	Diamond Coring Tool DD120	1	MRT
RC Radar	JRC NJJ-105	1	UBC
Bridge Inspection Camera	EASY CHECK CAMERA	1	MRT
Inspection Hummer	-	9	MRT & UBC
Crack Gauge	-	10	MRT & UBC



**Appendix-7 C/P Training in Japan**



[C/P Training in Japan]

Japan Training for counterparts was conducted twice in September 2014 and July 2015 in the Project, aiming at learning Japan technology of bridge rehabilitation and retrofitting. Schedule and contents and participants of the training are as follows.

Schedule for 1<sup>st</sup> Japan Training (13days; September 2014)

Date	Time	Contents	Place
Sep 12, Fri	9:00 ~ 12:00	Briefing session	Tokyo International Center (TIC)
	13:00 ~ 14:00	Program orientation	
	15:00 ~ 16:30	Lecture on the bridge management policy of Ministry of Land, Infrastructure and Transport / Partial revisions of the Road Traffic Law	
Sep 13, Sat	10:00 ~ 12:00	Presentation of current status of bridges in Mongolia	CTI Engineering International Co., Ltd.
	15:35 ~ 16:15	Bridges observation in Tokyo	Tokyo
Sep 14, Sun	9:00 ~ 17:00	Material organization	
Sep 15, Mon	10:00 ~ 14:00	Tokyo ⇒ Nagoya	
Sep 16, Tue	9:30 ~ 11:00	Visit bridge inspection facility for practical training (N2U Bridge)	Central Nippon Expressway Co., Ltd.
	13:00 ~ 16:00	Visit to bridge construction site	
Sep 17, Wed	9:30 ~ 12:00	Lecture on manufacturing technology of concrete girder	Abe Nikko Kogyo Co., Ltd.
	13:30 ~ 16:30	Lecture on bridge management by industry, government and academia	Gifu University
Sep 18, Thu	14:00 ~ 14:30	Courtesy call	Civil Engineering Research Institute for Cold Region (CERI)
	14:30 ~ 15:30	Lecture on damage and design/ rehabilitation in cold region	
	15:30 ~ 16:00	Visit to facilities in CERI	
Sep 19, Fri	10:00 ~ 12:00	Lecture on road maintenance by the municipality in cold region (Hokkaido)	CTI Engineering Co., Ltd. (Hokkaido Office)
	13:00 ~ 16:00	Visit to Bridge in Hokkaido	Hokkaido
Sep 20, Sat	9:00 ~ 15:00	Hokkaido ⇒ Tokyo	
Sep 21, Sun	9:00 ~ 17:00	Material organization	
Sep 22, Mon	10:00 ~ 12:00	Lecture on infrastructure management utilizing information communication technology	Tokyo Metropolitan Public Corporation for Road Improvement and Management
	14:00 ~ 16:00	Lecture on bridge management by the municipality	Machida City
Sep 23, Tue	9:30 ~ 12:00	Lecture on bridge asset management	CTI Engineering Co., Ltd. (Headquarters)
	14:00 ~ 17:00	Preparation for evaluation meeting	TIC
Sep 24, Wed	9:30 ~ 12:00	Evaluation meeting	TIC

### Contents of 1<sup>st</sup> Japan Training

Category	Contents
1. Acquire basic knowledge to establish a program for preventive and planned management	Lecture on road maintenance in cold region
	Lecture on kind of damage and method of design and rehabilitation in cold region
	Lecture on infrastructure management utilizing information communication technology
	Lecture on bridge management by the municipality
	Lecture on bridge asset management
	Visit Shin-Tomei Expressway and lecture on the technology of the bridge construction
2. Learn Japan rules and systems related to road and traffic for establishment of management program	Visit concrete girder manufacturing factory
	Lecture on the bridge management policy of Ministry of Land, Infrastructure and Transport / Partial revisions of the Road Traffic Law
	Visit bridge inspection facility for practical training (N2U Bridge)
	Lecture on engineers development for bridge management by industry, government and academia

### Member List of 1<sup>st</sup> Japan Training

Organization	Name	Position
Ministry of Roads and Transportation (MRT)	N.Sugarjav	Senior Expert, Road Transport Implementation and Coordination Department
	S.Munkhbat	Expert, Road Transport Implementation and Coordination Department
	Ts.Khosgerel	Expert, Road Transport Implementation and Coordination Department
	E.Bat-Orshikh	Expert, Roads and Transportation Development Center
Ulaanbaatar City (UBC)	D.Turbileg	Director, Road Department, Operation and Maintenance Division
	B.Enkhmandakh	Expert, Road Department, Operation and Maintenance Division
	B.Olzbayar	Expert, Road Department, Planning and Research Division



Schedule for 2<sup>nd</sup> Japan Training (9 days; July 2015)

Date	Time	Type	Contents	Place
July 16, Thu	9:00 ~ 12:00		Briefing session	Tokyo International Center (TIC)
	14:00 ~ 16:00	Visit	Visit the site of seismic reinforcing work of Horikiri Bridge	Sato and Kajima Renovate Joint Venture
July 17, Fri	9:00 ~ 11:00	Visit	Visit renewal work of Tobu-Isesaki Line (seismic reinforcing work of overpass)	Kajima Corporation
	14:00 ~ 15:00	Visit	Visit Communication Plaza Kawasaki	Communication Plaza Kawasaki
	15:15 ~ 15:45		Visit Ebina Service Area	Ebina Service Area
	15:45 ~ 16:45		Visit Tomei Expressway, Metropolitan Inter-City Expressway, Chuo Expressway	
July 18, Sat			Material organization	
July 19, Sun			( No training )	
July 20, Mon	13:30 ~ 15:00	Visit	Visit Nex Plaza	Nex Plaza
	15:30 ~ 16:30	Visit	Visit Nagoya Castle	
July 21, Tue	10:10 ~ 11:00	Visit	Visit the site of concrete fraking prevention work	Ichinomiya-Kisogawa Overpass
	13:00 ~ 16:00	Visit	Visit Meiko Triton and Meishin Expressway	
July 22, Wed	9:00 ~ 10:30	Lecture	Lecture on characteristic of CFRP sheet and method of design and construction	Toray Industries, Inc.
	10:30 ~ 12:00	Training	Practical training of construction work	
	12:00 ~ 13:00		Visit showroom	
	13:00 ~ 15:00	Training	Practical training of construction work	
	15:00 ~ 16:00	Visit	Visit material test laboratory	
July 23, Thu	9:30 ~ 11:00	Visit	Visit CFRP sheet manufacturing factory	SO-WA TEXTILE Co., Ltd.
	11:30 ~ 12:00	Visit	Visit the site of bridge rehabilitation work on Kanazawa Tatsuruhama Line of Ishikawa Prefectural Road	Work site of Kanazawa Tatsuruhama Line
July 24, Fri	9:00 ~ 12:00		Evaluation meeting	

### Contents of 2<sup>nd</sup> Japan Training

Category	Contents	
Improve bridge rehabilitation and retrofitting skill	Seismic reinforcing work of Horikiri Bridge	<ul style="list-style-type: none"> <li>• RC girder retrofitting work</li> <li>• Bearing replacing work</li> </ul>
	Seismic reinforcing work of overpass on Tobu-Isesaki Line	<ul style="list-style-type: none"> <li>• Sheet pile retrofitting work</li> <li>• Overlaying retrofitting work</li> </ul>
	Concrete structures rehabilitation work	Site visit of seismic reinforcing work of concrete structures
	Retrofitting method using CFRP sheet	Practical training of construction work using CFRP sheet
	Bridge rehabilitation work on Kanazawa Tatsuruhama Line	Site visit of retrofitting work using CFRP sheet
Develop an understanding the characteristic and quality control of materials for bridge rehabilitation and retrofitting	Characteristic of CFRP sheet and method of design and construction	Lecture on rehabilitation and retrofitting of bridges using CFRP sheet
	Material test	Visit of quality control test demonstration
	CFRP sheet weaving	Visit of carbon fiber textile factory
Consider application capability of Japan technology for infrastructure development in Mongolia	Japanese expressway	Visit of Communication Plaza Kawasaki
	Maintenance of Steel Bridge (Meiko Triton)	Design, construction and management of a cable stayed steel bridge in consideration of earthquake resistance

### Member List of 2<sup>nd</sup> Japan Training

Organization	Name	Position
Ministry of Roads and Transportation (MRT)	Kh. Oyunbileg	Expert, Road Transport Implementation and Coordination Department
	N. Enkhtulga	Expert, Roads and Transportation Development Center
	B. Giiviishinen	Expert, Road Transport Implementation and Coordination Department
	Kh. Bayartogtokh	Senior Expert, Road Network Management, Construction, Inspection Division, Roads and Transportation Development Center
	L. Bayanzul	Engineer, Capacity Development on Sustainable Bridge Maintenance and Management Project
Ulaanbaatar City (UBC)	L. Mendbayar	Chief, Road Department, Material Research Laboratory
	B. Enhkhmandakh	Expert, Road Department, Operation and Maintenance Division
	B. Enhsaikhan	Expert, Road Department, Planning and Research Division